

International Council For Scientific Development
INTERNATIONAL ACADEMY OF SCIENCE
H&E



SCIENCE WITHOUT BORDERS

Transactions
of the International Academy of Science
H&E

Volume 7
2023-2024



ISBN 978-9952-451-09-2

Innsbruck



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**Transactions
of the International Academy of Science
H&E**

**Volume 7
2023/2024**

Dedicated to the 20th anniversary of the Azerbaijan Section
of the International Academy of Sciences

Innsbruck – 2024



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**Science Without Borders. Transactions of the International Academy of Science H&E.
2023/2024. Vol. 7, Innsbruck, SWB, 2024, 350p.**

In the book are published the transactions of full members and corresponding members of the International Council For Scientific Development/International Academy of Science H&E, and the articles, presented by Academicians of ICSD/IAS H&E. The content of the book is multidisciplinary and covers the main spheres of modern natural technical and humanitarian sciences.

During selecting the articles to the book, the special priority was given to scientific researches, which are at the joint of different sciences.

This book is of interest for wide circles of scientists and students in different spheres of science.

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ISSN 2070-0334

ISBN 978-9952-451-09-2



Innsbruck – 2024

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FOREWORD

The seventh volume of the multidisciplinary book “Science without borders. Transactions of the International Academy of Science, H&E, 2023/2024”, has 31 scientific articles.

In the book are represented the articles of famous scientists from Azerbaijan, Russia, Kazakhstan, Georgia, Japan, North Ossetia.

This book solves one of the main problems of ICSD/IAS H&E the exchange of scientific information and uniting of efforts of different scientists of the world for solving of the most actual problems of humanity. The book consists of eight parts: multidisciplinary researches; medicine and biology; physical-mathematical sciences; agricultural sciences; earth sciences and ecology; humanitariansciences; architecture and construction; oil industry and chemical sciences.

Full members (Academicians) and Corresponding Members of IAS H&E from national sections of different countries have published their scientific articles in this book. Besides, there are the articles of scientists, recommended by Academicians of IAS H&E.

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MEDICINE AND BIOLOGY

LICORICE (*Glycyrrhizaglabra* L.) FITOCOMPOSITION ON THE CONFER ONCOPREVENTIVE AND ONCOTHERAPEUTIC EFFECTS

**Valiyeva M.N., Valiyev P.M., Madatli F.İ., Musayeva S.E.,
Yaqubova S.Q., Cafarli E.Z.**

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Abstract

Licorice (*Glycyrrhizaglabra* L.) is a national treasure of Azerbaijan, since the species growing in our country are distinguished by a high content of glycyrrhizin acid (up to 24%), which makes them indispensable in the fight against viral infections.

Scientific studies of licorice have revealed its lymphotropic, anti-inflammatory, antiviral, antibacterial, antitumor anti-oxidant, antidiabetic, antiasthmatic, immunomodulatory, gastroprotective, hepatoprotective, neuroprotective, cardioprotective properties.

The antitumor properties of licorice have been known since ancient times. Scientific research has confirmed the discoveries of ancient healers. Due to their antioxidant properties, licorice extracts have an antitumor effect. Licorice polysaccharides have immunomodulatory and pronounced antitumor properties. Licochalcone A of licorice root inhibits the process of metastasis of malignant tumors. Licorice contains phytoestrogens, due to which it has an antitumor effect on certain types of tumors. Licoricidin and glabridin from licorice inhibit the process of metastasis of breast cancer cells to the lungs and skeletal system. Glabridin inhibits the process of metastasis of hepatocellular carcinoma cells. The protein fraction of licorice root extract has a detrimental effect on colon cancer cells. A meta-analysis showed that the consumption of licorice root preparations prevents and has a therapeutic effect on nausea and vomiting that occurs during tumor on the confer oncopreventive and oncotherapeutic effects. A vital role in tumor proliferation and metastasis to play is considered angiogenesis or neovascularization. In tumors, angiogenesis is intervened by targeting numerous markers that regulate angiogenesis and are considered proangiogenic factors, such as matrix metalloproteinases and basic fibroblast growth factor. These angiogenesis markers have a broader spectrum

of target cells which play an essential role in angiogenesis. In a hypoxic condition, tumor cells cause the release of proangiogenic factors, such as epidermal growth factor insulin-like growth factor-1 and transforming growth factor- β 1, within the tumor. In tumor cells, is the main angiogenic activator that stimulates angiogenesis via binding to. Therefore, according to literature, targeting these pathways' inhibitors in angiogenesis by herbal plant extract and isolated phytoconstituents was considered an anticancer treatment approach with clinical importance.

Key words: licorice, cancer, cell cycle, angiogenesis, nano-preparation oncopreventive, onkoterepevtik effects.

The extract of *Glycyrrhiza glabra* used to treat mice with Ehrlich ascites tumor cells showed a reduction in the level of cytokines and decreased vascular endothelial growth factor revealing its angioinhibitory potential. is a potent constituent of licorice having various biological properties, such as anti-inflammatory, antiangiogenic and antitumor effects. Licochalcone A was reported for its apoptosis inducing potential in prostate cancer via modulating the protein expression of Bcl-2. Licochalcone A inhibits the process of angiogenesis and tumorigenesis both in vitro and in vivo by regulating the signaling of VEGFR-2. In addition, Licochalcone A also reduced the vessel formation by endothelial cells as well invasion and migration via modulating the expression of MMP-9, and plasminogen activators.¹⁵⁵ In a study, Jiang et al¹⁵⁶ reported that glabridin, a potent constituent of *Licorice*, has anticancer potential as it inhibits the migration, invasion and angiogenesis of human breast cancer cells by modulating the FAK/Rho signaling pathway. Glycyrrhizin isolated from the roots of *Glycyrrhizaglabra* inhibited the metastasis and survival of tumor by modulating the levels of onco-suppressor which led to apoptosis and showed antiangiogenetic effect.

Metastasis is a multistep process that contributes to the spread of cancer cells to distant organs of the body through blood or the lymphatic system, resulting in death in cancer patients. Targeting metastasis is an attractive strategy in the management of progression and development of cancer. According to literature, various in vitro and in vivo models showed that natural bioactive compounds, including those from *Glycyrrhizaglabra*, have antimetastatic potential including Matrix metalloproteinases and urokinase plasminogen activator play a significant role in the metastasis process by degrading extracellular matrix of cancerous cells as well as modulating the mechanism of angiogenesis in the maintenance of tumor cell survivability. PS are degradation enzymes that modulate numerous physiological processes, such as cell growth, differentiation and apoptosis. However, overexpression of

MMP-2 and MMP-9 is linked with prooncogenic events, such as neoangiogenesis, tumor cell proliferation, and metastasis. In addition to Furthermore, once cancer cells develop a more invasive nature, they can enter blood and spread to distant regions, resulting in metastasis. Tumor cells that have moved to a secondary site can either go into metastatic dormancy or stimulate angiogenesis and start growing new blood vessels. Hence, to control the mechanism of metastasis, targeting oncogenic molecular pathways by natural phytoconstituents is an important therapeutic approach.

Licorice is extensively used as an herbal medicine in Azerbaijan to treat gastric, liver, and respiratory problems and different types of cancers, and to reduce the toxicity caused by other herbs. Licorice glabra and its flavonoids show more potential effect against various cancers when used in conjunction with other anticancer drugs. Numerous studies have been conducted to investigate the role of Licorice glabra and other anticancer drugs individually in various cancers. These chemotherapeutic drugs showed great potential in the treatment of a diverse range of cancers, on the other hand, they also exert side effects to the normal cells and induce toxicity. But when the researchers used anticancer drugs, such as paclitaxel, cisplatin, and gemcitabine in combination with licorice, it inhibited the side effects by protecting the normal cells from toxicity along with enhancing anticancer potential. Table 1, 2 show the synergistic effects of Licorice with other anticancer drugs both in vitro, and in vivo.

Table1.
In vitro effect of LicoricePhypreparations with Various Anticancer Drugs

| № | Licorice(Glycyrrhizaglabra) fitopreparation | TypeofCancer | CellLines |
|----------|--|-------------------------|---------------------|
| 1 | Liquiritigenin | Melanoma | B16F10 |
| 2 | Glycyrrhizin | Hepatocellularcarcinoma | Huh7 |
| 3 | Licochalcone-A | Leukemia, breastcancer | MCF-7 and HL-60 |
| 4 | Licochalcone-A | Ovariancancer | OVCAR-3 and SK-OV-3 |
| 5 | Isoliquiritigenin | Cervicalcancer | U14 |

Nanotechnology Studies of Bioactive Constituents of Licorice (Glycyrrhizaglabra L.) in Cancer.

Nanotherapeutics (1–100 nm) have been shown to overcome the shortcomings of conventional treatments, such as unwanted side effects on rapidly growing healthy cells, non-specific targeting and distribution, dose-

dependent toxicity, and multi-drug resistance. They possess enhanced target-specificity, increased permeability and retention time of the drug in the cancer cells, improved biocompatibility, and decreased dose of the drug which together contribute to reduced toxicity. Nanoparticles possess various limitations, thereby shifting the focus of formulation sciences to natural compounds-based nanoparticles which would increase targeting efficiency to cancer cells and lower the rate of clearance.

Table 2.
In vivo Effect of Licorice (*Glycyrrhizaglabra* L.) with Various Anticancer Drugs

| No | Metabolites of Licorice | Type of Cancer | Model | Antitumor Effects |
|----|-------------------------|-----------------|----------------------------|---|
| 1 | Liquiritigenin | Melanoma | Female C57 BL/6 black mice | Suppressed cell migration and cell invasion |
| 2 | Licoricidin | Osteosarcoma | Female BALB/c nude mice | Enhanced cytotoxicity |
| 3 | Licochalcone A | Colon carcinoma | BALB/c mice | Suppressed cell proliferation |
| 4 | Isoliquiritigenin | Cervical Cancer | KM mice | Suppressed cell proliferation |

This is further supported by various advantages, such as increased patient compliance (with peroral administration), less extensive metabolic by-products and subsequent higher bioavailability. As summarized in Table 3, various nanoformulations containing licorice and its bioactive compounds were developed and tested against specific cancer types and results from these studies have been listed. Various cell line studies, as evidenced by Table 3, have focused on hepatic carcinoma due to the abundance of glycyrrhetic acid receptors which are over-expressed on hepatocytes making it a viable targeting options. These have been explored due to the limitations of conventional therapies as mentioned above. The results from cell line studies need to be tested in animal models to confirm the efficacy and safety of the drug or formulation under study. The studies listed in represent the intratumor studies conducted thereby helping to uncover the tremendous potential possessed by

these nanoformulations in the chemotherapeutic field. Our thorough search revealed that although there were *in vitro* and *in vivo* studies carried out for isoangustone A, licochalcone A and licochalcone E as anticancer molecules, there were no studies conducted for these molecules in the nanotherapeutics domain. The difficulties encountered during the manufacturing of these medications as nanotherapeutics could be one of the factors limiting their usage as anticancer moieties. The findings suggest that these compounds could be developed into viable anticancer nanomedicines in the future. As a result, the findings can be extended, implying that they have a lot of potential for future clinical research. More research is needed to overcome the problems of nanoformulations and generate reliable medicines with few adverse effects.

Table 3.
In vitro Studies of Nanoformulations of Licorice(*Glycyrrhizaglabra L.*)

| № | Nanoformulations of Licorice | CellLine | MainResults |
|---|----------------------------------|--------------------------------------|---|
| 1 | Glycyrrhiza acid alginatenanogel | Murine macrophage cell line | Activation and invasion by macrophages averted due to the presence of glycyrrhizin Cells retained the normal morphology, less nitric oxide production Reduced IL-6 and tumor necrosis factor- α expression Reduced phagocytosis of drug |
| | | Hepatocellular carcinoma HepG2 cells | Confirmed pathway of endocytosis and active liver targeting which increased nanogel particle phagocytic intake Decreased cell viability and increased cell toxicity, apoptosis due to reduced efflux activity of p-glycoprotein, upregulation of caspase-3 mRNA and a high Bax/Bcl-2 ratio |

| | | | |
|---|---|---|--|
| 2 | Glycyrrhiza acid nano-liposomes | Human hepatocellular carcinoma HepG2 cells and fibroblast cells | Decreased IC ₅₀ value and increased cytotoxicity (10x) than respective free drugs Synergistic action of silibinin in presence of GA |
| 3 | Glycyrrhiza acid Nano-micelles formulated as solid dispersion using tannic acid and disodium glycyrrhizin | Human hepatocellular carcinoma HepG2 cells | Increased cell inhibition and cell apoptosis activity compared to free drug Tannic acid inhibited P-gp glycoprotein efflux activity thereby increasing cellular drug uptake |
| 4 | Glycyrrhizin Conjugated Dendrimer and Multi-Walled Carbon Nanotubes | Human hepatocellular carcinoma HepG2 cells | Reduction in IC ₅₀ value of the drug compared to formulations without glycyrrhizin and free drug Increased cytotoxicity due to increased drug intake via receptor mediated endocytosis Dendrimers (more apoptotic cells) are more effective carriers than nanotubes (more necrotic cells) when attached with glycyrrhizin |
| 5 | GA-conjugated human serum albumin nanoparticles | Hepatocellular carcinoma HepG2 cells | Concentration dependent uptake |
| 6 | Valerate- conjugated chitosan nanoparticles surface modified with glycyrrhizin | Hepatocellular carcinoma HepG2 cells | Increased cytotoxicity due to glycyrrhizin receptor mediated intake of drug |
| 7 | Glycyrrhetic acid-modified hyaluronic acid nanoparticles | Human HepG2 cells, L02, Bel-7402 and MCF-7 cells | Absorption into HepG2 in a time dependent manner Targeting efficiency: HepG2>L02>MCF-7 Inhibition of colony formation in time and |

| | | | |
|----|---|---|--|
| | | | dose dependent manner Induced apoptosis in cancer cells thus inhibiting proliferation of cancer cells |
| 8 | Glycyrrhetic acid-modified hyaluronic acid nanoparticles | HepG2 cells and Human breast cancer MCF7 cells | More uptake by HepG2 than MCF7 cells Decrease in IC50 values and cell viability compared to free drug Inhibition of colony formation of HepG2 cells in time and dose dependent manner Increased apoptosis and deformed morphology |
| 9 | Hyaluronic acid-glycyrrhetic acid conjugated nanoparticles | Hepatocellular carcinoma HepG2 cells | Increased cleavage in presence of glutathione Rapid intracellular release and nuclear delivery of drug compared to standard of care conventional formulations |
| 10 | Glycyrrhetic acid-modified curcumin supramolecular hydrogel | Hepatocellular carcinoma HepG2 and Mouse fibroblast 3T3 cells | Reduced IC50 values Greater targeting efficiency Higher cellular uptake due to pro-gel formulation approach |
| 11 | Glycyrrhetic Acid Functionalized Graphene Oxide | Human hepatocellular carcinoma HepG2 cells, normal human hepatic L02 cells, and rat cardiac muscle H9c2 cells | Targeting efficiency: HepG2>L02>H9c2 Taken via endocytosis and delivered to mitochondria Decreased the potential difference of mitochondrial membrane which in turn opened up mitochondrial permeability transition pore to initiate a series of responses and leads to caspase-3 activation |

| | | | necessary for apoptosis |
|--------|---|---|--|
| 1 2 | Glycyrrhetic acid-functionalized mesoporous silica nanoparticles | Hepatocellular carcinoma HepG2 cells | Higher cytotoxicity compared to curcumin loaded mesoporous silica nanoparticles Receptor mediated endocytosis intake of drug Increased rate of apoptosis |
| 1 3 | Dual-functional (modified with glycyrrhetic acid and L-histidine) hyaluronic acid nanoparticles | Hepatocellular carcinoma HepG2 cells | Decrease in IC50 values Increased drug distribution in cytoplasm and nuclear regions Receptor mediated endocytosis intake of drug |
| 1 4 | Nano-suspension | A549 lungcancercells | Increased apoptosis at 7.5 to 10-fold Less cytotoxic to healthy cells |
| 1 5 | Isoliquiritigenin-iRGDnanoparticles | Human breast cancer cell lines (MDA-MB231 and MCF7) and mouse breast cancer cell line (4T1) | MCF7 cells showed better inhibition than free drug but not better than isoliquiritigenin nanoparticles MDA-MB231 and 4T1 showed better inhibition than isoliquiritigenin nanoparticles formulation and free drug Increased apoptosis compared to free drug and nanoparticles due to high rates of cellular drug uptake |
| 1 6 | Isoliquiritigeninloadednanolip osomes | HCT116, SW620 and HT29 colorectal cancer cell lines | Better inhibition compared to free drug Increased rate of apoptosis Decreased uptake of glucose and lactic acid Reduced oxygen consumption led to |

| | | |
|--|--|--|
| | | reduced adenosine triphosphate synthesis Decreased Akt/mTOR expression which is important for tumor progression |
|--|--|--|

In general, licorice products are considered to have no hazard to the public and are utilized widely in food (ice cream, candies, chewing gums, and beverages), cosmetics (toothpaste) and tobacco as flavoring and sweetening agents. However, before licorice extract or any of its individual components can enter into clinical oncological practice, due to their strong pharmacological activities, their safety must be verified thoroughly and systematically, paying special attention to the dosage and duration of the treatment. Several studies have indeed warranted for the toxicity of licorice depending on its dosage and duration. Actually, chronic licorice intake was shown to induce a condition comparable to that found in primary hyperaldosteronism, while licorice overconsumption resulted in hypermineralocorticoidism characterized by salt and water retention, hypertension, hypokalemia, metabolic alkalosis, and suppression of the renin-aldosterone system. Biochemical evidence suggests that licorice and its phytochemicals, particularly glycyrrhizinates, can reversibly block the cortisol-inactivating enzyme, 11β -hydroxysteroid dehydrogenase, thereby producing hypermineralocorticoid-like effects. In addition, based on a case report, excessive consumption of licorice may also lead to toxic consequences in the form of thrombocytopenia. Therefore, health care providers should be aware of the hazardous consequences related to chronic and excessive intake of licorice extracts to be able to prevent worsening of these symptoms when detected early. Furthermore, caution must be exercised when using licorice during pregnancy, as heavy licorice consumption has been associated with lower gestational age and preterm delivery in humans. Accordingly, the main challenge in exploiting the promising anticancer activities of licorice constituents in clinical settings primarily lies on its appropriate dosing, besides targeted delivery to malignant sites, inducing minimal adverse reactions in normal healthy tissues. It is highly expected that future experimental studies with nano-sized carriers will provide a strong base for overcoming these challenges by virtue of modern nano-technological methods.

Several clinical trials conducted with licorice products have also reported glycyrrhizin-related complications, such as elevated blood pressure due to increasing extracellular fluid volume and large artery stiffness, and reduced serum potassium levels. However, other clinical trials (mostly on the gastrointestinal disorders) have suggested diverse healing properties of licorice preparations without exerting any observable adverse effects. A clinical stage II preliminary trial revealed that licorice root extract in combination with docetaxel works in treating patients with hormonal therapy resistant metastatic prostate tumors. Similarly, licochalcone A and paclitaxel have been shown to increase natural cell death and apoptosis in OSCC tumors.

Our present review describes anticancer potential of the phytoconstituents of *G. glabra* along with synergistic chemotherapeutic insight. Traditionally, licorice has been utilized as a sweetening and flavoring agent for food items. Roots of licorice are reported to possess strong therapeutic potential to reduce inflammation and cancer progression. Among the reported phytoconstituents, the flavonoids and terpenoids are the major therapeutically active molecules. The *in vitro* and *in vivo* data presented in the current review article clearly show the strong potential of licorice-derived phytochemicals from the classes of triterpenes, chalcones and isoflavones in the fight against different types of cancer. Despite potential therapeutic importance of these effects, several obstacles, such as toxic reactions observed with excessive consumption, have impeded moving on with clinical trials. It is highly expected that surpassing these bottlenecks by using modern nanotechnological methods might lead us to expansion of the current anticancer arsenal. In addition, as licorice constituents possess a wide range of molecular targets in cancer, they might be helpful in preventing drug resistance. Therefore, synergistic mechanistic insight of licorice-derived phytoconstituents and conventional chemotherapeutic drugs should be further explored. There are few human studies available and more randomized controlled trials are needed to measure the effectiveness of licorice-based cancer treatment. The story of licorice reflects a fascinating example of how an ancient herbal medicine can be introduced as a drug into clinical settings, after intensive efforts in elucidating its constituents and molecular mechanisms behind their various bioactivities.

Conclusions

1. Licorice, being one of the leading medicinal plants in medicine, has been used for many years in the treatment of oncological diseases, which has been proven by numerous experimental works carried out in different countries.
2. Conducted nanotechnological works on the study of biologically active substances of licorice opened the possibility of using them as components of

effective antitumor molecules that significantly exceed the action of these same substances introduced in traditional dosage forms.

3. The introduction of licorice components into the anticancer drug should be preceded by toxicological and biopharmaceutical studies that will allow selection of the necessary dosage, determination of the functional role in the molecule and targeted delivery to malignant sites.

4. Taking into account the huge platform for cultivation and processing of licorice in Azerbaijan, it is expected that future experimental studies using nanotechnological methods to obtain nanoparticle carriers of this plant will enable their subsequent introduction into the treatment of serious oncological diseases and increase the survival rate of the population.

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A MODERN VIEW ON INNOVATIVE METHODS FOR THE TREATMENT OF BACKGROUND AND PRECANCEROUS DISEASES IN WOMEN

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In the modern world, a world of high technology and advanced progressive innovations, the state of human health holds significant and fundamental importance. This issue is particularly relevant for women, as gynecological cancers continue to be a pressing concern today. Special attention is given not only to the treatment of cervical cancer (CC) but also to its early detection [14; 16]. According to WHO materials, the incidence of CC is 14 cases per 100,000 inhabitants, and the mortality rate is 6.8 per 100,000 inhabitants; 87% of these deaths occur in developing countries [36]. Among all gynecological cancers, CC ranks second after endometrial cancer (EC). According to European data, CC ranks seventh among female cancers. According to statistical data, cervical cancer (CC) ranks fourth in the world. The risk group includes women aged 35 to 55. In Eastern European countries, over the past 10 years, there has been an increase in the number of patients with stage IV malignant cervical lesions from 37.1% to 47.3%. CC is considered one of the most common malignant tumors [32; 33; 34; 36; 43; 45]. According to WHO data, annually more than 500,000 women worldwide are diagnosed with CC, with a mortality rate of about 200,000 women. In developing countries, the incidence of CC ranks first among cancers, while in economically developed countries, it ranks third [36; 43; 47]. In Africa, Central and South America, and Asia (excluding Japan), CC accounts for 20-30% of all female oncological pathology, whereas in North Africa, Australia, Northern and Western Europe, it accounts for 4-6% [27; 29; 30; 31; 36; 43; 44; 45]. In Russia, cervical cancer (CC) ranks fifth in the structure of malignant neoplasm incidence. The one-year mortality rate remains high at 20.3% from the moment of diagnosis, indicating late diagnosis and sometimes inadequate treatment. In 70-80% of cases, squamous cell carcinoma is diagnosed, in 10-20% adenocarcinoma, and in 10% poorly differentiated cancer [11; 27; 29; 30; 31; 36; 43; 44; 45]. The development of CC is preceded by the emergence and progression of

precancerous processes known as dysplasia and leukoplakia. The WHO identifies three categories [32; 36; 47]. Atypical transformation of the squamous epithelium of the cervix without stromal invasion is regarded as cervical dysplasia, which is thus a precancerous condition. Cervical dysplasia may not cause any clinical symptoms but has the ability to progress, ultimately leading to the development of CC. However, if detected and treated in a timely manner, the precancerous process is reversible and does not lead to the development of CC. A prognostically unfavorable aspect is the transition of the tumor from locally infiltrative to manifest forms, as CC metastasizes both lymphogenously and hematogenously. Treatment and survival prognosis depend on the early detection of the disease. Approximately 90% of deaths from cervical cancer (CC) are registered in countries with low and middle income [27; 29; 32; 33; 34; 42; 47]. It is important to note that most cases of CC are caused by the human papillomavirus (HPV). Conducting targeted diagnostics for CC is of particular importance, as early detection of pathological changes helps prevent the transformation into an oncological process. The diagnosis of CC is based on the following examinations: gynecological examination, HPV testing, bacteriological testing, colposcopy, cytological Pap smear, cervical canal scraping, and cervical biopsy. Cytological examination allows for the detection of early pathological processes. Today, the primary and indisputable diagnostic method in the early stages of CC is colposcopy.

Issues related to the treatment of cervical cancer (CC) remain relevant, especially in the early stages of the pathological process. Undoubtedly, precancerous lesions of the cervix are treated with cryotherapy and laser surgery. Biopsy allows determining the degree of lesion and the stage of cancer. It is important to note that the stage of the oncological process depends on the extent of the spread. At stage zero, precancerous cells are present on the surface of the cervix. These cells are removed under local anesthesia. At stage I (CIN I), the tumor in the cervix may invade the uterus and nearby lymph nodes. At stage II (CIN II), cancer spreads beyond the cervix to the upper part of the vagina. In stage II, radiation therapy is performed along with surgical intervention. At stage III (CIN III), the tumor affects the lower vagina, pelvic walls, and may block the ureters. In stage III, radiation therapy is combined with chemotherapy. At stage IV (CIN IV), the process spreads to the rectum, bladder, or distant organs. In stage IV, radiation and palliative therapy are administered [12; 13; 14]. Thus, surgical methods, radiation therapy, and chemotherapy are used to treat cervical cancer (CC). Recurrences of the disease are possible. In case of recurrence, chemotherapy is administered. Radiation

therapy uses high-energy rays to destroy cancer cells. Undoubtedly, early diagnosis and HPV vaccination play a key role in reducing mortality from CC. It is especially important to emphasize that if the disease is detected at stage zero or stage I, the cure rate ranges from 80% to 100%. The choice of CC treatment is determined individually and depends on the extent of the process and the severity of concomitant pathology [12; 13]. Currently, the possibilities of drug therapy and chemoradiation therapy are being actively studied. Surgical methods for treating CC have been used for over 100 years. In 1902, Austrian gynecologist E. Wertheim first performed radical surgical interventions for CC. In his monograph "The Extended Abdominal Operation for Cancer of the Cervix," E. Wertheim described the results of 500 extended hysterectomies [26]. It is important to note that the development of cervical cancer (CC) is often associated with viral infections, particularly human papillomavirus (HPV) infection [22]. The main feature of this viral infection is its ability to cause productive infection, transforming cells without reproduction, ultimately leading to cell death. The clinical manifestations of HPV infection are characterized by a wide polymorphism, asymptomatic and subclinical courses. What is the difficulty? This question concerns many researchers. It may be related to the high cost of laboratory diagnostics and the challenges in choosing treatment strategies, which require the search for innovative and effective methods aimed at preserving women's reproductive health and quality of life. The unresolved issues related to the management of patients with oncogenic viral diseases often lead to unreasonable and, in some cases, aggressive treatment, which frequently results in long-term complications. Therefore, an important and relevant aspect is the implementation of innovative, effective, and safe treatment methods in clinical practice in obstetrics and gynecology. It is important to emphasize that there is no single etiological therapy for treating HPV infections. It has been established that the treatment of patients with manifest forms of HPV should be comprehensive and include various methods aimed at the destruction of lesions. The second component of this therapy involves the administration of immunotropic agents, and possibly natural sorbents with adsorptive and immunomodulating properties. In this regard, the adsorptive capabilities of papillomaviruses on the natural sorbent zeolite have been studied [1; 4; 5; 8; 17-20; 26; 28].

What is zeolite? What role does it play for the human body? Zeolites are a group of natural minerals with sedimentary-volcanic origin [25; 26]. Zeolite is a crystalline hydrated aluminosilicate. The distinctive feature of these compounds is their structure, which is characterized by internal porosity (see fig. 1).

Scientifically proven, zeolites are capable of adsorbing cations and molecules of many substances, which is why they are referred to as the "stone of the XXI century" and the "stone of life" [5; 25; 26; 35; 37-41; 46]. What is the popularity of this natural mineral zeolite associated with? Apparently, the popularity of this mineral is explained by its physicochemical properties, thanks to which zeolite can replace most of the known medicines in science [2; 5; 6; 8; 10; 15; 17-20; 37; 38].

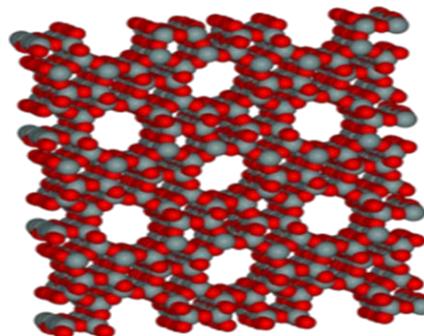


Fig. 1. Micro-porous molecular structure of zeolite

According to Khalilova T.S., Sadykhova F.A., Velieva M.N. et al., it has been shown that an important property of zeolite is that its porous structure remains intact under any conditions [17; 26]. Therefore, it is called a "molecular sieve" capable of eliminating substances foreign to the body, thanks to the microcrystalline lattice of the mineral [5; 8; 15; 17; 26; 35; 39].

It should be noted that zeolite contains almost the entire periodic table of elements by Mendeleev, namely, this mineral consists of about 84 different elements [8; 26]. With molecular-sized pores, zeolite is capable of "absorbing" and retaining radionuclides, heavy metals such as cadmium, strontium, chromium, lead, as well as nitrites, nitrates, ammonium salts, and so on. The adsorbing and unique natural antioxidant properties of zeolite allow its widespread use in medicine.

Let's consider some micro- and macro-elements that are part of natural zeolites [2; 6; 7; 8; 15; 23; 26; 28]. For example, iron (Fe), which is part of natural zeolite, is involved in the composition of a number of enzymes, participates in oxidation-reduction reactions, in the construction of the hemoglobin (Hb) molecule, and contributes to the transportation of oxygen (O_2)

in tissues. Iron is a cofactor of the enzyme catalase, which breaks down hydrogen peroxide. It is important to note that iron has the ability to initiate free radical reactions. The next element contained in zeolite is zinc (Zn), which is part of a number of enzymes and hormones, making it an essential mineral.

According to WHO data, over 2 billion people on the planet suffer from chronic zinc deficiency. It is known that zinc deficiency can cause irreversible health consequences. Zinc participates in stabilizing the functioning of all systems and organs, forms strong immunity, and contributes to hormone secretion. It is considered a powerful intracellular antioxidant. Zinc does not interact with active forms of oxygen (ROS) and, thanks to certain mechanisms leading to the activation of low molecular weight metallothionein proteins, it prevents oxidative stress; regulates the level of the enzyme superoxide dismutase, thereby causing the breakdown of the superoxide radical; prevents the oxidation of sulphydryl groups. Zinc is not synthesized in the human body, and its deficiency likely contributes to the development of many chronic diseases. The next element included in natural zeolites is copper. Copper (Cu) is a cofactor for a number of enzymes, influencing processes that contribute to the activation of metallothioneins; it also activates antioxidant pathways and initiates free radical reactions. Selenium (Se) is also included in the composition of zeolites, which contributes to the body's protection against oxidative stress through the enzyme glutathione peroxidase. This enzyme catalyzes the reduction of hydrogen peroxide to water and oxidized lipids to alcohols. Natural zeolites contain cations of elements from Groups I and II of the periodic table of Mendeleev, including sodium, calcium, potassium, magnesium, etc.

Summarizing the above, it can be concluded that zeolite possesses unique properties of selective ion exchange, supplying the body with missing macro-, micro-, ultramicro-, nano-, and pico-elements, and is a safe, non-toxic mineral. By atomic adsorption method, more than 25 different elements (Mg, Mn, Fe, Co, Cu, Ni, Zn, Cr, Ti, K, Na, Cl, S, Si, F, J, Se, etc.) have been identified in the composition of zeolite. The ion-exchange properties of zeolite consist in its ability to regulate the balance of microelements in the body, normalizing all ongoing biochemical processes in cells and tissues. It is known that hundreds and thousands of different biochemical reactions occur in cells. It is important to note that silicon is a key element supplied by zeolite. Silicon (Si) is the main element that prolongs the life and efficiency of almost all systems in the body. In 1978, in Stockholm, the Nobel Committee recognized silicon as an element of life. Silicon is a piezoelement, converting one form of energy into another, for example, mechanical into electrical, light into heat. Silicon has the property of "sticking" viruses, pathogenic microorganisms to itself. Silicon is also necessary for the formation of collagen, participates in the biosynthesis of

keratin, connective tissue, and cartilage. It is necessary for maintaining the elasticity of arteries, thereby playing a role in preventing cardiovascular diseases. Silicon is essential for the normal functioning of the skin's surface layer, mucous membranes, and connective tissue. In case of silicon deficiency in the body, the balance of energy supply and metabolism is disrupted. This is probably due to the fact that silicon deficiency contributes to the non-absorption of more than 70 chemical elements. As a result, the composition of liquid media in the body changes, and their properties as electrolytes do not meet the requirements for the normal functioning of the body's biosystem, ultimately leading to the onset of diseases. It has been proven that silicon is responsible for 38% of our body's health. This element stimulates DNA biosynthesis and, due to its chemical properties, creates electronically charged systems. The next microelement included in the composition of natural zeolite is selenium (Se). What is the role of selenium in the human body? Selenium is involved in the composition of more than 200 hormones and enzymes of the body, regulating the function of all organs and systems. With its participation, 80% of the energy (ATP) is produced in humans, serving as a cofactor for enzymes in antioxidant protection, participating in the neutralization of free radicals, the excess of which leads to premature aging and skin diseases. Selenium possesses cytoprotective properties, participates in tissue elasticity regulation, contributes to the increased activity of non-specific defense factors of the body, and prevents the development of secondary infections. It is an essential part of the glutathione peroxidase enzyme system, influencing the activity of the glutathione peroxidase enzyme (glutathione), which protects the body from harmful substances formed during toxin breakdown. Also, the enzyme glutathione peroxidase protects intracellular structures from the damaging effects of free oxygen radicals formed during metabolism. Selenium is one of the most important components in initiating the body's antioxidant defense process, enhances immunity, prevents tumor development, and contributes to the normal functioning of the endocrine and nervous systems. It is important to note that vitamins, flavonoids, and coenzymes cannot replace selenium in the body. Selenium is part of glutathione peroxidase, an enzyme that neutralizes dangerous and aggressive free radicals that other antioxidants cannot cope with. It is known that the intake of the plant form (selenium methionine) slows down and postpones the aging process, which is apparently associated with increased activity of stem cells. The role of selenium in the prevention and treatment of malignant neoplasms is well known. Selenium deficiency leads not only to suppression of the body's antioxidant defense system but also to a decrease in immune system function, contributes to the development of cardiovascular and oncological diseases, accumulation of heavy metals, premature aging, development of diabetes, joint diseases, male infertility, and female

reproductive weakness. Danish scientists have found that selenium prevents the development of heart and artery diseases, and its deficiency increases the risk of coronary heart disease by 70%. Selenium prevents liver damage and necrosis, facilitating the elimination of heavy metals from the body. Allergic diseases and the risk of developing bronchial asthma are also closely related to selenium metabolism. In Finland, after introducing selenium into the population's diet, the number of cardiovascular pathologies decreased by 2.5 times, the number of oncological diseases decreased by 1.8 times, and endocrine system diseases decreased by 77%. Another important element in the composition of zeolite is calcium (Ca), which is an antagonist to silicon. In case of silicon deficiency in the body, Ca²⁺ replaces it, making the blood vessel walls fragile. Magnesium (Mg) is also part of natural zeolites and acts as a cofactor for several enzymes. Sulfur (S) found in zeolites is present in amino acids involved in the formation of keratogialin, keratin, and other skin components. A deficiency of sulfur disrupts the function of sebaceous glands. Sodium (Na) and potassium (K) - both elements present in zeolites - help maintain water balance in cells and intercellular spaces and regulate the skin's hydration. It is well known that many diseases develop due to imbalances in the human body. Natural zeolites, with their crystalline structure, have the ability to eliminate harmful substances by replacing them with essential substances for the body. Scientists have proven that this mineral acts as a bioregulator, normalizing the interaction between free radicals entering the body from the outside and antioxidants that suppress the negative effects of nano-, ultra-, micro-, and macroelements that disrupt the human immune system [2; 5; 6; 8; 10; 15; 17-20; 26; 37; 38; 46]. Numerous studies have shown that zeolites are used for the treatment and prevention of a wide range of diseases and pathologies, positively affecting the body's functional state. Specifically, zeolite reduces tumors and improves chemotherapy tolerance; prevents obesity and hair loss; facilitates the rapid alleviation of clinical manifestations of musculoskeletal disorders; and endocrine system diseases [5; 6; 8; 10; 15; 17-20; 37; 38; 39-42]. The question naturally arises: why are zeolites in such demand in medicine? As it is known, most diseases are caused by the disruption of the primary structure of DNA. When radicals enter the body, they gradually alter the structure of carbohydrates, proteins, and lipids contained in healthy cells, depriving them of electrons. In turn, zeolite forms a crystalline lattice that attracts toxic substances like chlorides and ammonia, as well as binds radicals, blocking their proliferation and preventing their free movement throughout the body. The resulting compounds of radicals and zeolite molecules are excreted through the gastrointestinal tract, and healthy minerals appear in their place, supporting the tissues and cells of internal organs in normal functional activity. Thus, there is a

continuous metabolism of minerals, the production of necessary hormones is stimulated, and the functioning of the thyroid and pancreas is stabilized.

It is now proven that zeolite can significantly improve the recovery process of patients with radiation sickness, alleviate the effects of chemotherapy, and reduce the likelihood of developing oncological diseases [17; 20; 23; 24; 26; 28; 35]. Additionally, the mineral promotes faster healing of wounds and burns, as well as paralysis, so many doctors recommend its use as a preventive measure. It has been demonstrated that zeolites can treat many diseases. Specifically, they contribute to increasing the effectiveness in treating various infectious diseases, including viral infections, improving the treatment of tuberculosis and reducing its development, as well as diseases of the gastrointestinal tract (such as gastritis, heartburn, etc.). The effectiveness of zeolites has also been noted in the treatment of various gum diseases, bleeding, and periodontal disease [18]. The effectiveness of zeolite at the cellular level has been noted, enhancing immunity and the body's resistance. Additionally, positive effects of natural zeolite include improved productivity and endurance, skin rejuvenation and softening, stress reduction, memory enhancement, improved cognitive function, vision improvement, cavity prevention, rapid removal of toxic substances, and prevention of damage to the gastric and intestinal mucosa from food poisoning. The properties of natural zeolites and their application in dermatology have also been studied [17].

The effectiveness of zeolite in treating neurodermatitis, eczema, psoriasis, and other inflammatory skin conditions has been noted, as well as its efficacy in treating skeletal and muscular system disorders, osteoporosis, and degenerative joint changes. It also normalizes the function of the autonomic nervous system in vegetovascular diseases [19]. Natural zeolites possess catalytic, ion exchange, and sorption properties, exhibit high selectivity in absorption, and can separate ions and molecules of various substances based on size. Moreover, zeolites are non-toxic, harmless to human health, and have no side effects. However, the growing interest in the "stone of life" is leading to the development of alternative medicine in the form of various preparations and medications. These are gaining increasing recognition from patients, who report positive effects in combating viruses, strengthening the body's immune system, accelerating metabolism, and removing heavy metals and toxins, including radioactive ones, from the body. Examples are given of treatment for tumors, prevention of viruses, including the most well-known ones: HIV, HPV, H1N1, etc. [20; 21; 22; 23; 24; 26].

Undoubtedly, the above raises a lot of questions, but considering the crystalline structure, chemical composition of zeolite, its regulatory function in the mineral homeostasis of the human body, as well as its properties as a "molecular sponge," its justified application in oncoviral diseases is quite

possible [9; 12; 17; 21; 23; 24; 26; 35]. As mentioned above, zeolite restores mineral homeostasis, thereby contributing to the elimination of the root causes of many diseases, stimulating the T-cell arm of immunity, activating the process of lymphocyte proliferation, and increasing the resistance of blood cells to the effects of toxic substances [19; 20; 21; 26; 28; 35; 41; 42].

The unique ion exchange properties of natural zeolites allow them to remove various toxic substances, heavy and radioactive metals from the body, and to block enzyme systems of pathogenic bacteria, viruses, fungi, making them valuable for restoring normal homeostasis and treating many diseases. It is well known that micro- and macro-elements play an important role in human nutrition in everyday life. Over the course of 10 years, medical-biological and clinical studies of natural zeolites have been conducted. Being a natural mineral, zeolite contributes to strengthening the immune system, preventing infections, inhibiting and halting the development of inflammatory processes, and possesses antioxidant properties by binding free radicals. The antioxidant properties of natural zeolites allow them to be successfully used in cosmetology. Zeolites are included in the composition of face creams [17]. Zeolites have adsorption, exchange, molecular-sieve, and catalytic properties.

Thus, in the article "On the Epidemiology and Treatment of Papillomavirus Infection in Azerbaijan" by Sadykhova F.E., Eyvazova S.A., and Khalilova T.Sh., published in the scientific work "Application of Natural Zeolites in Dermatology and Cosmetology" [pages 18-21, 2012], the effectiveness of using a zeolite-containing compound - the drug "Azeomed" - in the complex treatment of HPV caused by the papillomavirus type 6 was studied [17]. The authors conducted titration of the papillomavirus with determination of the virus hemagglutination titer: the experiment used the transplantable tissue culture L-20B (mouse fibroblast cells) using methods of cultivating transplantable tissues on MEM nutrient medium with glutamine. The adsorption capabilities of papillomaviruses on the natural sorbent - zeolite, presented in the form of tablets "Azeomed," were investigated [17].

The results of the conducted studies revealed the adsorption of the papillomavirus on the natural zeolite-containing sorbent "Azeomed," as a result of which the authors applied this sorbent in the form of powder to the wound surface after the surgical removal of papillomas caused by HPV. The authors note that the treatment method applied had anti-inflammatory and regenerative effects, reduced pain, itching, and also contributed to shortening the healing period [17].

Authors Sadykhova F.A., Eyvazova S.A., and Khalilova T.Sh. identified the fact of papillomavirus adsorption on a natural zeolite-containing sorbent. The method provided anti-inflammatory regenerative effects, reduced pain, itching, and shortened the healing period. The data obtained on the adsorption

of papillomavirus on the natural sorbent - zeolite-containing compound "Azeomed" may serve as a basis for further research into the use of zeolite as an adsorbent for the viral population during the productive phase of infections [23; 24; 26]. It is necessary to note that the composition of "Azeomed" consists of zeolite - a biologically active natural mineral (from the Aydag deposit in the Tausky district of Azerbaijan) [23; 24; 26; 46]. In the article "Results of combined treatment of patients with papillomavirus infections using natural mineral zeolite-containing sorbent "Azeomed" in combination with basic therapy" published in the scientific work "Application of natural zeolites in dermatology and cosmetology" [17] by authors Sadykhova F.E., Eyyazova S.A., Khalilova T.Sh. [pages 22-24, 2012], the effectiveness of the zeolite-containing compound "Azeomed" in the complex treatment of PVI was investigated. The authors administered zeolite to 40 patients with PVI at a dose of 500 mg twice a day. According to the authors' recommendations, the use of the drug "Azeomed" in the complex treatment of PVI helped reduce the likelihood of recurrence of PVI. The authors indicate that zeolites have detoxifying, immunomodulatory, and radioprotective effects, which justified their use in the treatment of oncological diseases. Additionally, authors Sadykhova F.A., Kakhramanova Kh.T., Khalilov E.N. identified adsorption-desorption capabilities of modified zeolite - the drug "Azeomed" concerning malignant cells, which provides a basis to assume their potential use as sorbents for malignant cells during tumor decay and their removal from the body [20]. The authors believe that the method of complex treatment, including the natural sorbent "Azeomed," provides anti-inflammatory, regenerative effects, reduces the frequency of recurrences without side effects.

It is worth noting that there are about 2000 enzymes, which constitute one-third of the enzyme system of the body and are activated by the influence of micro- and macro-elements. Therefore, the balance of not only minerals but also micro- and macro-elements is disrupted under the influence of papillomaviruses. It is also important to emphasize that the anticancer effect is associated with the ability of zeolite to bind to the p21 gene, which not only stops the development of cancer cells but also destroys tumors [27; 40].

Zeolite also possesses cytotoxic lympho-hemosorptive action. Authors Lyubarsky M.S., Pleshakov V.P., Shevela A.I. first used natural zeolite in the form of finely dispersed powder in a mixture with proteolytic enzymes, which was named "Proteol," for treating purulent-necrotic wounds [10]. Bogomolov N.I. introduced natural zeolite into surgery for wound treatment [3].

The essence of Bogomolov's method was as follows: a container made of synthetic fabric filled with granules of crushed zeolitic tuff saturated with a solution of sodium hypochlorite was placed on the surface of the wounds. The average time for wound cleansing using this technique was 3.7 ± 0.2 days,

shorter ($p<0.05$) than with traditional treatment methods, allowing for the acceleration of early secondary sutures. The authors consider the hematocorpitive properties of zeolite to be its most important quality [3].

Thus, zeolite adsorbs various proteins, inhibits the growth of cancer cells in vitro and in vivo, hinders DNA synthesis in oncocytes, induces apoptosis (programmed cell death) of all tumor cells, adsorbs nitrogen oxide, adsorbs cations of carbon compounds in an anhydrous environment, causing blockage, which enhances the creation of resistance to tumor formation in the body, improves the transport of bioactive molecules, and prevents the absorption of free radicals. Therefore, the above indicates the need for further research into the use of natural zeolite mineral in the treatment of background and precancerous conditions in women.

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INFLUENCE OF CYTOMEGALIA VIRUS ON THE CENTRAL NERVOUS SYSTEM IN NEWBORN CHILDREN

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Key words: *cytomegalovirus infection, newborn infants, central nervous system.*

Introduction

In modern clinical medicine, cytomegalovirus infection (CMVI) is becoming increasingly relevant [1-5]. As a cause of mortality in moncausal disease genesis or as a concurrent disease, CMVI ranks fourth after influenza, herpes, and adenovirus. According to WHO materials, in developing countries, 90-100% of the population is infected with cytomegalovirus (CMV) during childhood. The European Regional Office of the WHO has classified CMVI as one of the diseases that will shape the future of infectious pathology. The relevance of CMVI is due to its widespread prevalence among pregnant women, high morbidity and mortality among children, and the wide range of clinical and pathological variants. The frequency of generalized forms of this disease, according to autopsy data, ranges from 2.2% among children who died at the age of 7-30 days to 63.4% among children who died in their first year of life. CMVI is classified as an "opportunistic" infection, the clinical

manifestation of which becomes possible only in the presence of primary or secondary immunodeficiency. In terms of impact, CMVI is second only to the AIDS virus. CMVI often proceeds asymptotically, which is especially dangerous during pregnancy. It is possible that the outcome of this asymptomatic infection can have serious consequences for the fetus: antenatal fetal death, spontaneous miscarriages, perinatal mortality, congenital defects, and developmental abnormalities. According to the literature, perinatally acquired CMVI can cause mental retardation in children and a decrease in their intellectual development quotient. It is also known that the virus can persist in the body of an infected person for life. It is quite possible that clinical manifest chronic pathology in the mother leads to intrauterine infection, which may cause CMVI in newborns. This is evidenced by several studies. For instance, the article "Congenital Cytomegalovirus Infection: Prenatal Diagnosis and Treatment of Newborns," published in 2020 by Barton, M.; Forrester, A.M.; McDonald, J., shows that CMVI has a negative impact on children's health [1]. The authors highlight the significant number of cases of asymptomatic infection at birth and the possible late consequences for children, such as hearing and vision problems, and delayed psychomotor development. Many complications and fatalities are also associated with primary maternal infection. In primary CMVI during pregnancy, the transmission rate of the cytomegalovirus to the fetus varies from 15% to 50% of cases. The mechanisms of immune system disorders in CMVI are also of significant interest. It is believed that a high titer of anti-CMV antibodies in pregnant women can have an unfavorable prognostic significance for the fetus, but by crossing the placenta, they also protect the fetus from infection. Intrauterine infection with CMV in women with primary CMVI during pregnancy reaches 30-50%. CMV has a teratogenic effect: exposure to this virus can cause damage to the central nervous system (CNS) in newborns. The rate of prenatal mortality due to CNS damage in the fetus and newborn reaches 45.3%. Opinions on this matter vary. It is believed that in 98-99% of cases, congenital CMVI at birth may have an asymptomatic subclinical nature but can also be associated with irreversible CNS damage. Therefore, our goal is to determine the impact of the CMV on the CNS in newborns. Therefore, consideration of intrauterine CMV infection in newborns and the characteristics of clinical and diagnostic aspects of central nervous system damage is relevant and informative for modern neonatal and pediatric practice.

Materials and Methods

A comprehensive examination of 284 newborn children and their mothers suspected of intrauterine CMV infection, aged from 1 day to 1 month, was carried out. CMV infection was detected in 110 (38.6%) newborns. CMV diagnosis was carried out as follows: cytological method (detection of specific

cells like "owl eye" in saliva secretion, urine in newborn babies and saliva secretion, urine and breast milk in mothers). Immune-enzyme method (IFA) - determination of specific anti-CMV full-term newborns antibodies of IgM class and peripheral blood IgG in newborns and their mothers; in some mothers and newborns, CMVI diagnosis was performed using polymerase chain reaction (PCR) to detect viral DNA in cell homogenies from blood, urine and saliva. Laboratory and clinical studies (blood, urine, etc.) and instrumental studies (X-Ray, ultrasound of brain and internal organs, dopplerographic studies and ECG studies conducted. According to the testimony, the children were examined by a neuropathologist, oculist and cardiologist. Diagnosis of CMV infection in mothers: Specific antibodies to the CMG virus IgM (-) and IgG (-) - seronegativity, a virus is absent in a female body, there is no threat for normal fetation. IgM(+) and IgG (-) - primary infection, active, acute CMVI. IgM (-) and IgG (+) - the CMVI latent form. The risk of development of secondary reactivation depends on a condition of the immune system. IgM (+) and IgG (+) - reactivation of the CMVI latent form. Diagnosis of CMV infection in newborns: specific antibodies to the CMG virus: IgM (+) and IgG (-) - congenital active CMVI in a newborn (congenital CMVI can be dissociated from intra- and postnatal in serological study in the first 3 weeks of the baby's life). IgM (-) and IgG (+) - Does not indicate the infection of the baby, which is due to the presence of maternal antibodies in the child. IgG is informative: 1) a one-stage blood test of the mother and child in the first months of life allows us to exclude the presence of a congenital infection in the child if the titers of antiviral IgG antibodies are lower than those of the mother. This is due to the catabolism of maternal Ig in the child's body with a half-life of 21 days. 2) For the same reason, the absence of congenital infections can be indicated by a 2-fold decrease in maternal IgG antibodies in the baby in the first months of life. These 2 approaches have limitations due to the fact that these patterns exclude infection of the child during childbirth or shortly after birth. Statistical processing was carried out using the software package "STATISTICA-6", graphs were constructed using "ORIGIN-7". Differences between the data were considered significant at $p<0.05$ and ($p<0.01$, $p<0.001$), which meets the requirements of biomedical research.

Results and Discussion

According to the study, CMV infection was detected in 110, which corresponds to 38.6% of newborn children. Anamnesis analysis showed that most children were born to mothers till 72(65.5%) 35 years old and the rest were over 35 years old 38(34.5%). According to the statistics, the percentage of infection in the first childbirth was – 36(32.7%). This percentage for women

who had more childbirth was 74(67.2%). Male newborns 51(46.3%); Female - 59 (53.6%). On the basis of clinical and laboratory data, as well as taking into account the history of the mother, newborn children were divided into 3 main groups: group I - newborns with an active form of CMVI n=32; group II - newborns with an inactive form of CMVI n=38; group III - newborns with a resident form of CMVI n=40. Among extragenital diseases in mothers, the following were identified: anemia – 28(25.4%); acute respiratory disease – 21(19.09%); hypertension – 21(19.09%); nephropathy – 15(13.63%); neurosis - 14(12.7%). Among the gynecological diseases in mothers, the following were identified: chronic inflammatory diseases of appendages – 6(5.45%); dysfunction of ovaries - 14 (12.72%); colpitis - 20 (18.2%); an erosion of a neck of the uterus – 19(17.3%); endometritis - 7 (6.4%); infertility - 7(6.4%). Characterizing the reproductive function of mothers, it should be noted: spontaneous abortions – 11(10%); stillbirth - 15 (13.6%); birth of children with various developmental defects – 12(10.9%); children died from previous pregnancies in infancy – 20(18.2%) cases, respectively. Aggravating factors in the mother's medical history: arterial hypertension in pregnancy – 77(70%); threat of premature birth – 25(22.7%); oligohydroamnions– 32(29%); oligohydramnios, polyhydramnios – 30(27.8%); dirty turbid amniotic fluid - in 17(15.5%) cases, respectively. The clinical signs of CMV infection observed in newborns were diverse, highlighting the multifaceted and polymorphic nature of this viral infection. An analysis of the clinical features of CMV infection in infants showed that involvement of the central nervous system (CNS) with various syndromes is characteristic of CMV infection: hypertensive syndrome (34.7% in group I, 17.5% and 10.5% in groups III and II, respectively), seizure syndrome (21.9% in group I, 15% in group III, respectively) ($p<0.05$). Hydrocephalic syndrome was observed in 12.5% of newborns in group III, and in 6.2% and 2.6% in groups I and II, respectively ($p<0.05$). Perinatal post-hypoxic CNS damage accounted for 75% of cases in group I, and 47.5% and 36.8% of cases in groups III and II, respectively ($p<0.05$). Microcephaly and craniosynostosis were observed in 10% of group III, compared to 7.9% in group II and 6.2% in group I. Intracranial hemorrhages of grades I-IV were most common in newborns of group I – 25% of cases, 22.5% and 7.9% of cases in groups III and II, respectively. Congenital hydrocephalus was observed in 7.5% of cases in group III. Cysts and brain calcifications were found in newborns with the residual form of CMV infection in 22.5% of cases. Neurosonographic studies of the brain in newborns revealed that among the features of CMV in children with CMV, a high balance of gross organic forms of brain damage should be noted: congenital hydrocephaly of 7.5%; periventricular and intraventricular pseudocysts – 11.7%; cysts in a thalamus of 1.8% and a calcifications of a brain of 9%, a microcephaly, craniostenosis - 10%. In the

course of the researches central nervous system at newborn children with CMVI also Arnold's syndrome – Kiari (Fig.1 A,B), combined with congenital occlusal hydrocephaly, heavy degree ventricle dilatation and existence defects of development of lumbar and sacral area - "spina bifida" was revealed subependimalny to a zone at the left 9x6 mm; on the right 11x6.5 mm blood clots (Fig. 2,3). Morphologic and functional immaturity of a brain hemorrhage of the I drade; periventricular leucomalacia. The strengthened pulsation of brain vessels, crescent and symmetric dilatation of side ventricles, the increased echogenicity of periventricular area, expansion of side ventricles, at the level of frontal horns, at the level of bodies, intracranial hemorrhages in periventricular area. The neurologic signs at newborns was observed from the first days.

Doppler studies showed: In 6.2% of children with hydrocephaly significant increase in the index of resistance of vessels is revealed. Blood-groove speed on brain arteries was increased, and minimum - is reduced. This results from the fact that ventricular dilatation leads to stretching of arteries and reduction of their gleam.

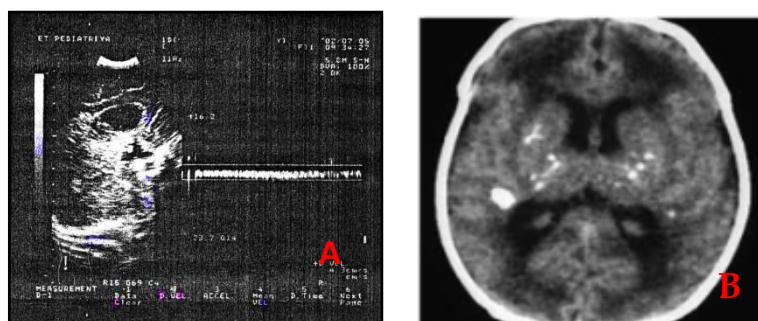


Fig.1 (A,B) Occlusion hydrocephalus, Arnold-Kiari syndrome in a newborn 11 days old (Fig. A; B)



Fig. 2. Subcortical cyst in newborn age 13 days

Fig. 3. Dilatation of side III-IV ventricles (heavy degree) of a brain, disturbance of a brain blood-groove. The occlusal hydrocephaly (progressing)

At children with intracranial hemorrhage delay of a blood-groove was noted, is more often on an average brain artery, and indicators of the index of resistance raised. At 14 (12.7%) children with post-hypoxic encephalopathy and hemisyndromy acceleration of the maximum linear speed of a blood-groove on the struck party were observed. The clinical presentation of visceral lesions varied. The disease mainly manifested in the bronchopulmonary system: 71.9% in newborns of group I, and 22.5% and 18.4% of cases in infants of groups III and II, respectively ($p<0.05$). It is important to note that newborns with the active form of CMV infection were characterized by severe acute bilateral bronchopneumonia with respiratory distress syndrome, while those with the residual form exhibited mild focal, unilateral bronchopneumonia of moderate severity with a subacute course. Bronchopulmonary disease was observed from the first days of life and was accompanied by CNS involvement. Cardiovascular system involvement was also observed in children with both active and residual forms of CMV infection. Specifically, mitral valve prolapse (anterior leaflet) was seen in 8.3% of cases, patent foramen ovale in 12.5%, and ventricular septal defect in 7.5% of cases, respectively. Hepatobiliary system involvement was observed in all newborns across the compared groups. Fetal hepatitis was observed in 18.7% of infants in group I and in 10% of newborns in group II. The incidence of congenital biliary tract anomalies was 2.5% in infants with the residual form of CMV infection and manifested as biliary atresia, hypoplasia of intrahepatic and extrahepatic bile ducts, liver dystrophy, and vascular system abnormalities of the liver, including portal vein anomaly and angiomatic transformation of the portal vein, confirmed by ultrasound and Doppler studies. It is important to emphasize that hepatobiliary system involvement was also accompanied by central nervous system involvement. Ophthalmopathology was observed in 12.5% of cases, mainly in children with the residual form of CMV infection. Thus, intrauterine infection of the fetus with cytomegalovirus infection is an urgent problem for all pediatrics in general. Changes in the central nervous system and in other systems and organs prove the seriousness of this problem from the point of view of both structural and functional damage to the nervous system of the fetus and newborn who have suffered the influence of pregnancy pathology in a mother with CMV.

Conclusion

The infection rate of cytomegalovirus among newborns with perinatal pathology and their mothers is 38.7%, indicating the etiological significance in the development of perinatal pathology. A significant difference in the health status of newborns depending on the form of CMV infection in mothers was identified. Particularly severe disorders were found in newborns born to

mothers with the residual and persistent forms of CMV infection. Newborns typically exhibit generalized CMV infection with multi-organ involvement and polymorphic clinical manifestations: CNS involvement of varying severity (100%), hepatobiliary system involvement (46.3%), respiratory tract involvement (42.7%), eye involvement (12.5%), cardiovascular system involvement (12.5%), and congenital malformations (10%).

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PHARMACOTECHNOLOGY OF PHYTOCOMPOSITIONS WIDELY USED IN TRICHOLOGY ON THE BASIS OF GLYCRRHIZA GLABRA

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Abstract

Every day, hair is exposed to harmful external influences: aggressive cosmetics, styling, blow-drying, ultraviolet radiation, etc. This provokes loss of

shine, weakness, fragility and other problems. Moderate hair loss is completely normal. Normally, a person loses about 100 hairs every day. If this figure is significantly exceeded, we can talk about the development of pathological processes. According to statistics, 60-70% of men and 25-40% of women face the problem of hair loss. As a rule, with age, or under the influence of internal factors (for example, albinism), hair changes its structure. The production of melanin is disrupted, and a large number of air bubbles appear. As a result, the hair takes on a silvery or yellowish-white hue.

In this article we will tell you about phytocompositions that will quickly improve their condition.

Key words: *Cosmetics, hair, herbal formulation, alopecia, Glycyrrhiza glabra*

1. Natural hair coloring

In modern times, dyes of synthetic origin are mostly used for hair coloring. They, in turn, are fixed either directly by dyes or by the oxidation of dyes (the dyeing effect occurs only in the presence of an oxidizing agent).

The use of synthetic dyes can cause allergies in a number of people. For this reason, in order to reduce the likelihood of allergic reactions, a special interest has arisen in herbal coloring agents.

The invention is known as a hair coloring agent in the form of a powder, containing various parts of the *Impatiens balsamina* species or a plant homogenate as a coloring component. It is possible to get the homogenate from the roots, leaves, flowers, aerial parts of the plant (the part of the plant without roots), as well as from the whole plant as a whole. The homogenate is considered partially dehydrated, making it easier to store.

The coloring component is mainly the lyophilization of the plant and its various parts or the addition of various ingredients or excipients, such as thickeners (egg, cypress, resin and alginate), surfactants, antioxidants, penetrants, complexion agents, fresheners, pH buffers and modifiers. , dispersants, hair straighteners, veiling agents, colorless preservatives can be obtained by grinding. However, its preparation is a complex process and contains many chemicals (patent RF No. 2161953, 2001).

The most widely used of the plant materials for hair coloring is henna powder, which is made by crushing the dried leaves of the *Lawsonia inermis* plant and basma obtained from indigo leaves.

However, the coloring property of henna varies depending on the origin of the plant and the time of harvest, and the lack of known dyes is the availability of a limited number of shades [1].

In addition, natural dyes of "ASAN TEYARAT COMPANY INTERNATIONAL" (ASTRACO) company "ROYA" manufactured in Iran are

known. They are made from different plants - henna, pomegranate, walnut, tea, coffee, chamomile and other plants, from which it is possible to buy 4 color shades for each of 5 types of hair: from colorless to light brown. The disadvantage of these dyes is that the composition and composition of the hair are multi-component with limited color shades during the use of ink. Among the means for hair coloring, the closest in terms of technical essence and the results obtained is the 2-time use of henna and basma: first, it is dyed with henna, washed with water and dried, then dyed with basma. At this time, henna or basma is poured into an earthenware and plastic container, hot water (up to 80C) is added to it, and it is mixed until a porridge mass is obtained. The obtained mass is applied to the washed and dried hair through a cyst; the hair is combed and covered with a scarf. The duration of coloring depends on the purchase of desired shades [1].

The purpose of the present invention is to prepare a means for hair coloring that gives unlimited color shades after coloring using natural plant colors and has a unique healing effect.

The problem before us is solved by the fact that instead of boiled water, medicinal plant extracts are used in the preparation of henna-based hair dye: roots and rhizomes of the hairless licorice, rose hips, quince leaves, leaves and green bark of the Greek walnut, sage herb, respectively 3:2 It is taken in the ratio of:2:3:2. For dry hair, add 5-6 drops of sage essential oil.

The essence of the proposed invention is that the existing extracts are used for the purpose of coloring, as well as preventing the process of hair loss and stimulating new hair follicles, but there is no information in the literature about their combined use [2, 3].

The synergistic effect of henna with the combination of plant extracts in the mixture gives a wide spectrum of colors during coloring. In addition, each component of the herbal collection has a beneficial effect on the hair.

The root and root juice of hairless bee has an anti-inflammatory effect, hypotensive, capillary-strengthening, antibacterial effect. It has a high rejuvenating effect on epidermal cells and hair follicles as part of a complex of active ingredients, and strengthens the amino acids in the hair follicles.

Sage is considered an excellent remedy for preventing hair loss and stimulating the growth of new hair follicles. Its composition includes a number of useful substances that normalize the work of sebaceous glands, which give hair beauty, strength and elasticity.

The essential oil, phytoncides, and carotene contained in medicinal roses stimulate hair growth and prevent hair loss in the future. Physiological effects: promotes hair growth, prevents hair loss, anti-seborrhea effect, anti-inflammatory, anti-inflammatory.

Walnuts contain antioxidants, essential oils, carotene, ascorbic acid, vitamin B. Infusions and extracts are used for hair treatment and coloring.

Infusion of quince leaves is very popular for coloring white hair; its mineral is used against dandruff and normalizes the work of sebaceous glands [4, 8].

It should be noted that only natural brown or dark-chestnut colored hair is dyed with henna. Henna has the ability to fade quickly, but it is not recommended to use it more than 2 times a month. Frequent use can have the opposite effect: the hair becomes lifeless. If the hair has been recently dyed with chemical dyes or has been subjected to chemical curling, do not dye with henna, as vegetable dyes mix badly with chemical dyes. In this case, the result will not be satisfactory. The color can take different shades: from orange to green.

The proposed tool is prepared by the following method:

At the same time, a decoction is prepared from the root and root of *Glycyrrhiza glabra* taken in the ratio of 3:3 and the green bark of the Greek walnut, and separately, a decoction is prepared from the flowers of the rose, quince leaves and sage grass in the ratio of 2:2:2. For this reason, they are crushed and water is added in the ratio of 1:5:7 and they are kept in a water bath for 30 minutes. is heated no higher than 65C. Then both liquid parts are separated, the extracts are mixed and concentrated. With the received hot infusion (infusion temperature should not be lower than 80C), henna is cooked until porridge mass is obtained in the ratio of 1:5:7, depending on the length of the hair. The obtained mass is cooled to a temperature slightly above room temperature (\approx 35C). Then the dye is applied to the hair, the hair is combed and a polyethylene cap is put on, and it is kept for 30 minutes to 2 hours. 5-6 drops of sage essential oil are added to the gruel obtained for dry hair. The duration of coloring depends on the desired color shade [5]

2. Anti-hair loss

Since hair loss is caused by various reasons, the problem of its treatment is quite complex. As a result of the long-term effects of various adverse internal and external factors, the scalp is first damaged - microcirculation and oil-water balance are disturbed, the nutrition and development of hair follicles deteriorates, and hair loss occurs [6,7].

The main reason for hair loss - androgenic alopecia - hormonal hair loss - is the lack of testosterone, the male sex hormone. Climax in women can occur during pregnancy and adolescence.

Various means are known that stimulate hair strengthening and growth, containing various plant extracts as biologically active components. The positive effect of aqueous-alcohol-glycerin extracts obtained from medicinal plants is based on the regenerating effect of the biologically active substances

contained in them on hair roots and scalp, improving the metabolism of hair roots and skin cells, and the toning effect of amino acids, vitamins, microelements.

For example, hair care products containing ethyl alcohol extracts are known: red pepper, nettle, garlic, onions, horse chestnut fruits, pollen, camphor, lanolin, d-panthenol, lactic acid, lavender oil, dimethylsulfoxide and water.

The missing aspect of the known composition is the insufficient activity of stimulating hair growth and strengthening and the presence of a large amount of deficit components.

It is considered an anti-hair loss agent based on oak bark, which is more suitable for the claim. The mask based on oak bark is suitable for all types of hair. For its preparation, oak bark, mint leaves, dandelion and plantain are mixed. A few spoons of bear claw oil are also added and kept for several hours. Before using it on the hair, the mask is heated in a water bath. It is necessary to rub the mask on the hair and keep it all night, tie a polyethylene cap and a towel. Wash with shampoo and rinse again with ore made from oak bark. Repeat every 7-10 days

The lack of this tool is that it does not have enough activity to stimulate hair growth and strengthening.

The subject of the invention is the preparation of a product that prevents hair loss in women, strengthens hair, improves blood circulation in the scalp, stimulates hair growth, has a regenerating and strengthening effect on hair roots, and also restores the damaged structure of hair [8].

The problem is solved by mixing oak bark, root and rhizome of hairless beech, sage leaves in the ratio of 1:4:2:4, chitosan as gelling agent - 0.5-1.5; salicylic acid as a preservative-0.1-0.5 and as a flavoring agent in a ratio of 0.2-1.0. % is added:

Medicinal plant extracts in the ratio of water: oak bark: root and rhizome of hairless beech: medicinal sage, 1:4:2:4 85-97, Chitosan 0.5-1.5, Salicylic acid 0.1-0.5, Flavoring 0.2-1.0

The essence of the proposed composition is that the use of each component (oak bark, hairless licorice, medicinal sage) in hair strengthening is known, but their joint use as a preservative with the addition of chitosan and salicylic acid has not been found in the literature.

The tool has positive effects: it accelerates metabolism in the scalp, improves blood circulation, nourishes the hair roots with nutrients, removes dryness of the skin, restores the hair cuticle and stimulates its growth.

Changing the ratio of medicinal plants: its decrease leads to a weakening of activity and a delay in hair growth, hardening of the cuticle.

If you use less than the specified amount of chitosan, the mixture thickens, it becomes runny during use, and it is not recommended to use more, because it spreads unevenly when you rub it on the bottom of the head.

Low use of salicylic acid leads to acidification of the composition, and excessive use is not recommended.

Oak bark is rich in a large amount of grafting substances, various acids, flavonoids, pectin substances, and carbohydrates. It has astringent, antiseptic and anti-inflammatory effects, normalizes the secretion of sebaceous glands of the head and improves the appearance of hair. Medicinal sage contains a number of useful substances that normalize the work of the sebaceous glands of the head, gives hair beauty, strength and elasticity. Sage is considered an herb that prevents hair loss and accelerates the development of new hair follicles. Sage infusion is used for various hair problems and improves hair structure (hair becomes stronger). Sage leaves are anti-inflammatory and anti-microbial. Roots and rhizomes of *Glycyrrhiza glabra* have anti-inflammatory, hypotensive, capillary-strengthening, antibacterial effects; it is used in cosmetics against hair growth and loss. The complex of active ingredients has a highly rejuvenating effect on the cells of the epidermis and hair follicles, and increases the amino acids that form the basis of the hair base [8]

Chitosan is a natural polymer and is used as an anti-caking agent, emollient, barrier agent and anti-inflammatory agent. The ability of chitosan to be highly absorbed by hair is used in the preparation of hair care products. Amino groups in chitosan act as cations. However, since the surface of the hair is anion, the absorption capacity is high. Since chitosan has a high adhesion property, it is well fixed on the hair, does not split and does not roll. Chitosan forms a thin film that protects the hair from external environmental factors, prevents hair tangling and reduces hair combing; its inclusion in hair care products gives it shine, shape and volume (*From the site "Chitosan in cosmetics"*). The tool is prepared as follows: in advance, the oak bark, the roots and rhizomes of the hairless beech are chopped up to 2 mm in size, and the sage leaves are chopped up to the same size. The crushed ingredients are mixed in the specified amount and poured into a 200-400 g flask, 1-2 l of distilled water at room temperature is added to it, and it is kept for one day to swell in a dark place. Then the flask is connected to a counter cooler, a thermometer and a stirrer, installed in a water bath. Extraction is carried out for 1.5 hours at a temperature not higher than 70C. Then, up to 0.5 l of water is expelled. The obtained extract is cooled to room temperature and added in the following order: chitosan, salicylic acid and fragrance. The obtained remedy is fragrant (rose, geranium or jasmine), yellowish-brown in color with a gelatinous structure. The tool is used as follows: it is applied to clean wet hair with a circular massage from the bottom to the ends, a polyethylene cap is put on and

covered with a towel, it is kept for 2-3 hours, it is washed with warm water (do not wash with hot water). There is no need to use shampoo. This procedure should be carried out daily for 3-4 months. It should be noted that the color of the hair darkens when used on light-colored or gray hair. Example N1. By mixing the oak bark chopped up to 2 mm, the roots and rhizomes of the hairless beech, and sage leaves of the same size, adding 200 g of the obtained mixture to 1 l of purified water; it is poured into a three-necked flask. It is kept in a dark place for a day to swell. Then the flask is connected to a counter cooler, a thermometer and a stirrer, installed in a water bath. Extraction is carried out for 1.5 hours at a temperature not higher than 70C. Then, up to 0.5 l of water is expelled. The obtained extract is 85 mass% of the ratio of oak bark: hairless beech root and rhizome: medicinal sage cooled to room temperature and added in the order: chitosan-0.5 wt. %, salicylic acid-0.1 wt. % and fragrance- 0.2 wt. %. [9].

Conclusion

1. Thus, the proposed hair coloring tool is more effective, besides hair coloring, it provides hair strength, normalizes the work of sebaceous glands, accelerates hair growth, prevents hair loss, and has an anti-seborrhea effect.
2. The use of each component of the purchased anti-hair loss product is allowed in the pharmacopoeia, the preparation processes are simple and do not show any side effects.

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INTEGRATIVE MEDICINE - MEDICINE FOR THE TREATMENT OF CHRONIC DISEASES

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Abstract

Over the past 30 years observed worldwide increase in the prevalence of chronic non-infectious diseases around the world. Chronic non- infectious diseases are a serious problem of the 21st century, as they are one of the main causes of premature death and every year 41 million people die from these diseases, which is 71% of all deaths in the world.

Most WHO Member States, including Azerbaijan, have their own national strategy plan for control chronic non-infectious diseases. The experience accumulated over the past 25 years in the treatment of chronic non-communicable diseases shows that the most effective is an integrative approach and the use of integrative medicine. This article presents data on the progress in the development of integrative medicine in the world in the 21st century, aspects of its application in chronic non-infectious diseases. Information about education, research and publications in integrative medicine in various regions of the world is also summarized. Fundamental discoveries in medicine in the 20th century made possible to achieve significant success in the treatment of a large number of infectious diseases, increase the availability and quality of medical care, as well as the overall life expectancy of people. However, along with this, rapid urbanization, population aging and the globalization of unhealthy lifestyles have led to the development of another, no less serious problem - the widespread prevalence of chronic noninfectious diseases (CNIDs). The Centers for Disease Control and Prevention (CDC, 2021) defines chronic diseases as conditions that last 1 year or more and require constant medical supervision or limitation of daily activities, or both. The development of chronic diseases can be influenced by a combination of genetics, lifestyle and social behavior, health system factors, community influences and environmental determinants of health (Cockerham et al., 2017). Many researchers and public health professionals often find it necessary to sufficiently

consider the relationship between chronic diseases and social, behavioral and community factors (Jack, 2020). According to WHO every year 41 million people die from noninfectious diseases, which is 71% of all deaths in the world. Every year, 15 million people aged 30 to 69 die of CNIDs: more than 85% of these “premature” deaths occur in low- and middle-income countries. The main types of CNIDs include cardiovascular diseases, malignancies, chronic respiratory diseases and diabetes mellitus. Chronic diseases such as cardiovascular disease, cancer, respiratory disease and diabetes caused 58 million deaths worldwide in 2005 (WHO, 2005). In the structure of mortality from CNIDs, the largest share is accounted for cardiovascular diseases, from which 17.9 million people die every year. Further followed by oncological diseases (9 million cases), respiratory diseases (3.9 million cases) and diabetes mellitus (1.6 million cases). CNIDs are common in all age groups and all regions of the world. These diseases are often associated with older age groups, but the actual data show that the 16 million people who die from CNIDs are in the under-70 age group and 82% of these premature deaths occur in low- and middle-income countries. Children, adults and the elderly are all vulnerable to risk factors that contribute to the development of NCDs, such as unhealthy diet, physical inactivity, exposure to tobacco smoke or alcohol use, etc. Although major chronic diseases are largely amenable to prevention, but they are one of the main causes of premature death and the overall burden of disease in the European Region (WHO, 2002). It is also noted that in the countries of Central and Eastern Europe, the incidence of chronic diseases and mortality from them are characterized by a significantly younger age than in other regions of the EU (WHO Regional Office for Europe, 2003). It has been documented that CNIDs have a significant impact on the national economies of countries, depriving them of the ability to work and killing the population of working age. On this basis, the World Health Assembly in 1998 recognized the threat posed by CNIDs and developed a global strategy for their prevention and control (Brundtland, 2002). WHO called on all Member States to develop their own public policies for the prevention and control of chronic diseases, which would be determined by the provisions of the global strategy (Resolution WHA53.17.). The goal of this WHO policy is to develop innovative and effective strategies to improve chronic disease outcomes in various populations around the world. The efforts to improve global health, have accelerated in response to the achievement of the Sustainable Development Goals. However, NCDs continue to be a major cause of adverse health outcomes, often leading to reduced quality of life, including increase the associated costs in health care (Van Alsten et.al., 2019). WHO notes that any NCD prevention and control strategy must prioritize addressing the underlying risk factors. (who.int/whr/2002/WHR). As early as 20002, WHO emphasized that action to

prevent NCDs should focus on an integrated approach to managing risk factors (Brundtland, 2002). To date, reducing the burden of chronic diseases remains a global challenge, and the pace of growth in the burden of NCDs has also accelerated the establishment in 2018 of a high-level commission by the United Nations to develop a global response to NCDs (Heller et al., 2019). At the 61st session of the WHO Regional Committee for Europe, held in Baku on September 12-15, 2011, the Action Plan for the implementation of the European Strategy for the Prevention and Control of NCDs for 2012-2016 was adopted. On December 23, 2015, President of Azerbaijan Ilham Aliyev signed an order approving the “Strategy for Combating Noncommunicable Diseases in the Republic of Azerbaijan for 2015-2020.

Integrative medicine

Integrative medicine is a direction in medicine when a symbiosis of technologies and methods of modern Western medicine and traditional medical practices (for example, traditional Chinese medicine, Indian Ayurveda, Tibetan medicine) is used in the diagnosis and treatment of diseases. Combines the best of conventional medicine with a holistic approach to improving health (Wen-Jian, Teng, 2017). However, integrative medicine is not just the sum of methods and tools from different medical systems. Integrative medicine is a synergy of efforts of various medical worldview schools, which as a result leads to the emergence of a “spiritualized technology” - pragmatic and focused on a quick effect, and at the same time maximally aimed at using the vital reserve forces of the human body. Integrative medicine is an opportunity to use the advantages of both medical systems for the benefit of people's health. Integrative Medicine is a healing-oriented medicine that embraces the whole person (body, mind, and spirit), including all aspects of lifestyle. Integrative medicine emphasizes therapeutic treatment and uses all appropriate therapies, both traditional and alternative (Ai-ping et al., 2008). The advantages of this direction are obvious, since each of the medical systems has its own strengths and weaknesses. Thus, Western medicine, with its technological know-how, is most effective in providing emergency medical care and performing complex surgical operations. Traditional Chinese medicine - allows to more accurately determine the cause of the disease and the nature of local pathological changes, timely monitor changes occurring in the body during treatment, gives excellent results in the treatment of chronic diseases, in the rehabilitation and restoration of impaired body functions. Integrative medicine, based on the approach to a person as an integral biological system, simultaneously works in harmony with each person. The task of integrative medicine doctors is to treat the whole person, and not some organ or disease. For this are used combined methods, which can consist

of both elements of classical medicine and elements of alternative medicine. In integrative medicine is drawn up an individual medical treatment plan. A deep analysis and identification of the etiology of the disease is necessary in each case, and then a systemic effect on the body to eliminate the causes that problem and to harmonize the state of the whole organism. This therapy is always individual, as no two organisms are the same. And this is a therapy that requires a certain time, however, giving a long-term positive effect.

Integrative medicine has emerged as a potential solution to the health crisis. Today, a vision for a new kind of healthcare is emerging and is patient-centered, healing-centered, and includes traditional and complementary therapies (Victoria, 2009). Integrative medicine is rapidly developing all over the world. Its associations have been established in the USA, Canada, Brazil and many European countries. But in China integrative medicine has achieved the most notable success and has already become an integral part of the public health system (Victor et al., 2006)

Integrative medicine treatments

Integrative Medicine focuses on the whole person, is evidence-based, and uses all relevant therapeutic and lifestyle approaches to achieve optimal health and healing. A personalized approach to the patient allows to look at the human body much deeper than in classical medicine. Integrative medicine includes a wide range of integrative approaches that work together and complement academic medicine. In integrative medicine, along with academic medicine, are successfully used the following methods:

- Acupuncture
- Homeosiniatry (Homeopuncture)
- Autohemotherapy
- Hirudotherapy
- Phytotherapy
- Apitherapy
- Aromatherapy
- Modern homeopathy
- Osteopathy
- Massage
- Deep breathing exercises
- Yoga, tai chi and qigong
- Manual therapy
- Meditation, etc.

Psychology in integrative medicine is allocated a separate place, since many health problems come primarily from the psychological state of the

patient. One of the main and primary tasks on the path to health is precisely overcoming psychological disorders, because they have a direct impact on the patient's hormonal background. The most common symptoms of psychological disorders can be depression, anxiety, insomnia, persistent fatigue, stress, increased aggression and other symptoms. Nutritionology also occupies a separate place in integrative medicine, since from the point of view of health, the human microbiota plays a huge role, the correct balance of vitamins, macro and microelements, and so on. In the modern paradigm of health, the intestine and its condition is one of the key factors of health. Proper nutrition and the right daily routine can significantly improve the quality of life, improve overall well-being and overcome many psychological problems, so it is extremely important to listen to the advice of an integrative doctor.

Training, scientific journals and research In the field of integrative medicine

The most intensively implemented training in integrative medicine is in the United States. Since 2006, the University of New Mexico School of Medicine has begun implementing educational projects on integrative medical education for medical students, residents, teachers and communities of the country. Integrative Health and Complementary and Alternative Medicine (CAM) content is currently being taught in hundreds of educational programs across the country. Nursing, medical, osteopathic, chiropractic, acupuncture, naturopathic and other programs are finding creative and innovative ways to incorporate these approaches into new models of education and practice (Victor et al., 2006). Today there are various scientific peer-reviewed journals and international societies for research in the field of integrative medicine:

Journals:

- 1. Journal of Integrative Medicine** (China 2003)
<https://www.elsevier.com/journals/journal-of-integrative-medicine>
- 2. Journal of Complementary and Integrative Medicine** (Germany 2004)
<https://www.degruyter.com/journal>
- 3. Alternative and integrative medicine** (USA 2012)
<https://www.scholarscentral.org/submissions/alternative-integrative-medicine.html>
- 4. Integrative Medicine Research** (Koreya 2012)
<https://www.sciencedirect.com/journal/integrative-medicine-research>
- 5. Advances in Integrative Medicine** (Australia 2014)
<https://www.sciencedirect.com/journal/advances-in-integrative-medicine>
- 6. Journal of Integrative and Complementary Medicine** (USA 2016)

<https://www.liebertpub.com/doi/10.1089/acm.2016.29005.jjw>

7. Journal of Evidence-Based Complementary and Alternative Medicine (USA 2017)

<https://journals.sagepub.com/home/chp>

8. European Journal of Integrative Medicine (United Kingdom 2018)

<https://www.sciencedirect.com/journal/european-journal-of-integrative-medicine>

9. Future Integrative Medicine (China 2022)

<https://www.xiahepublishing.com/journal/fim>

Societies:

1. Academic Consortium for Integrative Medicine and Health.

<https://imconsortium.org/>. The Academic Consortium for Integrative Medicine and Health began with a visionary vision shared by eight US academic medical institutions in 1999. The Academic Consortium is the organizational home of academic medical centers and health systems with programs in integrative medicine and health care, as well as thousands of scientists, educators, clinicians and other health professionals who share an interest in this field. The mission of the Academic Consortium is to promote the principles and practice of integrative healthcare in academic institutions. Today, the consortium has grown to over 75 academic medical centers and health systems working together to advance integrated, integrative medicine and healthcare. A symposium on integrative medicine and health was hosted by this consortium in March 2023 in Chicago, Illinois.

2.Osher Collaborative for Integrative Health

<https://www.oshercollaborative.org/>. Started in 2001 and includes an international group of eleven academic centers funded by the Bernard Osher Foundation. These centers together make up the Osher Collaborative for Integrative Medicine, which enhances each center's influence on the study, teaching, and practice of integrative medicine. Eleven programs offer both unique and shared strengths in research, education, and clinical care. Osher Collaborative advances the field of integrative medicine through the sharing of knowledge, resources and best practices.

3. International Society for Research in Traditional, Complementary and Integrative Medicine (ISCMR)<https://www.iscmr.org/>. It is an international interdisciplinary scientific organization established in 2003 in the United States and to promote the development and dissemination of new knowledge about human healing and research in health systems, including traditional, holistic, alternative, complementary and integrative forms of medicine. The ISCMR provides a platform for the exchange of knowledge and information. Since

2003, the ISCMR has been promoting international communication and cooperation among members from over 50 countries.

4. European Society for Integrative Medicine (ESIM)<https://european-society-integrative-medicine.org/about/about-the-society/>. This international European association was founded in 2011 with the aim of promoting the development of science, research, education and professional development, support for the best and evidence-based care, and policy advice on integrative medicine. It annually hosts the European Congress of Integrative Medicine (ECIM), and since 2017 the World Congress of Integrative Medicine and Health (WCIMH, which is held every four years). In September 2023 will be held the 2nd World Congress in Italy (Rome).

5. Australasian Integrative Medicine Association (AIMA)<https://www.aima.net.au/about/>.

It is established in 2020 and is the highest medical organ which representing physicians and other healthcare professionals practicing integrative medicine. The goal is to encourage and nurture a new generation of integrative doctors, develop standards and guidelines for integrative medicine, support/accredit education in the field of integrative medicine, promote integrative medicine both in the general medical community and in society as a whole.

According to the literature, there is also a growing need and demand for research in the field of integrative medicine (Eunhye et al., 2022), as shown in Fig.1. Over the past decade, the number of publications in the journal of integrative medicine has doubled. The top 5 countries with the most publications are the USA (161,897), China (118,918), Germany (41,812), England (38,533) and Italy (30,436).

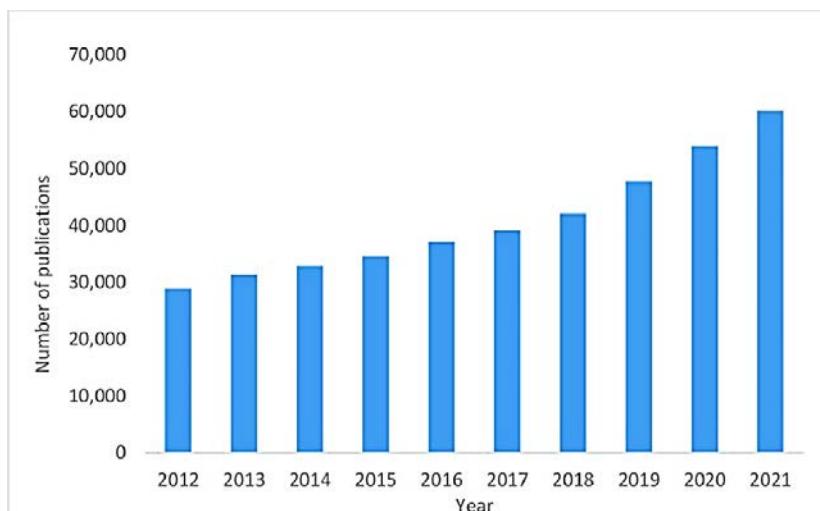


Fig. 1. Number of publications from 2012 to 2021.

There is a growing number of researches supporting the use of integrative medicine approaches for the treatment of various diseases with a high safety and efficacy profile. An analysis of research in the field of an integrative approach to the treatment of chronic diseases shows that integrative medicine is already developing in the following areas:

1. Complementary and Integrative Medicine for Head and Neck Cancer (Joseph et al., 2022)
2. Integrative medicine for headache (Denise et al., 2017)
3. Integrative oncology - integrative medicine therapy for the treatment of pain in cancer patients (Mao et al., 2022; Walach, 2012; Gary et al., 2019)
4. Complementary and Integrative Medicine for Neurological Diseases (Rebecca et al., 2017)
5. Complementary and Integrative Medicine for Neurocognitive Disorders (Sarah et al., 2022).
6. Complementary/Integrative Medicine in Otolaryngology (Ajay et al., 2022; Matthew, Miller, 2022)
7. Complementary and integrative medicine for episodic migraine (Rebecca et al., 2019)
8. Integrative medicine for insomnia (Yu-fang et al., 2016)
9. Integrative medicine for gastrointestinal diseases (Michelle et al., 2017; Wu-Wen et al., 2021)
10. Pediatric Integrative Medicine (Hilary, 2019)
11. Integrative Medicine for COVID-19 (Ang et al., 2021)

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THE TREATMENT OF DIABETIC FOOT IN INTEGRATIVE MEDICINE

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Abstract

The aim of this study was to develop an effective complex method for the treatment of diabetic ulcers of the lower extremity in patients with type 2 diabetes mellitus, including various methods of integrative medicine therapy. The study was conducted on 36 patients with diabetic foot with type 2 diabetes mellitus aged 46-86 years, whom were prescribed surgical treatment. Group 1 consisted of 18 patients with severe stenosing occlusions of the peripheral distal arteries of the lower limb, complicated by gangrene on the heels and fingers. In the 2nd group there were also 18 patients with trophic ulcers as a result of diabetic neuropathy with damage to peripheral nerves and complicated by osteomyelitis. The integrative approach included drainage-detoxification, alkalization, neural, orthomolecular and PRP therapy, as well as homeosintiatry and ozone therapy against the background of generally accepted sugar-lowering therapy and surgical sanitation of the affected areas.

Depending on the severity, the presence of concomitant diseases and the individual characteristics of the course of the disease, the treatment lasted 3-6 months. As a result of such an integrated approach, was noted a high efficiency of treatment in both groups: the state of health of patients improved, collateral circulation and sensitivity in the lower extremities increased, and the destruction of the bones of the foot stopped. There was a complete healing of wounds in all patients. In all patients of the 1st group, according to the results of ultrasound Doppler study was recorded a significant increase in collateral blood flow, in the 2nd group were noted normalization and restoration of sensitivity according to the results of electromyography.

Key words: diabetic foot, neuropathy, stenosing occlusions

1. Introduction

Diabetic foot ulcers represent a global medical, social and economic problem. This is the most common primary endpoint of diabetic complications. In the absence of early diagnosis and effective treatment, morbidity and

mortality increase significantly (Blanchette, Brousseau-Foley, 2021; Mhd Bela et al., 2022).

Diabetic foot ulcer is one of the slowest healing wounds affecting the human body. The etiology of diabetic foot ulcers is complicated because of their multifactorial nature. Diabetic neuropathy and diseases of peripheral vessels are the main etiological factors of the formation of foot ulcers and can act separately, together or in combination with other factors (Reza Ghotoslou, 2018; Gabriela, 2020; Alberto, 2019; Dennis 2018).

Polyneuropathy is important in the pathophysiology of diabetic foot ulcers and according to epidemiological data, it is the cause of about 50% of cases of diabetic foot syndrome (Maren et al., 2016). Available data indicate that the prevalence of neuropathy is high and ranges from 43% to 66% among patients with diabetic foot ulcers. (Ruman et al., 2021). Occlusive disease of the peripheral arteries of the lower extremity in diabetes mellitus type 2 by itself is the cause of only 15% of cases, while in 35% of cases foot ulcers develop as a combination of neuropathy and angiopathy (Rumenapf et al., 2008; Van Battum et al., 2011; Zimmermann et al., 2009; Boulton, 2014).

Diabetic foot syndrome is the leading cause of hospitalization among all possible complications of type 2 diabetes mellitus. The need for major amputation is approximately 30-40 times higher in patients with type 2 diabetes mellitus in comparison with patients without diabetes. Five-year mortality after amputation is estimated at 39–68%. (Risse, 2007; Boulton, 2008; Rumenapf et al., 2008; Van Battum et al., 2011; Zimmermann et al., 2009). In those cases where postoperative care is not optimal, about 70% of patients have at least one ulcer recurrence and approximately 12% of cases require amputation within five years after the initial foot injury. If amputation has already been performed, the cumulative risk of repeated amputation in the next year is about 27%, and after five years - 61% (Graiani, 2004; Krishnan et al., 2007; Pereira et al., 2014; Tiaka et al., 2011; Cavanagh, Buss, 2011). Since 2011 has been emphasized the need for an interdisciplinary approach and multiprofessional teamwork in the treatment of diabetic foot syndrome (Tiaka, et al., 2011; Cavanagh, Bus, 2011; Pereira et al., 2014).

Considering the above-mentioned, goal of this study was the development of an effective complex method of treating diabetic ulcers of the lower extremities in patients with type 2 diabetes, which includes various methods of integrative medicine therapy.

Materials and methods

The study was conducted on 36 patients with diabetic foot and type 2 diabetes mellitus aged 46-86 years who were prescribed operative treatment due

to the ineffectiveness of therapeutic treatment. The 1st group consisted of 18 patients with severe stenotic occlusions of peripheral distal arteries of the lower extremity, complicated by gangrene on the heels and fingers. In the 2nd group there were 18 patients with trophic ulcers as a result of diabetic neuropathy with peripheral nerve damage and complicated by osteomyelitis. The general characteristics of patients are presented in table 1.

During the initial examination of the patients, pulsation on the foot, temperature, contact, pain and vibration sensitivity on the lower extremity, as well as muscle reflexes on the Achilles and popliteal tendons were determined. The course of the disease was followed up on the basis of patient complaints, laboratory data (complete blood count, D-dimer, glucose, HbA1c, CRP and ESR).

The general analysis was carried out on the device Susmex-XS500I (Japan), glucose - Archi tect C 100 (Abbott USA), CRZ - Archi tect C 100 (Abbott USA), Hb Alc - SD-biosensor (Korea), D-dimer - apparatus Kinecare Hondfo (Mini vidas bio Merilux France). Doppler ultrasound study was performed using HITACHI ALOKA arietta v70 (Japan), electromyography - using Neuro-MEP-Micro (Neyrosoft Russia) and X-rays were taken using SEDECAL (Italy).

Table 1.
General characteristics of patients in the examined groups

| Groups | Age (years) | Duration of disease (years) | Duration of formation of ulcers (months) | Gender | |
|--|----------------|-----------------------------------|---|--------|-----|
| | | | | Women | Men |
| Group 1 - patients with trophic ulcers of the lower extremities, as a result of impaired peripheral blood supply in type 2 diabetes | 46 - 86 | 10-40 | 1-24 | 10 | 8 |
| Group 2 - patients with trophic ulcers of the lower extremity | 59 – 80 | 4-24 | 1-48 | 12 | 6 |

| | | | | | |
|--|--|--|--|--|--|
| as a result of damage to peripheral nerve endings in diabetes type 2 | | | | | |
|--|--|--|--|--|--|

A therapist, an endocrinologist, an infectious disease specialist, a general and vascular surgeon, an orthopedist and a nutritionist participated in the treatment of patients with diabetic foot in a multidisciplinary approach. Normalization of the blood sugar level in a short period of time was carried out by an endocrinologist. In the absence of contraindications in patients with type 2 diabetes mellitus, as well as in the absence of systemic infection, metformin was added along with insulin. The surgeon performed wound remediation - cleaning of necrotic tissues. To reduce the pressure of the body weight on the wound, were provided bed rest, a plaster cast on the leg, wearing special orthopedic shoes and using orthopedic devices. In case of infected wounds, antibiotic therapy was carried out depending on the response to the culture of the secretion from the wound tissues and the assessment of the patient's kidney and liver function. Depending on the condition of the wound, antibiotics were prescribed orally or intravenously. Dietary nutrition included - restriction in the diet of animal proteins (dairy products, red meat, chicken eggs, etc.) and sugars, the diet included low-carb products, increased the amount of consumed vegetables, eliminated the deficiency of vitamins and minerals, excluded the consumption of trans-fats and omega-6 fats. An integrative approach to the treatment of patients with diabetic foot included drainage-detoxification, alkalization, orthomolecular and Platelet-Rich Plasma (PRP) therapy, ozone therapy, as well as neural therapy against the background of generally accepted hypoglycemic therapy and surgical rehabilitation of affected areas.

In both groups, they conducted:

1. **Drainage - detoxification** with the aim of removing toxins from the body, cleaning the extracellular matrix, supporting important drainage organs (liver, urinary, gastrointestinal and lymphatic systems). Intravenous infusions (200 ml 0.9% NaCl + 50 ml 8.4% Na bicarbonate + Traumeel, Lymphomyozot, Hepar comp., Solidago comp., Coenzyme comp., Ubichinon comp.) were used in one day (10 sessions). Further followed intravenous infusions of alpha-lipoic acid 600 mg in 100 ml of 0.9% NaCl, 2 times a week (10 sessions).

2. **Alkalizing therapy** to reduce tissue acidosis: Alkala N - 1 teaspoon of powder in 1 glass of warm water in the morning on an empty stomach, Sanuvis - 1 tablet in the morning, Citrokehl 1 tablet in the evening.

3. **Orthomolecular therapy:** vitamin D, vitamins of group B, Lipiscor, Znkokehl.

4. **Ozonotherapy:** general (ozonation of 100 ml of blood and reinfusion) - 10 sessions; local ozone therapy (microinjection of small doses of ozone into the wound and surrounding area) - 10 sessions, ozone bags on the affected foot - 20 sessions.

5. **Regenerative therapy** with the goal of activating microcirculation and repairing damaged tissues: 3 sessions of PRP therapy were performed locally with an interval of 10 days.

In addition, in both groups, during the entire duration of therapy

- **for 1st group** of patients, injections of bioregulatory drugs were performed by the homeosintiatry method (introduction into acupuncture points (RP-10,9,6; F-3; E-36, VB- 34) Placenta comp., Circulo-injeel, Vipera berus, Chrysosan) - 20 sessions.

- **for 2nd group** of patients - neural therapy was carried out by injecting 1% novocaine in combination with MD-Neural in the paravertebral zones of the lumbar vertebrae, ilio-sacral points and points along the course of the sciatic nerve, as well as in acupuncture points (E-36, V- 60,62,64, R-3, VB-34) - 20 sessions. In addition, intramuscular injections of Artrokehlan A, Traumeel, Zeel T per day (10 injections) 10 times and tablets Osteoheel were also prescribed for patients of this group. Depending on the severity, the presence of accompanying diseases and the individual characteristics of the patient, the treatment lasted 2-6 months, in the 1st group it was 3.4 months on average, and in the 2nd group it was 3.8 months on average.

Results and discussion

The results of the examination of patients in 1th group before treatment showed the following. All 18 patients with severe stenotic occlusions of peripheral distal arteries had ulcerative defects on the feet, heels and fingers. Among them, necrobiotic changes in the feet - in 5 people, in the heels - in 3 people, in the fingers - in 10 people. According to the results of Doppler ultrasound study, the velocity of collateral blood circulation in all patients was determined within the range of 0-18 cm/sec along the anterior tibial artery (ATA), 0-45 cm/sec along the posterior tibial artery (PTA) and 0-23 cm/sec at the foot. Out of 18 patients, 13 had complete absence of collaterals: in ATA in 2, in PTA in 8, in foot - in 3. The study of laboratory parameters after the complex treatment revealed the following (tab. 2, fig.1).

Table 2.
Laboratory parameters in patients with trophic ulcers as a result of damage to the peripheral nerves of the lower limb in type 2 diabetes after treatment
(M ± m, n=18)

| Indicators | Normative data | Study timeline | |
|---|----------------|------------------|-----------------|
| | | Before treatment | After treatment |
| WBC^{x 10³} /ml | 4,23-9,07 | 13,7 ± 1,27 | 8,6 ± 0,3*** |
| Min-Max | | 9,42 – 28,46 | 6,33 – 11,52 |
| ESR mm/hour | 2-30 | 69,11 ± 8,74 | 26 ± 3,1*** |
| Min-Max | | 35- 160 | 10 - 70 |
| CRP mg/l | 0,0-5,0 | 17,33 ± 3,33 | 4,61 ± 0,14*** |
| Min-Max | | 6,0 – 5,1 | 4,0 – 5,6 |
| Glucose mg/dl | 70-110 | 226,8 ± 16,27 | 127,1 ± 5,36*** |
| Min-Max | | 114 - 414 | 100 - 176 |
| HbA1c % | 4,4-6,0 | 9,44 ± 0,4 | 6,33 ± 0,2*** |
| Min-Max | | 6,5 – 12,1 | 5,6 – 8,9 |
| D-dimer ng/ml | <500 | 1033 ± 126,5 | 463,3 ± 18,8*** |
| Min-Max | | 503 - 2800 | 360 - 645 |

Note: Statistical significance compared to pre-treatment scores: *-p <0,05;
-p <0,01; *-p <0,001

After the treatment in the 1st group, in 5 patients developed collateral blood circulation in the foot and the process ended with a mini-toe amputation; in 13 patients, as a result of a significant increase in collateral blood circulation, acute ischemia stopped and necrobiotic wounds healed. Also, according to the results of Doppler ultrasound study, the collateral velocity was - in ATA 26-61 cm/sec - in PTA 13-65 cm/sec - in the foot 12-53 cm/sec.

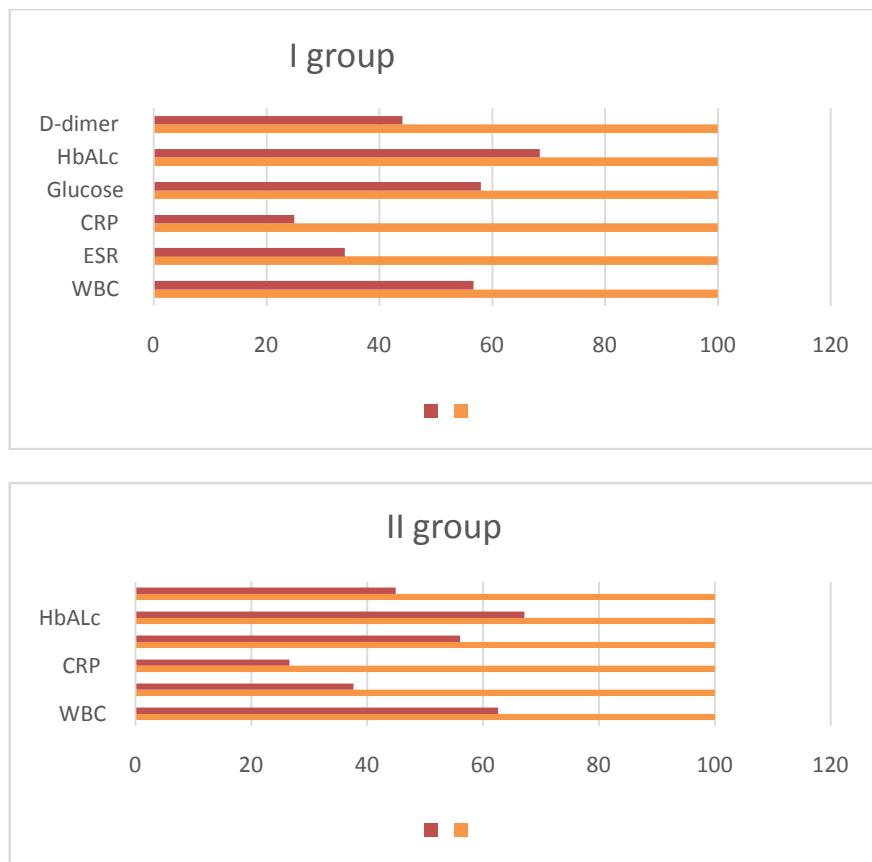


Fig. 1. Laboratory parameters in patients with trophic ulcers in 1th and 2nd groups.

The number of leukocytes, which before treatment was increased by almost 3 times compared with the normative data, decreased by half and reached the limits of fluctuation of normative values after treatment.

Table 3.
Laboratory parameters in patients with trophic ulcers as a result of stenosing occlusions of lower limb arteries in type 2 diabetes after treatment (M ± m, n=18)

| Indicators | Normative data | Study timeline | |
|------------------------------------|----------------|------------------|-----------------|
| | | Before treatment | After treatment |
| WBC ^{x 10³/ml} | 4,23-9,07 | 14,64 ± 1,4*** | 8,3 ± 0,41*** |

| | | | |
|----------------------|---------|-------------------------|------------------------|
| Min-Max | | 9,5 – 30,0 | 5,02 – 11,52 |
| ESR mm/hour | 2-30 | $80,94 \pm 6,97^{***}$ | $27,5 \pm 2,31^{***}$ |
| Min-Max | | 36 - 127 | 13 - 48 |
| CRP mg/l | 0,0-5,0 | $28,77 \pm 5,9^{***}$ | $7,17 \pm 1,95^{**}$ |
| Min-Max | | 6,9 - 110 | 2,98 - 40 |
| Glucose mg/dl | 70-110 | $216,2 \pm 11,97^{***}$ | $125,4 \pm 4,25^{***}$ |
| Min-Max | | 126 - 281 | 101 - 160 |
| HbA1c % | 4,4-6,0 | $9,83 \pm 0,35^{**}$ | $6,72 \pm 0,21^{***}$ |
| Min-Max | | 6,9 – 12,6 | 5,2 – 8,7 |
| D-dimer ng/ml | <500 | $1077 \pm 125,2^{**}$ | $475 \pm 17,1^{***}$ |
| Min-Max | | 590 - 2699 | 330 - 620 |

Note: Statistical significance compared to pre-treatment scores: *-p <0,05;
-p < 0,01; *-p < 0,001

Also, other indicators that exceeded the normative data by an average of 2-5 times (p<0.001), significantly decreased and were within the normative values after the treatment: thus, ESR decreased by more than 3 times (p<0.001), CRP - by 3 times (p<0.001), glucose by 2 times (p<0.001), HbA1c by 68% (p<0.001), and D-dimer by 44% (p<0.001).

In the 2nd group of patients, which consisted of 18 patients with damage to the peripheral distal nerves as a result of diabetic neuropathy, all also had trophic ulcers on the lower extremities. Of these, 4 people had neuropathy complicated by osteoarthropathy, 14 people had osteomyelitis (1 on the heel, 13 on the toes). At the same time, an electromyography study showed a complete loss of sensation in both legs in 4 patients, a zero distal M-response (0) and a negative proximal N response (-) in 14 patients, and a decrease in the impulse conduction velocity was noted. After the treatment, in 10 patients the sensitivity was completely restored, in 6 people - by 50%, in 2 - by 30%. According to X-ray data, in 9 out of 14 patients no signs of osteomyelitis were detected, in 5 patients X-ray signs of chronic osteomyelitis were recorded.

The study of laboratory parameters in the 2nd group after the treatment showed the following (table 3, fig. 2). Also, as in group 1, the values of laboratory parameters were 2-4 times higher than the normative data before treatment. After the treatment, compared with the data before treatment, the number of leukocytes significantly (p < 0.001) decreased on average by 63%, ESR - by 38%, CRP - by 27%, glucose levels by more than 2 times, HbA1c - by 30% , and D-dimer - almost 2 times.

It should be noted that in both examined groups, after the treatment, the ulcers completely healed in all patients (Fig. 2, 3).



Fig. 2. Healing of ulcers in patients of the 1st group



Fig. 3. Healing of ulcers in patients of the 2nd group

At the same time, normalization of blood pressure and blood glucose levels was also achieved in the examined patients.

Thus, summarizing the results of the studies, we can say that the complex use of integrative medicine methods had a high treatment efficiency in both groups: increased collateral circulation in patients with trophic ulcers as a result of stenosing occlusions of the arteries of the lower extremity in type 2 diabetes, increased sensitivity in the lower extremities stopped destruction foot bones in patients with trophic ulcers as a result of damage to the peripheral nerves of the lower limb in type 2 diabetes.

All examined patients showed complete healing of ulcerative defects. The obtained results are confirmed both by the results of laboratory analyzes and the results of Doppler ultrasound study for patients with ischemic form and electromyography data for patients with neurogenic form of diabetic pillars in type 2 diabetes.

Conclusions

In patients with trophic ulcers on the lower limbs with type 2 diabetes, the complex use of bioregulatory, isopathic, neural, orthomolecular and PRP therapy, as well as ozone therapy against the background of standard academic

therapy, allows achieving complete closure of ulcerative defects on the lower limbs in both occlusive and neuropathic forms in diabetes type 2.

Integrative medicine has great therapeutic potential to prevent amputations, disability, improve the quality of life, and increase the life expectancy of patients with trophic ulcers of the lower extremities in type 2 diabetes.

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RADIOPROTECTIVE PROPERTIES OF SAFFRON EXTRACT UNDER X-RAY IRRADIATION AT A DOSE OF 2 GY

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Abstract

It was shown that effect of X-ray irradiation at 2 Gy leads to activity suppression of the studied enzymes in various structures of brain. As well as it has been established that on the background of preset of saffron extract, X-ray irradiation in many cases do not lead to activity suppression of the studied enzymes but on the contrary this antioxidant promotes to increase their activity in brain structures studied by us.

Key words: saffron extract, radioprotective activite, X-ray irradiation, antioxidant.

Introduction

Found that during low-dose irradiation, the role of the antioxidant system in ensuring the body's radio-resistance is significantly higher than in the sublethal area and minimal lethal doses of acute irradiation (1). The intensity of free radical processes during chronic irradiation depends primarily on the dose rate (2, 3).

Bearing this in mind, we have studied the dynamics of changes in one of the main components of endogenous antioxidant system, which is catalase, under the effect of x-radiation in a dose of 2Gy on various brain structures (table 1.1). After 1 hour of action in the medulla oblongata, a decrease in catalase activity was observed at 4.8%, correspondingly in the cerebellum 2.5% below the control, in the visual cortex of 4% below, and in the sensorimotor cortex of 5.7% (control equals to 234.64 ± 2.01 vol./mg protein).

As mentioned above, under the action of X-ray radiation in a living organism, the intensity of lipid peroxidation processes increases. At the same time, the accumulation of lipid peroxidation products consists in an inverse correlation with changes in catalase activity. Thus, the increase in the accumulation of free-radical oxidation products is manifested by a decrease in the activity of catalase.

Tracking the dynamics of enzyme activity changes in different brain structures, it was found that the level of catalase activity in the medulla, cerebellum, visual cortex and sensorimotor cortex of the rats during 3 days of irradiation at a dose of 2 Gy is reduced by 5.6%, 4.8%, 6% and 7% respectively.

This means that after 3 days of irradiation, the decrease in catalase activity is accelerated in all the studied structures of the brain. On the 6th day, on the other hand, there is an increase in activity compared to previous dates. In accordance with these indicators, the activity of this enzyme is 2.7%, 1%, 3% and 3% lower compared to the control indicators.

It is known that the impact of extreme factors, including X-ray radiation, leads to wavy-total destruction due to oxidation of the lipids of the cell membrane.

Taking into account the enormous role of the mechanisms of regulation of this destructive process with the help of the endogenous antioxidant system in the protection of membrane lipids, we considered it important in addition to catalase to study the dynamics of changes in the activity of glutathione peroxidase enzymes under the action of X-ray radiation.

Table 1.1.

The effect of x-ray irradiation at a dose of 2 Gy on the background of the introduction of saffron extract on catalase activity (in a single mg protein), (M ± m, n = 10).

| | | Medulla | Cerebellum | Visual cortex | Sensorimotor cortex |
|-------------------------|------------------------------------|-----------------------|-----------------------|-----------------------|----------------------------|
| 1. Control | | 254,34±2,31 | 241,82±2,41 | 224,34±2,12 | 234,64±2,01 |
| 2. X-ray rad. | 1 hour P₂₋₁ | 241,88±2,18 <0,001 | 235,64±2,13 <0,01 | 214,64±2,11 <0,001 | 221,13±2,18 <0,001 |
| 3. | 3-rd day P₃₋₁ | 240,12±2,24 <0,001 | 230,13±2,11 <0,001 | 210,11±2,04 <0,001 | 218,14±2,26 <0,001 |
| 4. | 6-th day P₄₋₁ | 247,26±2,12 <0,001 | 238,64±2,09 <0,02 | 217,18±2,08 <0,05 | 226,84±2,43 <0,001 |
| 5. Saffron + X-ray rad. | 1 hour P₅₋₁ | 248,12±2,13 <0,001 | 238,21±2,03 <0,01 | 218,46±2,12 <0,001 | 228,64±2,04 <0,01 |
| 6. | 3-rd day P₆₋₁ | 250,13±2,19 <0,01 | 240,14±2,13 <0,001 | 216,41±2,21 <0,02 | 226,44±2,03 <0,001 |
| 7. | 6-th day P₇₋₁ | 253,24±2,21 <0,001 | 241,34±2,01 <0,001 | 221,14±2,03 <0,001 | 231,64±2,17 <0,01 |

Long-term exposure of laboratory animals with dose rates greater than 1 cGy/day shows a decrease in the activity of the glutathione-dependent enzymatic system (4).

Under the action of x-ray irradiation at a dose of 2 Gy, a decrease in the activity of glutathione peroxidase is observed in the medulla oblongata, cerebellum, visual cortex and somatosensory cortex. A sharp decrease in glutathione peroxidase activity in the medulla oblongata (16.2%) is observed in the first hour of the experiment, and after 3 days the decrease is accelerated (24%). After 6 days, the decrease in ferment activity slows down to 8%. This is the result of the mobilization of the body's defense system for a certain time. The change in the activity of glutathione peroxidase in the cerebellum after 1 hour of effect, is 11% less than the control, after 3 days it is 15.5% less, on the 6th day it is 7.7% less than the control.

When observing a change in the visual cortex during the initial period of irradiation, the activity of glutathione peroxidase is 13.6% below control, on day 3 20.5% below than control, on day 6, 17.5% below than control. Similar changes are also observed in the sensorimotor cortex. After 1 hour of irradiation

at a dose of 2 Gy, glutathione peroxidase activity reduced by 6.5%, and on the 3rd and 6th day of experiments by 14.5% and 10.2%, respectively. (table 1.2)

Based on the analysis performed, it can be concluded that the suppression of glutathione peroxidase activity during X-ray irradiation occurs due to complex physicochemical processes, which are caused primarily by the intensification of lipid peroxidation.

Table 1.2.
Influence of X-ray irradiation in the dose of 2 Gy on the activity of glutathione peroxidase (in nmol NADR +/min/mgbel), (M±m, n=10).

| | | Medulla | Cerebellum | Visual cortex | Sensorimotor cortex |
|-------------------------|------------------------------------|---------------------|---------------------|----------------------|----------------------------|
| 1. Control | | 14,8±0,82 | 11,6±0,74 | 23,4±0,84 | 27,4±1,18 |
| 2. X-ray rad. | 1 hour P₂₋₁ | 12,4±0,52 <0,01 | 10,3±0,61 <0,001 | 20,2±0,71 <0,02 | 25,6±1,12 <0,05 |
| 3. | 3-rd day P₃₋₁ | 11,2±0,43 <0,01 | 9,8±0,91 <0,001 | 18,6±0,44 <0,01 | 23,4±1,18 <0,01 |
| 4. | 6-th day P₄₋₁ | 13,6±0,91 <0,02 | 10,7±0,78 <0,05 | 19,3±0,21 <0,01 | 24,6±1,14 <0,001 |
| 5. Saffron + X-ray rad. | 1 hour P₅₋₁ | 14,6±0,48 <0,001 | 11,2±0,44 <0,05 | 22,8±0,91 <0,01 | 26,8±1,18 <0,01 |
| 6. | 3-rd day P₆₋₁ | 13,4±0,53 <0,001 | 10,9±0,43 <0,01 | 21,7±0,88 <0,02 | 25,6±1,13 <0,02 |
| 7. | 6-th day P₇₋₁ | 14,7±0,42 <0,001 | 11,2±0,52 <0,001 | 23,2±0,78 <0,01 | 26,7±1,12 <0,001 |

As a result of the increase in the content of active oxygen species in tissues against the background of depletion of reserves of antioxidant protection, biomolecules are subjected to oxidative modification, changes in the activity of enzyme systems and disturbance of membrane structure are observed (7, 8). Since in most cases the endogenous antioxidant system does not cope with pathological damage, additional antioxidants are required in the body (8, 9). It is now known about a wide range of biological, including antioxidant

effects of saffron on structural, metabolic and regulatory systems of the body, which is provided by the diversity of its chemical composition (10, 11).

Taking into account the aforesaid, the purpose of this work is to reveal antioxidant and radio-protective properties of saffron extract. In this study, the study focused on the tissues of the medulla oblongata, cerebellum, sensorimotor and visual cortex. The condition of the antioxidant in these structures was judged by the activity of catalase and glutathione peroxidase. The analyses were carried out one hour, 3 and 6 days after the X-ray radiation in the dose of 2 Gy and under the combined influence of saffron extract and X-ray radiation.

In Table 1.2 the dynamics of the glutathione peroxidase enzyme activity change in different brain structures under the influence of X-ray irradiation in the dose of 2 Gy on the background of saffron extract administration is shown. Analysis of the data showed that preliminary administration of saffron extract leads to a slight decrease in enzyme activity in all investigated brain structures. As shown in Table 1.2, glutathione peroxidase activity in the medulla oblongata an hour after irradiation of animals was reduced by 1% in the cerebellum by 3%, in the visual cortex by 2.5%, and in the sensorimotor cortex by 2% (when compared to intact parameters). After 3 days, these indicators were higher in the medulla oblongata by 19.6%, in the cerebellum by 11%, in the visual cortex by 16.6%, in the sensorimotor cortex by 1% (compared to those in the group where animals were exposed x-ray irradiation at a dose of 2 Gy). On the 6th day of experience the enzyme activity in all investigated brain structures was recovered and approached to the indices in the intact group.

As a result of the research (the data are presented in Table 1.1 it was revealed that the animals that had previously received saffron extract in the initial period of irradiation at a dose of 2 Gy had the enzymatic activity of catalase in the medulla oblongata with a lower control value by 2%, but higher by 2.5% of the index obtained for irradiated animals. By the end of irradiation (on the 6th day) there is a tendency to restore the activity of the studied enzyme almost to the control level, but in comparison with the group of irradiated animals it is higher by 2%.

A similar pattern can be observed in the study of changes in catalase activity in the cerebellum. The activity of the catalase on the 1st hour, 3rd and 6th day decreases from the control level by 1.5%, 0.7% and 0.2%, respectively. Compared to irradiated groups of animals, the level is lower by 1% (on the 1st hour and 6th day) and 4% (on the 3rd day).

In the visual cortex (shown in Table 1.1), the initial period of irradiation of animals shows a 2.6% decrease in the level of catalase and a 2.5% decrease in the sensorimotor cortex. This is 1.7% and 3% higher than the irradiated animals, respectively. On day 3, a sharp decrease in the activity of the enzyme under study was observed, both in the visual and sensorimotor cortex (in both

brain structures by 3.5% compared to control). Compared to irradiated experimental animals, the differences in the visual and sensorimotor cortex are 3% and 3.8%. Based on experimental data, it can be concluded that the preliminary introduction of saffron extract to irradiated rats helps reduce the level of radical formation and thus leads to a decrease in lipid peroxidation products.

Conclusions

Thus, in the brain structures studied by us, due to the action of X-ray irradiation (2 Gy), the content of various enzymes decreases depending on the duration of the study. The introduction of saffron extract stabilizes the concentration of thiol groups and protects against the oxidative action of free radical compounds that are formed as a result of the influence of irradiation.

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PHARMACOGNOSTIC STUDY OF PLANT RAW MATERIALS OF THE DESERT SAGE (*SALVIA DESERTA SCHANGIN*)

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Abstract

This article presents the findings of a pioneering pharmacognostic study on the desert sage (*Salvia deserta Schangin*), a plant from the *Lamiaceae* family that has received limited attention. The study, conducted in the Southern region of Kazakhstan, identified characteristic diagnostic signs and established the anatomical and diagnostic features of the aboveground part of the desert sage (stem, leaves, flowers). The study also determined the numerical parameters of the plant's raw materials and the quantitative content of various biologically active compounds, including flavonoids, saponins, polysaccharides, coumarins, free organic acids, vitamin C, and tannins.

Key words: plant raw materials, desert sage, macroscopic and microscopic research, numerical indicators, quantitative determination.

Introduction

The use of medicinal preparations prepared from plant raw materials has a rich history, dating back to ancient times, and continues to hold significant value in modern medicine. Plant preparations serve as the primary remedy for a wide range of diseases. In liver and gastrointestinal diseases – 5.62%; in Nervous Diseases – 5.06%; in the treatment of the respiratory tract – 4.24%; in the treatment of cardiovascular diseases – 2.96%; and in the share of drugs with immunomodulatory properties about – 2.76% of drugs made from plants. Phytopreparations made from plants are included in the group of more than 85 pharmacotherapeutic drugs and, in most cases, do not have equal synthetic analogues [1]. This is because, despite the high degree of maturity of organic chemistry, the synthesis of many natural compounds (alkaloids, cardenolides, flavonoid glycosides, acyl coumarins, etc.) is not yet possible or cost-effective. Even if it is possible to synthesise these compounds, phytopreparations, the main active substances, have many advantages due to the complex with excipients that enhance their effect. In addition, plant-originating preparations contain substances created in the "living" system; therefore, they can participate in metabolic processes in the human body, making it possible to use them long-term for many chronic diseases. For this reason, phytopreparations, in comparison with synthetic drugs, are hypoallergenic, have low toxicity, are easily absorbed by the body, and have a low risk of causing side effects so that they can be used for a long time; the effects are mild and reliable [2].

Despite the large assortment of synthetic drugs, treatment with phytopreparations is increasing in countries around the world. According to the World Health Organization, about 80% of the world's population uses medicines of natural origin. The wide popularity of medicinal products based on medicinal plants is due to their origin, environmental friendliness, and high demand in the pharmaceutical market [2].

According to the National Center for Drug Expertise, in January 2023, 7107 medicines were registered in the State Register of the Republic of Kazakhstan; according to the consulting agency Vi-ORTIS, in 2022, the share of drugs on the market was 84.4%, biologically active compounds -9.9 % (in 2021-9.2%), and medical devices -5.7% [3].

A comprehensive plan for the development of the pharmaceutical and medical industry in Kazakhstan for 2020-2025 has been adopted. According to this plan, by 2025, the share of domestic producers in the market of medicines and medical products of the Republic of Kazakhstan will increase from 17% to 30% in monetary terms and from 39% to 50% in in-kind terms [4].

Much attention is paid to using local plant raw materials to increase the share of domestic medicines. In Kazakhstan, 6000 vascular plants grow in the

natural environment, of which 26% are medicinal plants. Pharmaceutical organisations use two hundred sixty types of them, of which only 1.5% are studied and included in the state register [5, 6]. Many plant species have been studied little and are of great interest to scientific research. One of these plants is a species related to salvia.

Salvia officinalis widely used in medicine as a medicinal plant and is included in the state Pharmacopoeia. The pharmaceutical market uses leaves, collections, phytosanitary, solid, soft and liquid forms of *salvia officinalis*[12].

Sage is a relative of *Salvia*, belonging to the *Lamiaceae* family, which has more than 900 species worldwide. There are 13 species of salvia in Kazakhstan. In offal medicine, only *salvia officinalis* introduced as a medicinal plant. One of the little-studied plant species of the genus sage is the desert sage (*Salvia deserta Schangin*). Desert sage is found in Kazakhstan, in the mountainous regions of Uzbekistan, Tajikistan, China, and Russia [6].

The sage has anti-inflammatory, antiexsudative, bacteriostatic and fungicidal, general invigorating, antioxidant, digestive-improving, anti-stinging, antidiabetic, blood-thinning effects [6]. The raw materials of the desert sage contain organic acids, alkaloids, tannins, flavonoids, phenol carboxylic acids and their derivatives, quinones, essential oils, vitamins, and minerals [5, 7, 8].

Materials and methods

Of interest as a source of raw materials is the desert sage, a species of a relative of sage that grows in southern Kazakhstan. To this end, our research was conducted on the scientifically little-studied desert sage plant. A study of the pharmacognostic features and composition of the surface parts of the desert sage collected during the flowering period (June-July) from the foothills of the Kaskasu settlement, Tolebi district, Turkestan region, was conducted. A herbarium was created from the studied plant's raw materials and sent to the Republican State Enterprise "Institute of Botany and phytointroduction", where it was confirmed that it was a desert sage.

Macroscopic and microscopic studies of the desert sage plant were carried out in accordance with the article "Identification of morphological groups of Medicinal Plants" of volume I of the state Pharmacopoeia of the Republic of Kazakhstan (MF RK) [11]. The morphological groups of the desert sage plant's aboveground parts (stem, leaves, inflorescences) were determined using the naked eye and a magnifying glass (10x) [9, 10, 11]. Plant raw materials' anatomical and diagnostic signs were determined based on microscope and microscopic analysis [11, 12]. Anatomical and morphological analysis of the studied object was performed using magnifiers (7x1.5x4. 5; 7x1.

5x8; 7x1. 5x40) in a trinocular digital microscope MT4300L, equipped with an electron microscope of the Meiji TECHNO brand (Japan).

At the next stage, the quality indicators of the desert sage plant were determined. Commodity analysis of desert sage raw materials was carried out according to the state pharmacopoeia of the Republic of Kazakhstan for moisture content, total ash, 10% insoluble in hydrogen chloride, and organic and mineral foreign impurities [11]. Qualitative and quantitative determination of biologically active compounds in the composition of raw materials was carried out according to the methods proposed by Professor R.A. Muzychkina and state pharmacopoeia of the Republic of Kazakhstan [11, 13]. Quantitative determination of biologically active compounds of the desert sage plant was carried out according to the state pharmacopoeia of the Republic of Kazakhstan using spectrophotometric, gravimetric, permanganometric, and titration methods [11, 13].

Results and discussion

Macroscopic research. Desert sage is a shrub or semi-shrub perennial plant that reaches 100 cm in height. The stems of the plant are erect, quadrangular, pubescent, grey-green in colour, and branched; the lower stems are thick up to 1-5 mm, and the upper stems are thin, 1-2 mm, on which inflorescences are located. Species with only one stem are rare (Fig.1).



Fig. 1. Appearance of the desert sage plant

Leaves of the lower stem: up to 10 cm long, up to 4-5 cm wide, oval-ovate shape, sagebrush, heart-shaped at the base, pointed at the tip, nervous system wing-webbed, hairy; leaves in the middle part of the stem: have a medium shape and have short sagebrush; leaves in the upper part of the stem:

delicate, with short or without sagebrush. The upper surface of the leaf plate is green, and the lower surface is grey (Fig. 2).

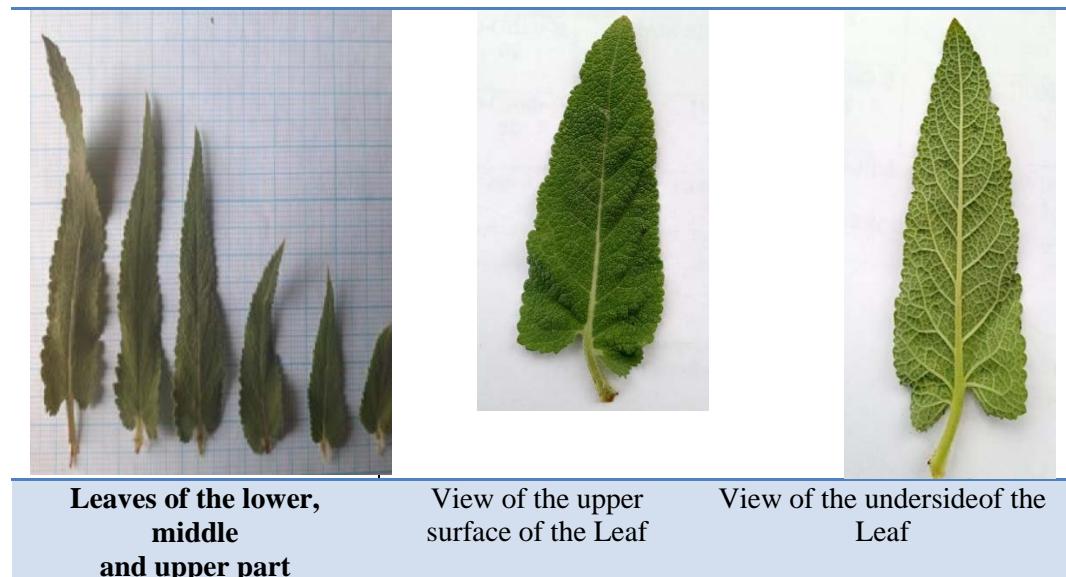


Fig. 2. External view of the leaves of the desert sage plant

The inflorescence is a simple one-two-sided bush with 20-25 false 4-5-flowered branches. The flower is double-lipped, hairy, and purple; the upper lip is round, and the lower lip is two-toothed, shorter than the upper lip. The fruits are dark brown, triangular spherical nuts—bloom in June-August and bear fruit in August-September (Photo 3).



Inflorescences

Flower

Fig. 3. Inflorescences and appearance of the Flower of The Desert sage plant

Location: on steppe slopes, river and ditch banks, steppe slopes, river banks, gravel slopes of mountains, gorges and valleys, from meadows and salt marshes to low-lying mid-mountain belts of mountainous regions [14].

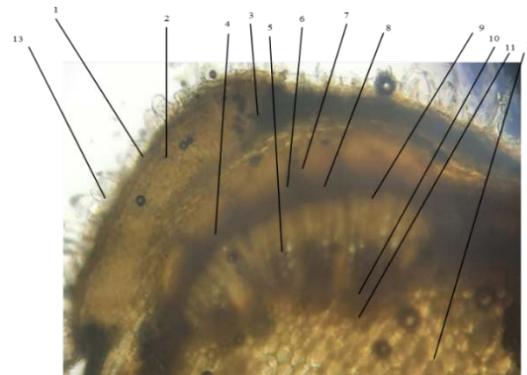
A macroscopic description of the desert sage plant's stem, leaves and flowers was given, and diagnostic signs were determined. As a result of a macroscopic study, it was found that the stems are erect, quadrangular, and grey-green, the lower stems are thick, and the upper ones are thin. The leaves are oval-ovate in shape, saggy, heart-shaped at the base, pointed at the tip, webbed, and pubescent; the colours of the front and lower surface of the leaf plate are different. The flower is double-lipped and purple, the upper lip is round, and the lower lip is two-toothed, shorter than the upper lip.

Microscopic research

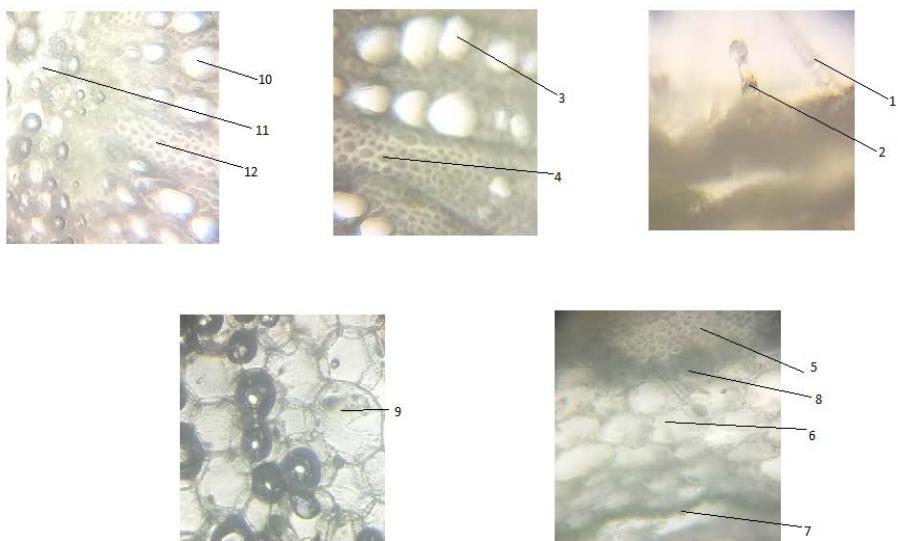
The cross-section of the entire stem of the desert sage is quadrangular; each corner is visible. The collenchyma layer is thick at the corners, and the chlorenchyma is a double layer. The xylem and phloem tubes are radially located from the transverse section of the stem. The core consists of the primary tissue (parenchyma cells). The stem is covered with epidermal covering tissue. Under the epidermis layer are the tangential elongated epidermal cells. There is an endoderm layer between the libriform fibres and the epidermis cells (Fig. 4).

Microscopy of the desert sage *leaf* showed that the upper and lower plate epidermis cells are the same, and the walls are straight or five-hexagonal, thick, and multifaceted.

As a result of microscopic examination, diagnostic signs of the leaf are revealed: abnormal stomata, head hairs, and multicellular essential oil glands. The lower surface of the leaf, in comparison with the upper surface, has a more significant number of stomata and less multicellular hairs. In flower ash, the epidermis cells are weak and strongly zigzagged; there are many essential oil glands; simple and multicellular hairs are often found. The anatomical structure of the stem: epidermis, collenchyma, chlorenchyma, phloem, xylem, the main nucleolus with conductive tufts, conducting elements, formed simple multicellular trichomes.



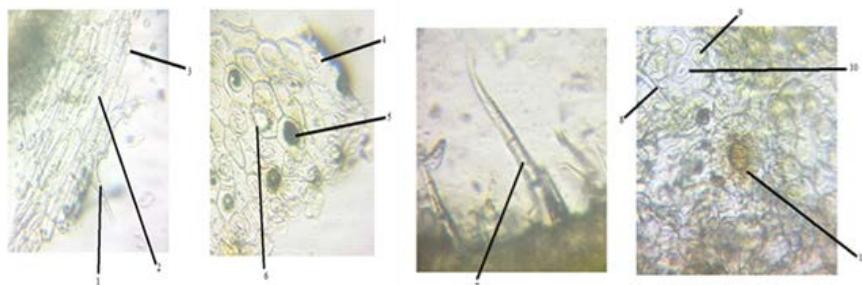
1-epidermis, 2 – collenchyma, 3 – chlorenchyma, 4 – phloem, 5 – xylem, 6 – primary fibers, 7 - main nucleolus in phloem, 8 – conducting elements, 9 – cambial zone, 10 – primary xylem, 11 – perimedullar zone, 12 - nucleus, 13 – simple multicellular trichomes. (10 x 0.22)



1-multicellular hairs, 2-main hairs, 3-xylem (tubes), 4-phloem (roe tubes), 5-libriform (tissue fibres), 6 - tangential elongated epidermal cells, 7 - covering tissue (epidermal layer), 8-endoderm, 9 - core (main tissue, parenchyma), 10 - tubes, 11 – core, 12-roe tubes. (40 x 0.65)

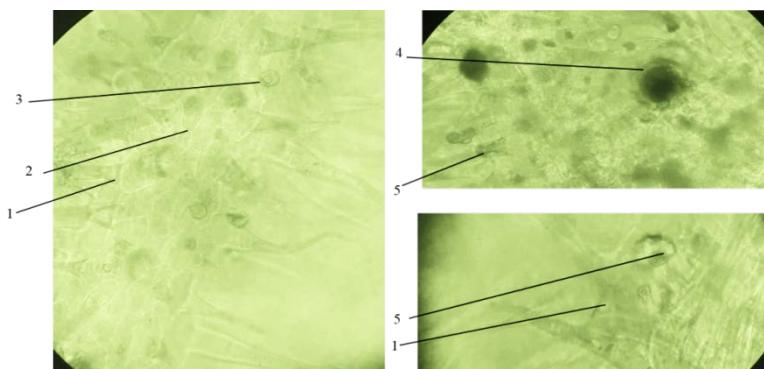
Fig. 4. Microscopy of the anatomical structure of the transverse section of the stem of the desert sage (*Salvia deserta Schangin*)

The following diagnostic signs of the leaf plate were identified: simple pubescence, main pubescence, anomalous stomata, tricellular pubescence, and multicellular essential oil gland. Ethereal glands are located on both sides of the leaf plate. On the upper and lower leaf plates, there are head and multicellular hairs (fig.5, 6).



1-simple hair, 2-elongated epidermal cell with straight walls, 3-main hair, 4- abnormal stomata, 5-place of hairs, 6-five-hexagonal epidermal cell with straight walls, 7-tricellular hair, 8-simple hair, 9-place of hairs, 10-stomata, 11- multicellular essential oil gland

Fig. 5. Microscopy of the anatomical structure of the front surface of the leaf of the desert sage (*Salvia deserta Schangin*).



1-simple hair, 2-five-hexagonal epidermal cells with straight walls, 3 - anomacytic stomata, 4-multicellular essential oil glands, 5-head hairs

Fig. 6. Microscopy of the anatomical structure of the lower surface of the leaf of the desert sage (*Salvia deserta Schangin*).

Microscopy of the desert sageflower was made on a whole ash. In the course of the study of flower ash microscopy, the following diagnostic signs were revealed: the walls of epidermal cells are strongly zigzagged, simple and

main hairs, diacytic stomata, elongated epidermal cells located along the essential sebaceous glands and the conducting tuft (Fig. 7).

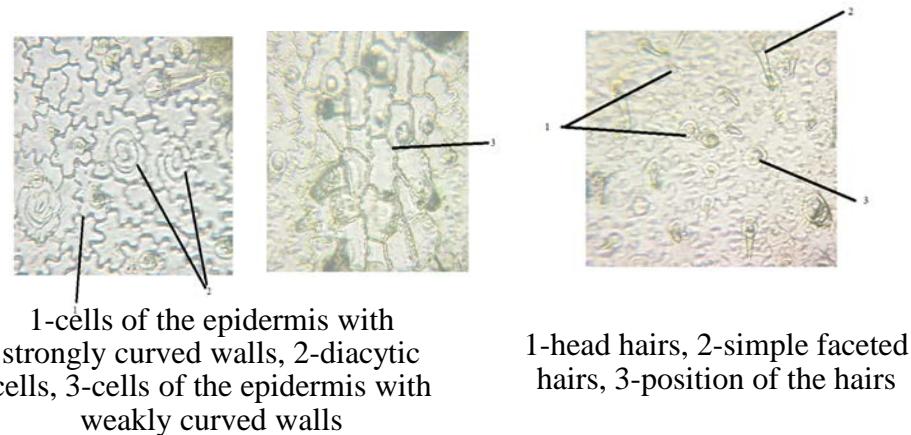


Fig.7. Microscopy of the anatomical structure of the flower of the desert sage (*Salvia deserta Schangin*).

Commodity indicators of the desert sage plant are given in Table 1 in comparison with the indicators of the *salvia officinalis* plant shown in the pharmacopoeial Article [8]. To determine the commodity indicators of desert sage raw materials, the results of 3 repeated studies were obtained, and the data obtained were statistically processed in Excel.

Table 1.
Results of commodity analysis of desert sage raw materials

| № | Quantitative indicators | The result | |
|---|--|---------------------------|----------------------------|
| | | <i>Salvia officinalis</i> | <i>Salvia deserta Sch.</i> |
| 1 | Humidity, % | Not more than 14 | 4,2644±0,22 |
| 2 | General ash, % | Not more than 10 | 9,4517±0,07 |
| 3 | 10% hydrogen chloride insoluble ash, % | Not more than 3 | 1,4632±0,1 |
| 4 | Organic foreign impurities, % | Not more than 3 | 1,06±0,07 |
| 5 | Mineral foreign impurities, % | Not more than 0,5 | 0,536±0,08 |

The study's results showed that the moisture content of desert sage plant raw materials is 4.2%, the total ash content is 9.4517% and 10% insoluble ash in hydrogen chloride is 1.4632%. These indicators correspond to the requirements of the pharmacopoeial Article for *Salvia officinalis*. It was found that the content of organic foreign impurities is not higher than 3%, and the content of mineral impurities is slightly higher.

Qualitative studies of biologically active compounds in desert sage plant raw materials were carried out using special reactions characteristic of the main groups (Table 2). The addition of qualitative reagents that identify the biologically active compound in the composition resulted in discolouration and precipitate formation. A liquid extract of desert sage prepared with 70% ethanol was used for a qualitative study.

Table 2.
Biological active compounds of desert sageraw materials qualitative determination

| Raw materials | Qualitative reactions | | | | | | |
|---|-----------------------|-------------------|---|--|--|---------------------|--------------------|
| | Flavonoids | | Saponins | | Polysaccharides | Coumarins | Tannins |
| H ₂ SO ₄ 1% vanillin solution | | FeCl ₃ | vanillin + H ₂ SO ₄ conc. | Pb(CH ₃ COO) ₂ | 20% ethanol solution of thymol + H ₂ SO ₄ (inulin) | Dragendorff reagent | Iron-ammonium alum |
| Desert sage | red colour | dark green colour | red colour | mucus is a voluminous precipitate like cotton wool | pink, purple color | brown colour | dark green colour |

The *Quantitative determination* of 7 groups of biologically active compounds found in raw materials was carried out, the results of which are presented in Table 3.

It was found that the quantitative content of biologically active compounds of desert sage raw materials, when recalculated to quercetin, contains flavonoids 0.039%, saponins 8.35%, coumarins 2.35%, tannins 8.67%, polysaccharides 0.62%, vitamin C 0.83%, and free organic acids 0.11%.

Table3.

**Biological active compounds of desert sage raw materials
quantitative determination**

| № | Type of biologically active substance | Research approach | Surface part of the desert sage, % |
|----------|--|--|---|
| 1 | Flavonoids | spectrophotometric ($\lambda=430$ nm) | 0,0392±0,002 |
| 2 | Saponins | spectrophotometric ($\lambda=258$ nm) | 8,350±0,014 |
| 3 | Polysaccharides | gravimetric | 0,626±0,021 |
| 4 | Coumarins | spectrophotometric ($\lambda=272$ nm) | 2,350±0,041 |
| 5 | Free organic acids | alkalimetric titration | 0,114±0,018 |
| 6 | Vitamin C | titration | 0,830±0,024 |
| 7 | Tannins | permanganatometric titration | 8,67±0,013 |

Conclusions

So, a pharmacognostic study was conducted on the desert sage plant, a South Kazakhstan population of a plant of the Lamiaceae family, a relative of sage *Salvia*. As a result of the study, anatomical and morphological diagnostic features of the desert sage were identified.

A commodity analysis of raw plant materials was conducted, and the leading quality indicators were determined. Research of the desert sage plant as a medicinal raw material continues.

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NEW APPROACHES FOR THE TREATMENT OF DISEASES, CAUSED BY ANTIMICROBIAL RESISTANT MICROORGANISMS

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Abstract

Antimicrobial resistance of causative agents is one of the most urgent problems of modern medicine. Diseases and deaths caused by antimicrobial resistant microorganisms are increasing all over the world. So, the measures aimed at preventing resistance - consideration of sensitivity to antibiotics, rational use of antibiotics, control over the use of antibiotics, prevention of it by affecting resistance mechanisms, etc. has not yet been able to solve these problems. Thus, the treatment of diseases caused by antimicrobial resistant microorganisms requires new approaches. Considering this point of view, bio regulatory therapy, which treats disorders caused by various factors in the biological system, is of special interest. The drugs used in bio regulatory treatment are complex drugs, and in addition, they act by activating the body's defense factors, which is one of the important principles in the treatment of infectious pathology.

Bacterial resistance to antibiotics poses a serious threat to human health. The spread of resistance makes effective treatment increasingly difficult. Since antibiotics are used everywhere - in medicine, veterinary medicine, industry, etc., the problem of antibiotic resistance is growing and deepening.

Between 2014 and 2016, around 700,000 people worldwide died each year from infections caused by antimicrobial resistant bacteria, according to the UK Department of Health. By 2050, this number could increase to 10 million people per year [3]. As of 2019, in the United States and European countries alone, about 68,000 people die annually from infections caused by antimicrobial resistant bacteria [4, 5].

Antimicrobial resistant strains of bacteria can be passed from one person to another, and the extent of the problem is not yet known. For example, the question "could the situation in countries with high consumption of antibiotics and unregulated use worsen the epidemiological situation in other countries

where the use of antibiotics is regulated?” The answer of this question is the affirmative. This means that the danger is greater than we think.

The spreading of resistance is influenced not only by antibiotic consumption or travel, but also by other factors. Thus, a study conducted in 2017 showed that bacterial resistance to antibiotics increases with an increase in average annual temperature by 2-4% [6]. According to another study conducted in 2018, the social and economic factors also influence the spreading of resistance: the better the infrastructure is developed and the more the government spends on healthcare, the lower the prevalence of antibiotic resistance [7].

The depletion of effective antimicrobial drugs also means that safe surgical operations will be impossible, as well as immunosuppressive drugs used in transplantology, in the treatment of malignant tumors, will not be able to be used [3].

It is practically impossible to prevent the development of antimicrobial resistance in bacteria. However, it is possible to limit its occurrence to a certain extent by rational use of antimicrobial drugs. For example, antibiotics should be prescribed only when there is a definite indication, they should not be used as much as possible for prophylactic purposes, antibiotics with a limited spectrum of action should be used whenever possible, and antibiotics should not be used as the conservants.

Synthesis of new antibiotics is one of the ways to prevent resistance of microorganisms to antibiotics. However, experiments show that after a certain period of time, the resistance to newly synthesized antibiotics are formed. For example, there are resistant strains as methicillin-resistant staphylococci that are resistant to all beta-lactam antibiotics.

Therefore, it is necessary to look for drugs that affect the resistance mechanism, because there are already bacteria that cannot be destroyed by any antibiotic. On the other hand, there is a need for research that discovers new properties of drugs that are already known as one of the ways to stop resistance and thereby save millions of lives.

Based on the study of the resistance mechanisms of the microorganisms to antibiotics, recently some antibiotics are combined with beta-lactamase enzyme inhibitors. Sulbactam and clavulanic acid are better studied among beta-lactamase enzyme inhibitors. The beta-lactam ring in the composition of these substances combines with beta-lactamases and neutralizes them, as a result, the effect of these enzymes on beta-lactam antibiotics is prevented. Ampicillin combined with sulbactam (unazine, etc.), and amoxicillin with clavulanic acid (augmentin, amoxiclav, etc.) are widely used in medical practice.

One of the ways to prevent the resistance of microorganisms to antibiotics is to consider the sensitivity to antibiotics during treatment.

The search for new solutions in the fight against antimicrobial resistance is mainly carried out in two directions: First, to develop more and more new drugs that can effectively kill antimicrobial resistant microorganisms. Second, to slow the spread of resistance by reducing the amount of antibiotic consumption.

In the first direction, new antimicrobial substances are synthesized and put into use every year. However, experiments have shown that the use of new antimicrobial agents cannot solve the problem of resistance, as resistance to new antimicrobial drugs is also formed over time. Therefore, in the fight against resistance, it would be good to conduct research in the direction of converting *известные* already known antibiotics into effective medicine. For this, it is necessary to analyze the mechanisms of transmission, maintenance and implementation of the antibiotic resistance.

Resistance to antibiotics is mainly provided by resistance genes (r-genes). Resistance genes primarily encode the synthesis of enzymes (eg, beta-lactamase, etc.) that ensure drug resistance of microorganisms. These genes can be transferred from one bacterial cell to another in the form of transposons and plasmids. The plasmids with resistance genes are called R-plasmids or R-factor. A bacterial cell can have one or several R-plasmids. In the latter case, resistance to several antibiotics - polyresistance is observed at the same time. It should be noted that antibiotics do not induce the formation of r-genes, but only cause the selection of the microbial population possessing these genes. Such selection occurs easily under the influence of antibiotics, with resistant microbes gaining an advantage over other cell populations that are sensitive to the antibiotic. The formation of a continuous microbial population due to the effect of antibiotics is ensured by this mechanism.

Currently, plasmid-related resistance is widespread among bacteria, and one of the main characteristics of this resistance is rapid spreading in the microbial population. For example, in the medicine, diseases caused by carbapenem-resistant enterobacteria (CRE) are increasing. Carbapenems are so-called "last chance" antibiotics, that is, antibiotics used only in extreme cases when no other antibiotics have helped. CREs are often resistant not only to carbapenems, but also to antibiotics from many other groups, which makes the treatment of diseases caused by these bacteria extremely difficult [8]. In 2019, the US Centers for Disease Control and Prevention placed carbapenem-resistant Enterobacteriaceae among the five groups of microorganisms that are a priority for protection as a public health threat [4].

Recently, in the fight against resistant bacteria such as CRE, they try to stop their work by interfering with the resistance plasmids located in the

bacteria. Research conducted in line with this idea has proven the effectiveness of blocking resistance plasmids in the fight against antibiotic-resistant strains [9]. After testing more than 12,000 bioactive compounds, the researchers found that plasmid copies associated with resistance in CRE strains are not propagated in the bacterial culture during division, so subsequent bacterial generations are susceptible to carbapenems. Casugamicin, one of the first representatives of such drugs, is an aminoglycoside antibiotic that inhibits the synthesis of the RepE protein, which, according to researchers, plays a key role in the propagation of CRE through replication (duplication) [9].

Thus, the use of some of these drugs can lead us to victory against carbapenem-resistant enterobacteria. But the scientists who conducted the mentioned studies have a long and arduous task to find or synthesize substances that will be effective in overcoming the resistance mechanism that we have described. On the other hand, since the studied substances affect the gene level, their effect on human genes should be evaluated quite correctly. Research like this gives hope that we can also stop existing resistance mechanisms by creating antibiotics to which bacteria have not yet developed resistance. Thus, 10 million deaths in the future will never become a reality.

Mutations occurring in the microbial population also play a role in ensuring the resistance of microorganisms to antibiotics. For example, resistance to methicillin of some *S.aureus* strains is associated with gene mutations in them, which encode the synthesis of penicillin-binding proteins that cannot combine with beta-lactam antibiotics. For this reason, methicillin-resistant *S.aureus* strains are resistant to all beta-lactam antibiotics. Such mutations are not caused by antibiotics, in this case antibiotics only play a selective role in the persistent microbial population, eventually, the entire microbial population becomes resistant to a certain antibiotic.

Finally, despite their selective effectiveness, the use of antibiotics can cause many additional effects in the body. Since most antibiotics have antigen properties, their use can cause allergic reactions and even life-threatening anaphylactic reactions.

Since the long-term use of antibiotics, especially broad-spectrum antibiotics, as a rule, causes the destruction of the representatives of the normal microflora of the body, dysbiosis and dysbacteriosis can develop in the body. The risk of secondary infection arises in dysbacteriosis accompanied by the selection of representatives of the facultative microflora (*Pseudomonas aeruginosa*, *Staphylococcus* spp, *Proteus* spp, *Candida* spp, etc.) that have resistance to the applied antibiotic.

Long-term use of some antibiotics can have a toxic effect on the body. For example, aminoglycoside antibiotics, especially streptomycin, kanamycin, gentamicin, etc. Effects on the vestibular and auditory organs (ototoxic effect),

tetracycline on the liver (hepatotoxic effect), cephalosporins on the kidneys (nephrotoxic effect) are well known. Many antibiotics (for example, teracyclines, quinolone drugs, etc.) pass through the placenta and can have a negative effect on the development of the fetus, especially during the first trimester of pregnancy. Quinolones (ofloxacin, ciprofloxacin, etc.) are not prescribed to children and adolescents because they have a negative effect on the formation of cartilage and bone.

In the treatment of infections caused by antimicrobial resistant microorganisms, the importance of treatment aimed at increasing the body's defense is undeniable. However, immunostimulators and immunomodulators, which are widely used in traditional medical practice, do not have the desired effect in diseases caused by resistant microorganisms, but are used as auxiliary drugs.

Therefore, as mentioned, it is necessary to search for new opportunities in the treatment of diseases caused by resistant microorganisms. From this point of view, bio regulatory therapy based on the principles of detoxification, immunomodulation, cell, tissue and organ support is of particular interest [1, 2]. Bio regulatory therapy treats disorders caused by various factors in the biological system. The drugs used in bio regulatory therapy are complex drugs, and their combined effect creates a detoxification effect. On the other hand, another principle of bioregulatory therapy is not only to eliminate symptoms, but also to activate the body's defenses. Thus, the principles of bioregulatory therapy are as follows:

- Regulatory effect on the organism, which is an open biological system;
- Combining and removing substances that are toxic for the body;
- Increasing the body's defense forces;

Based on the above-mentioned principles of bioregulatory therapy, complex medicinal preparations have been prepared. These preparations consist of natural components, plant extracts, animal organ extracts, sterilized cultures of microbes, mineral substances, enzymes, etc. These components are not concentrated substances, prepared by special methods, but their micro doses. When these micro doses enter the body, they do not overload it, but instead stimulate its systems and activate additional defense mechanisms. It is related to the stimulation of regulatory, detoxifying and defense forces, unlike traditional treatment methods.

The main advantages of bioregulatory treatment include:

- Treatment affects the etiology and pathogenetic mechanisms of the disease,
- Treats the patient, not the disease,
- During the treatment, the impaired functions of self-regulation, recovery and defense systems are restored,
- Other organs and tissues are not damaged during treatment,

- The effect of the treatment is long-lasting and effective,

One of the main links of bioregulatory therapy is immunomodulation. In most diseases, there is an imbalance of the immune system, and this imbalance is mainly observed among T helpers. Thus, Th2 lymphocytes are involved in immediate type allergic reactions, and Th1 lymphocytes are involved in slow type allergic reactions and other inflammatory processes. Since the balance between these cells can be ensured by Th3, it is necessary to activate Th3 lymphocytes. For the purpose of immunomodulation, all preparations containing bacterial lipopolysaccharides and amino acids are used in dilutions.

Medicine based on bioregulatory therapy has a unique approach to disease development mechanisms. All diseases have a development mechanism (pathogenesis) consisting of 6 phases. The human body and each of its organs is composed of cells and intercellular substance (matrix). Due to the influence of homotoxins, the first begin changes in the matrix. In the first - secretion phase, due to the body's ability to self-regulate, these changes are easily eliminated, therefore, almost no treatment is required. In the second - inflammatory phase, changes in the matrix are accompanied by inflammatory reactions, in which the body tries to eliminate toxins through inflammatory reactions. In the third - storage phase, homotoxins accumulate in the matrix, but the body is still able to remove them. The fourth - impregnation phase is accompanied by homotoxins combining with the matrix, "absorbing" there, in which case the body is no longer able to eliminate them. In the fifth - degeneration phase, changes in the matrix disrupt the normal functioning of cells and they undergo degenerative changes. The last (sixth) phase results in the dedifferentiation (malignization) of cells, which leads to the development of various tumors.

By influencing each of these phases through bioregulatory therapy, it treats the disease phases on the principle of reversing them.

Some of the bioregulatory drugs recommended for use in the treatment of diseases caused by antimicrobial resistant microorganisms are as follows:

Echinacea compositum is widely used as an immunomodulator in bioregulatory therapy. Fever and inflammation, postvaccinal encephalitis, influenza, angina, boils, abscesses, gingivitis, stomatitis, sinusitis, gastroenteritis, enterocolitis, cystitis, pyelitis, colpitis, leucorrhoea, adnexitis, glomerulonephritis, fistula suppurations, osteomyelitis, otitis media, chronic brain abscess, meningitis, anthrax, carbuncles, mononucleosis, skin diseases, mastitis, etc. it has an effect by stimulating the internal defense of the body.

Traumeel S regulates inflammatory processes. The mechanism of immunological action of Traumeel is related to inhibition of secretion of inflammatory cytokines IL-1 β , TNF- α and IL-8. In addition to reducing acute inflammation in vivo, the drug does not affect the function of granulocytes (for example, superoxide anion production), which indicates that the normal defense

and homeostatic functions of these cells are preserved. Traumeel acts by speeding up the healing process by regulating the general processes of acute local inflammation. The low potency of plant extracts (including *Bellis perennis* and *Atropa belladonna*) contained in Traumeel has a stimulating effect on the synthesis of the inhibitory cytokine TGF- β by lymphocytes in whole blood cultures. By inhibiting other inflammatory cytokines (eg, TNF α and IL-1) through the synthesis of TGF- β in T-lymphocytes, the support of the inflammatory process is prevented. Engystol - slows down the reproduction of microorganisms, including viruses, in the body by stimulating non-specific defense systems. Engystol stimulates γ IFN secretion, significantly increases the activity of T-lymphocytes and granulocytes.

Galium-heel - is applied for activation of non-specific defense mechanism, especially in chronic diseases. Its use is especially appropriate for diseases located in the matrix and cellular phases. The use of this drug is especially necessary in diseases accompanied by dedifferentiation by acting through intracellular detoxification.

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ROLE OF THE HUMAN INTESTINAL MICROBIOTA IN THE DEVELOPMENT OF DISEASES

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Abstract

The intestinal microflora of different individuals differs quantitatively and qualitatively and depends on age, diet, environmental factors and other factors. Each person has their own unique microbiota. The intestinal microbiota develops, becomes more diverse and stabilizes during approximately the first three years of life. After reaching adulthood, its composition remains relatively stable until old age, when it again undergoes profound changes, but for the worse.

The intestinal ecosystem is characterized by various physiological and pathological relationships with the host, which include the regulation of mucosal/systemic immunity, metabolic and trophic functions. The gut microbiota plays a key role in maintaining human health, and many diseases are associated with imbalances in the gut microbiota.

Key words: *intestinal microbiota, human health*

The human gut is a densely populated heterogeneous microbial system consisting of at least 10^{14} bacteria and archaea, which belong to more than 1000 species. It is estimated that the number of microbial cells in the intestinal lumen is 10 times higher than the number of eukaryotic cells in the body - they contain 150 times more genes than the human genome [1].

The gut microbiota plays a key role in maintaining human health. The intestinal microbiota is considered one of the functional organs of the human body. This organ works closely with the intestines, playing 4 important roles:

1. Promotes digestion by helping intestinal cells absorb nutrients (sugars, amino acids, vitamins, etc.), or participates in the enzymatic breakdown of a small part of food. Fermentation produces various gases and metabolites,

such as short-chain fatty acids, which act as fuel for bacteria in the large intestine [2].

2. Supports the functioning of the digestive tract by actively participating in the production of mucus, irrigation of intestinal cells and modulation of the enzymatic activity of the mucous membrane [3].

3. Acts as a barrier protecting against pathogenic microbes and toxins [4]. In addition, some bacteria secrete antimicrobial substances that inhibit the growth of pathogenic bacteria, while others stimulate the production of mucus, which protects intestinal cells from microbial invasion and the development of diseases that adversely affect the body as a whole [5].

4. Protects the body by strengthening the immune system. Bacteria in the intestinal flora contribute to the maturation and activation of cells of the intestinal immune system, which protects us from pathogenic bacteria and viruses. The intestine is the main reservoir of immune cells in our body. In turn, the immune system influences the composition and diversity of the microbiota [6].

The intestinal microflora in the gastrointestinal tract differs quantitatively and qualitatively between individuals and depends on age, diet, environmental factors and other factors. Each person has his own unique microbiota, as unique as, for example, fingerprints [7]. The human intestine, which remains sterile in utero, becomes colonized immediately after birth. When a person is born, fecal and vaginal microorganisms transmitted from the mother during vaginal birth, or microorganisms from the environment (in the case of cesarean section) [8] begin to colonize the intestine, forming the microbiota [9]. During the first 3-4 weeks, the composition of the bacterial flora is finally established. It is specific to different parts of the gastrointestinal tract.

In the stomach, duodenum, and jejunum, bacteria are contained in limited quantities. The bacterial flora is represented by oropharyngeal aerobic gram-positive bacteria (gram-positive lactobacilli and enterococci). In the small intestine, the concentration of bacteria reaches 10^5 - 10^9 colony-forming units (CFU) per 1 g of intestinal contents. These are mainly *E. coli*. Behind the ileocecal valve, the concentration of bacteria increases to 10^9 - 10^{12} CFU. The most common are *bacteroides*, *bifidobacteria*, *clostridia* and *lactobacilli* [10].

During approximately the first three years of life, the intestinal microbiota forms, becomes more diverse and stabilizes [11]. After reaching adulthood, its composition remains relatively stable until old age, [12] when it again undergoes profound changes, but for the worse [13].

The intestinal ecosystem is characterized by various physiological and pathological relationships with the host, which include the regulation of mucosal/systemic immunity, metabolic and trophic functions [14]. The

intestinal microbiota is also involved in the metabolism of peptides. Proteolytic fermentation leads to the formation of polyphenols with anti-inflammatory effects, and anaerobic metabolism leads to the formation of potentially toxic substances such as ammonia, amines, phenol and indole.

The complex interaction between bacteria and the mucosal surface is necessary not only for the maturation of the immune system, but also for adequate trophism and ensuring the integrity of the intestinal barrier. The microbiota is involved in the absorption of some nutrients through their fermentation, and this is the only possible route for their absorption. Fermentation of carbohydrates leads to the formation of short-chain fatty acids, which covers part of the body's energy needs (approximately 5-15%) and affects the differentiation and proliferation of mucosal cells, the absorption of iron and vitamins.

The mucous membrane represents a barrier between the environment and the human body, at this level a complex dialogue takes place between the host and intestinal bacteria. Intestinal microflora contributes to the maturation of the immune system, the simultaneous development of protective functions and immune tolerance, and maintains intestinal homeostasis.

Intestinal microorganisms have stable molecules - so-called pathogen-associated molecular patterns (PAMPs), which are recognized by specific pattern recognition receptors (PRRs). PRRs include Toll- and Nod-like receptors. The Toll-like receptor family includes 11 different receptors that are specific for different PAMPs. Stimulation of PRR leads to the activation of several different intracellular signaling cascades, many of which activate nuclear factor κ B, which increases the transcription of a large number of inflammatory cytokines and chemokines [15].

The microbiota itself is an integral part of the “gut barrier”, as it inhibits the engraftment and growth of pathogenic flora by competing for nutrients, producing antimicrobial substances and reducing the free surface for the attachment of enteroinvasive bacteria [16,17].

It is well known that qualitative and/or quantitative changes in the intestinal microbiota play an important role in the occurrence of gastrointestinal and systemic diseases, such as inflammatory bowel diseases, colon cancer, bacterial overgrowth syndrome, irritable bowel syndrome, etc. [18, 19].

Diseases are associated with imbalance of the intestinal microbiota

- Infantile colic occurs in 20–25% of infants aged 1–4 months [20].
- Antibiotic-induced diarrhea occurs in 5–35% of patients receiving antibiotic therapy [21].

- Traveler's diarrhea is an infection caused by contaminated food or water. Post-infectious irritable bowel syndrome may occur in 3–17% of patients with this infection [22].
- Gastroenteritis is usually benign and is most often caused by viruses. However, it is responsible for more than 200,000 child deaths per year worldwide [23].
- Obesity is a very common, socially and health-costing serious chronic disease, affecting 13% of adults worldwide in 2016 (11% of men and 15% of women) [24].
- Irritable bowel syndrome is one of the most common functional gastrointestinal disorders, which is manifested by abdominal pain and a change in the usual rhythm of bowel movements (constipation, diarrhea, or alternation of both). The prevalence of this condition varies greatly between countries [25]
- Crohn's disease is an inflammatory bowel disease that can affect any part of the digestive system from the mouth to the anus. Recent research data indicate an important role of the intestinal microbiota in the development and course of this disease [26].
- Gastric cancer is also associated with disruption of the intestinal microbiota [27,28].

The functions of the human gut microbiota are not limited to the intestine: recent studies have shown that the gut microbiota may play a role beyond the gastrointestinal tract. It has been established that the intestinal microbiota is associated with the development of a number of extraintestinal diseases, such as acne [29], allergies [30], obesity [31], anxiety disorders and autism spectrum disorders [32]. However, this is not all. It is believed that the intestinal microbiota may be associated with the development of neurodegenerative diseases such as Alzheimer's disease [33] and Parkinson's disease [34].

It has long been established that there is a bidirectional connection between the gut and the brain, called the brain-gut axis, and the gut microbiota can influence the interactions between these organs. This is why our gut is sometimes called the “second brain.” The ability of bacteria to produce and recognize neurochemicals [35] provides a mechanistic basis for studying the ability of the microbiota to influence the microbiome-gut-brain axis. Recognition that prokaryotic as well as eukaryotic microorganisms produce and possess receptors for a wide range of neuroendocrine hormones has been known for decades [36, 37].

The spectrum of neurohormones found in microorganisms is extremely diverse: from somatostatin to acetylcholine and progesterone. Most importantly, microorganisms inhabiting the gastrointestinal tract are capable of producing

neurochemicals that can bind to host receptors (intra- and extra-intestinal) in sufficient quantities to cause neurophysiological changes in the host.

The connection of the gut microbiota to the brain through the so-called microbiota-gut-brain axis represents a new biological axis through which new diet-based treatments could be developed to influence brain function and behavior. The role of the microbiome in determining behavior and cognition is increasingly recognized [38, 39]. The development of the brain itself in the growing infant has been shown to be influenced by the microbiome [40].

Ways to positively influence the balance and diversity of gut microbiota:

- Diet: The variety and quality of our food helps maintain the balance of the intestinal microbiota, since an unbalanced diet will negatively affect the composition of the intestinal contents and leads to the development of certain diseases. It is important to know which foods have a beneficial or negative effect in order to keep your gut in optimal shape.
- Probiotics: These are “live microorganisms that, when consumed in sufficient quantities, provide a health benefit to humans.” The use of probiotics is highly effective in all diseases when it is necessary to restore the normal composition of the intestinal microbiota.
- Prebiotics: These are specific health-promoting non-digestible dietary fibers that are selectively used by beneficial microorganisms within our microbiota. Some foods are especially rich in prebiotics, so it is important to monitor their presence in the diet. In some products, prebiotics are added to probiotics - these are called symbiotics.

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AUTHORIAL EDUCATIONAL MODULE FOR DEVELOPING COMPETENCIES IN CREATING MODERN QUALITY SYSTEMS

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Summary

An authorial model is presented for training specialists capable of creating modern quality systems in pharmaceutical organizations, along with the characteristics of the educational-methodological complex for a new elective discipline.

Abstract

A modern educational module has been developed, reflecting the trends of modern transformations in the pharmaceutical industry. The study also revealed low motivation of pharmaceutical organizations' personnel to improve their qualifications in quality systems development, due to the lack of basic knowledge among pharmacists and the lack of sufficient educational programs and modules.

Introduction

The rules of Russian Good Pharmacy Practice (GPP) and Good Pharmaceutical Storage and Transportation Practice (GPS&TP) [4, 5], define the basic requirements for the work of pharmaceutical (PO) and medical organizations (MO), which are based on elements of international standards ISO 9000 series [3]. The creation of a quality system for FIs is the main innovation of the above documents. The construction of such a system will guarantee the improvement of the quality of drug circulation and increase consumer satisfaction [1, 2]. However, due to the lack of a holistic understanding of the basics of standardization and quality standards in management processes among pharmacists and health workers, the

implementation of the quality system in the work of pharmaceutical and medical organizations is slowing down. The structure of the main identified violations during inspections within the framework of state control (supervision) is common for all pharmaceutical and medical organizations: lack of quality system, approved quality manuals and standard operating procedures (SOPs), necessary journals, internal control by the management of organizations, internal inspections (audits), non-compliance with the conditions of storage of medicines, rules of sale and dispensing of medicines in the inspected entities.

Research objective. Develop an authorial program to develop competencies in creating modern quality systems for pharmaceutical services and products..

Results. Insufficient level of basic knowledge of pharmacists on modern normative and legal documentation, on quality management systems of services and products, proves the need to develop modern educational programs (modules) to eliminate the gap in the level of knowledge and skills of specialist pharmacists and graduates of pharmaceutical faculties. There is an obvious need to train qualified personnel with knowledge and understanding of the role of quality systems of organizations and standards. The introduction of the variant discipline "Standardization and certification in pharmaceutical activity" into the basic educational program of the specialty 33.05.01 - pharmacy in NOSMA is dictated by the needs of the pharmaceutical industry, the requirement of GPP. It will allow to form in future specialists the necessary competencies in the field of the basics of creating systems to ensure and improve the quality of products, processes, services of PHO. The purpose of mastering the discipline is to form an understanding of the role of standardization and certification in improving the quality of products, processes, services at the current level of development of the pharmaceutical industry.

The program of elective discipline in the 5th course "Standardization and certification in pharmaceutical activities" is aimed at the acquisition by students of the basics of standardization, ensuring:

fulfillment of the rules of GPP and GPS&TP, established requirements for the implementation of retail trade in the PO;

safety of products, processes and services for consumers;

creation of conditions for activity in the common commodity market of the Russian Federation.

The following competencies and benchmark indicators of competency achievement were selected (Table. 1) To ensure the educational process at the Department of Pharmacy of NOSMA was developed educational and methodological complex for the discipline "Standardization and certification in pharmaceutical activity". The content of the discipline is divided into three

modules. The first module is designed to study the basics of standardization in the Russian Federation, terminology and requirements for standardization.

Table 1.
Content of competencies in the discipline "Standardization and certification in pharmaceutical activity".

| Competencies | Contents of competence |
|--------------|--|
| SC – 12 | Capable of creating systems to ensure and improve the quality of products, processes, services and quality management systems in a pharmaceutical organization |

The second - studies international quality management systems, terminology used, basic provisions and requirements. This general knowledge is lacking in order for providers to understand the requirements of good practices developed on the basis of the ISO 9000 standard requirements. The study of all the requirements of good practices [1, 2] is included in the third module (Table 2).

Table 2.
Contents of the discipline «Standardization and certification of pharmaceutical activity»

| Semester | Name of topic (section) of the discipline |
|----------|--|
| 1 | 2 |
| 9 | Section 1. State system of standardization in Russia (SSS RF). The essence of standardization, its role and place in modern conditions of market relations. Legal foundations of standardization |
| 9 | Section 2: International Standards 9000 (ISO 9001 / ГОСТ Р ISO). Quality management systems, basic concepts and requirements. International organizations for standardization and quality control. System and concept of technical regulation. |
| 9 | Section 3: Good practice in pharmacy. Documentation of processes of pharmaceutical organization. Standard operating procedures as an integral part of the quality management system. |

The types of learning activities in mastering this discipline are

represented by lectures in the amount of 20 hours, practical classes in the amount of 52 hours and supplemented by independent work of students (IWS) in the amount of 36 hours. A new mechanism for assessing the level of competence formation in traditional and interactive forms has been developed (Table 3).

Table 3.
Decoding the educational technologies used.

| LV | Lecture - visualization | SC** | Situational challenges |
|------|---|-------------|---|
| LD* | Lecture - discussion | BG*, RP* | Business game Role-playing game |
| WS** | Work with information sites | WD** | Work with regulatory documents |
| PT** | Practical training | IS | Independent study of the program |
| M ** | Meetings with representatives of pharmaceutical organizations | SERW** | Student's educational and research work (information search, literature review, reports, formalizing the results of participation in internal audits (protocols). |

Note: without asterisks - traditional educational technologies;

* - interactive educational technologies; ** - practice-oriented educational technologies.

The forms of current control of progress in this discipline are presented in Table 4.

Table 4.
Forms of current progress control

| CW | Control work | T | Testing |
|----|------------------------------------|-----|--------------------------------|
| H | Homework (check) | Ps. | Assessment of practical skills |
| CA | Comprehensive knowledge assessment | I | Interview, oral survey |
| R | Review of internal audit protocol | | |

For independent work of students on this discipline there are developed educational and methodical support and sets of documentation on quality (table 5)

Table 5.
List of educational and methodological support for independent work of students in the discipline

| semester | Name of educational and methodological development |
|----------|--|
| 9 | Methodical recommendations on extracurricular activities for 5th year students |
| | Set of Test Assignments |
| | Multimedia Lectures |
| | Set of Quality Manuals with Quality Policy and Objectives |
| | Set of Standard Operating Procedures (SOPs) |
| | Set of Work Journals |
| | Set of Regulatory Orders |

Discussion

In order to fulfill one of the main requirements of the federal state educational standard, the creation of learning systems in the workplace, or in a situation simulating the work environment, part of the classes on standardization and certification in pharmaceutical activity in the 9th semester is conducted in the pharmacy of the basic clinic of NOSMA. Students are familiarized with quarantine areas, study the documentation of the quality system in accordance with the GPP and GPS&TP, guidelines, objectives, quality policy, SOPs for the main processes of the PO, including product acceptance and storage.

The region's practice sites are helping to consolidate these skills in establishing quality management systems for PO and pharmaceutical sales processes. All these innovations require changes in the working programs of practical training and other disciplines.

At the regional consulting company MedPharmConsulting and Expertise, classes of the elective discipline "Standardization and Certification in Pharmaceutical Activities" are organized jointly with the company's experts to involve students in internal audit procedures. PO and MO engage accredited experts from Med Pharm Consulting and Expertise for conducting internal and external audits and jointly developing quality systems for goods and services. The company's personnel includes pharmacists, analyst experts, and specialists in creating quality systems for goods and services in the field of drug

circulation.

During such joint activities, students acquire the following skills:

Identification of processes affecting service quality, establishing their sequence and interaction in PO and ;

Preparation of systemic quality documents (quality manuals with goals and quality policy, SOPs, journals);

Preparation of regulatory documents (orders for conducting internal audits, appointing the audit team);

Conducting periodic internal audits in PO and MO;

Drafting protocols for internal audit results based on checklists (self-control), corrective and preventive measures.

As can be seen, innovative educational technologies are integrated into the classes of this discipline, ensuring forced initiative and student activity.

Materials and Methods

The studies were conducted at the North Ossetian State Medical Academy in collaboration with experts from the consulting company Limited Liability Company "MedPharmConsulting and Expertise" in Vladikavkaz in May 2023.

Conclusion

In response to changing market needs, the Pharmaceutical Faculty of NOSMA integrates into the educational program for students and the thematic improvement of specialists the necessary competencies for a modern pharmaceutical worker, instilling skills necessary for graduates' further work in the industry. The elective discipline module "Standardization and Certification of Pharmaceutical Activities" proposed by the authors for 5th-year students and a similar thematic improvement course for pharmacists meet the requirements of the modern pharmaceutical industry and the needs of practical pharmacy in forming professional competencies in future specialists in creating quality systems for pharmaceutical organizations based on international standardization principles.

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STUDY OF THE ESSENTIAL OILS, PHENOLIC COMPOUND CONTENT, AND ANTIMICROBIAL ACTIVITY OF THYMUS GROSSHEIMI RONN. GROWING IN AZERBAIJAN

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Abstract

Thymus L., one of the taxonomically complex and important genera, belongs to the *Lamiaceae* family. There are 20 species of this genus in the territory of the Republic of Azerbaijan. Essential oils obtained from plants contain mainly thymol and carvacrol, as well as phenolic and terpenic compounds. In addition to flavonoids such as apigenin, luteolin, timonin, sirsilineol, flavones, phenol glycosides, biphenyl compounds of monoterpenic origin, monoterpenic glycosides, phenolic acids such as caffeic acid and rosmarinic acid, saponins, long-chain saturated hydrocarbons, aliphatic aldehydes, and aliphatic alcohols are also found. In the study, the antibacterial activity of essential oils obtained from grossheim's thyme - *Thymus grossheimii* Ronn. was evaluated. The composition of essential oils was determined by gas chromatography (GS-MS). The essential contains linalool, geranyl acetate,

caryophyllene. *Thymus grossheimi* essential oil of the plant had a moderate antimicrobial effect against selective bacteria. Maximum effect of essential oils and selected almond oil as a control was recorded against *Klebsiella pneumoniae* culture. A weak effect was recorded against *Escherichia coli* and *Pseudomonas aeruginosa* strains from Gram-negative bacteria.

Key words: *hymus, essential oil, GC-MS, LC-MS-MS, antimicrobial effect*

Introduction

Thymus L., one of the taxonomically complex and important genera, belongs to the *Lamiaceae* family. Thyme is represented by 200 species in the world. There are 20 species of this genus in the territory of the Republic of Azerbaijan. Species of the genus *Thymus* are important medicinal plants used in traditional medicine in the countries of the Mediterranean basin for thousands of years [3]. *Thymus serpyllum* L. and *Thymus vulgaris* L., which are officinal species, are used in medical and pharmaceutical practice. It is cultivated in Europe, the United States of America and other countries [1].

Thyme species are widely used in folk medicine. *T.vulgaris* flowers and leaves are used as flavoring in food, tea and liqueurs, dried flowers are used along with lavender to protect linen from insects [3]. The herb of *T. serpyllum* plant is used as an anthelmintic, antiseptic, expectorant, expectorant, antispasmodic agent [2].

1.1. Botanical features

The subject of this research is *Thymus grossheimi* Ronn., which grows in Azerbaijan. It is a perennial semi-shrub. The flowering branches are hairy, the leaves are opposite. Its flowers are collected in the head flower group [1]. (*Figure 1, Table 1*).

Table 1.

Taxonomy of research object

| | |
|--------------------|----------------------------|
| KINGDOM | Plantae |
| DIVISION | Tracheophyta |
| CLASS | Magnoliopsida |
| ORDER | Lamiales |
| FAMILY | Lamiaceae |
| GENUS | Thymus |
| SPECIES | T. GROSSHEIMI Ronn. |
| COMMON NAME | Grossheim thyme |



Fig. 1. Grossheim's thyme

1.2. Chemical composition

The main effective group of biologically active substances contained in plants belonging to this genus are essential oils. Essential oils obtained from plants contain thymol and carvacrol, as well as phenolic and terpenic compounds [5]. In addition to flavonoids such as apigenin, luteolin, timonin, sircillineol, flavones, phenol glycosides, biphenyl compounds of monoterpene origin, monoterpene glycosides, phenolic acids such as coffee and rosmarinic acid, saponins, long-chain saturated hydrocarbons, aliphatic aldehydes, aliphatic alcohols are also found [6].

1.3. Use in medical practice

Thymus species have antispasmodic, antibacterial, antifungal, antioxidant, expectorant, anti-inflammatory effects [7, 12]. There are drugs such as "Teabronx", "Bronxonat", "Bronchofort", "Kalinol", "Pertussin", "Broksevin" etc. in the pharmaceutical market [2].

2. Materials and methods

2.1. Research objects

Grossheim's thyme (*Thymus grossheimii*) was selected as research objects (Fig. 1). *Thymus grossheimii* was collected from Julfa district of Nakhchivan Autonomous Republic in June. (Fig. 2, Table I).

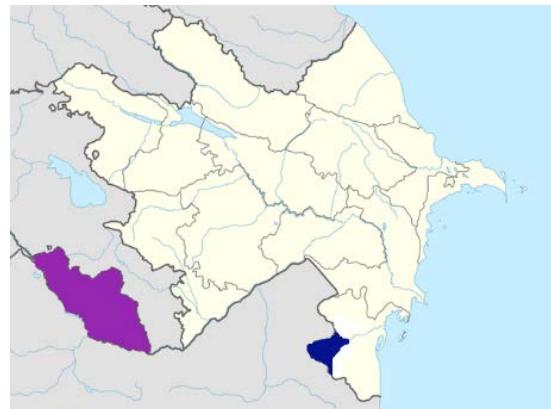


Fig. 2. Collected areas of research object

2.2.Extraction of essential oil

70 grams thyme was taken and essential oils was obtained by hydrodistillation. 1.1 ml of essential oil was obtained from from plant B.

2.3. Extraction of plant for HPLC

The extraction method was used to obtain the total amount of phenolic compounds from the raw material, the plant was extracted in 80% ethanol for 3 days and dried using a rotovapor device. The dry residue was dissolved in an appropriate amount of absolute methanol to prepare a dose of 10 mg/ml and stored at +4 degrees [9].

2.4.Identification of essential oils by GC/MS

The chemical composition of essential oils was determined by means of gas chromatography mass spectroscopy - *GC-MS*. *GC-MS* analyzes were performed using an *Agilent 5977A MSD* instrument. Chromatographic conditions were defined as mobile phase helium gas (99.99%), stationary (stationary) phase apolar polymethylsiloxane, temperature in the range of 60-260°C, injection time 35 minutes, injection volume 1 μ l, and MS as a detector. Gas chromatography was performed in the laboratory of the Republican Toxicological Center.

2.5. Identification of phenolic compounds by high-performance liquid chromatography (LC-MS-MS)

Characteristic quality reactions and chromatographic methods were used for the determination of phenolic compounds, including flavonoids, oxycinnamic acids, in raw materials. Benzene-ethyl acetate-acetic acid (5:5:1), 15% acetic acid, chloroform-methanol (9:1-1:9) systems were used as the chromatographic system [10, 11].

The components of phenolic compounds were studied by high-performance liquid chromatography method. For this purpose, *Agilent Technologies 1200 chromatograph with G-1316 A column and Agilent chemistry program* was used. *LC-MS-MS* grade methanol, acetonitrile, orthophosphoric acid and water solvents were used for chromatography.

Chromatographic conditions: *C-18 brand (Discovery), 4.6x250 nm chromatographic column*; Mobile phase: acetonitrile-water-orthophosphoric acid (40:60:0.5); The speed of the mobile phase - 0.9 ml/min; The temperature of the thermostat is 25 ° C; The injection volume of the studied sample is 3 μ l; Analysis time - 50 minutes.

2.6. Microbiological analysis of essential oil

The disc-diffusion method was used to study the antibacterial and antifungal effect of essential oils. To study these effects, *Staphylococcus aureus* - strain 700699 as a representative of Gram-positive bacteria, which are the main causative agents of purulent-inflammatory processes, as a test culture, *Escherichia coli* - strain 25922 from Gram-negative bacteria, pigment-forming Gram-negative bacteria *Pseudomonas aeruginosa* - strain 1022; *Candida albicans* from yeast-like fungi - strain 2024 as a representative of fungi; *Bacillus anthracoides* as a representative of spore-forming gram-positive rod-shaped bacteria; *Klebsiella pneumoniae* as a representative of capsular bacteria - strain-505562. In the disk-diffusion method, a suspension with 1 mld of microbial cells per 1 ml is prepared from the daily culture of microorganisms, that is, a small amount is taken from the daily microbial culture on the surface of agar with a bacteriological loop and placed on a sterile physiological solution, the suspension is prepared and adjusted to the standard, with 1 mld of microbial cells in 1 ml. is brought to the limit. Separate microbial suspensions are then poured into Petri dishes containing *EPA* and *Saburo* agar. The bowls are gently shaken so that the suspension is evenly distributed. The remaining suspension is removed from the process by sucking it through a pipette and

adding it to the disinfectant solution. The bowls are kept at a temperature of 37°C for 10 minutes to slightly dry the solution. Then the bowls are removed from the thermostat and the sterile disks impregnated with the special substances provided are arranged on the surface of the nutrient medium in which the microbe is grown, carefully pressed with tweezers so that it is well wetted. After that, seedlings with *EPA* are placed in a thermostat at a temperature of 37°C, and seedlings in Saburo medium at a temperature of 28°C. As the disks get wet, the substance absorbed there diffuses into the agar and, depending on its antimicrobial effect, stops the growth of the microbe.

3. Results and discussions

3.1. Study of essential oil composition by gas chromatography mass spectroscopy

From the results of the gas chromatography analysis, it was determined that all *T. grossheimi* have a rich essential oil content. (Fig. 3.) Studies have shown that the essential oils of *T. grossheimi* contains compounds from the group of monoterpenes, aromatic monoterpenes and sesquiterpenes.

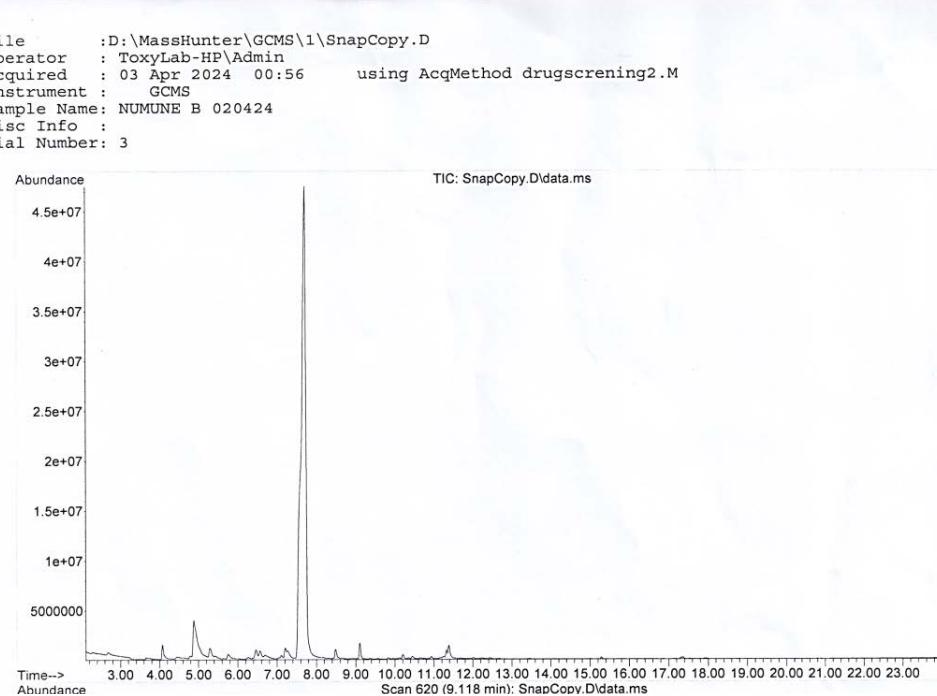


Fig. 3. Grossheim's thyme (*Thymus grossheimi*) chromatograms

Table 2.
Essential oils of *Thymus grossheimi*

| GROUP | SUB-GROUP | SUBSTANCE | IUPAC NAME | PHARMACOLOGICAL ACTIVITY |
|----------|----------------------|-----------------|--|---|
| TERPENES | Monoterpens | linalool | 3,7-dimethylocta-1,6-dien-3-ol | Sedative, anti-inflammatory, antioxidant, antimicrobial |
| | | borneol | 1,7,7-trimethylbicyclo[2.2.1]heptan-2-ol | Sedative, anti-inflammatory, antioxidant, antimicrobial |
| | | camphene | 2,2-Dimethyl-3-methylidenebicyclo[2.2.1]heptane | Antimicrobial, antioxidant |
| | | geranyl acetate | [(2E)-3,7-dimethylocta-2,6-dienyl]acetate | Antibacterial, antifungal |
| | | terpinene | 1-methyl-4-propan-2-ylcyclohexa-1,3-diene | Antibacterial, antioxidant, anti-inflammatory |
| | | mircene | 7-methyl-3-methylideneocta-1,6-diene | Antimicrobial, sedative |
| | Aromatic monoterpens | thymol | 5-methyl-2-propan-2-ylphenol | Antibacterial, antioxidant, anti-inflammatory |
| | | carvacrol | 2-methyl-5-propan-2-ylphenol | Antimicrobial, anti-inflammatory, hepatoprotective |
| | Sesquiterpenes | caryophyllene | 1R,4E,9S)-4,11,11-trimethyl-8-methylidenebicyclo[7.2.0]undec-4-ene | Antimicrobial, hepatoprotector, gastroprotector, antioxidant, |
| | | spathulenol | (1aR,4aR,7S,7aR,7bR)-1,1,7-trimethyl-4-methylidene-1a,2,3,4a,5,6,7a,7b-octahydrocyclopropa[h]azulen-7-ol | Antioxidant, antimicrobial, anti-inflammatory |
| | | bisabolene | 1-methyl-4-(6-methylhepta-1,5-dien-2-yl)cyclohexene | Antimicrobial, anti-inflammatory, antioxidant, |

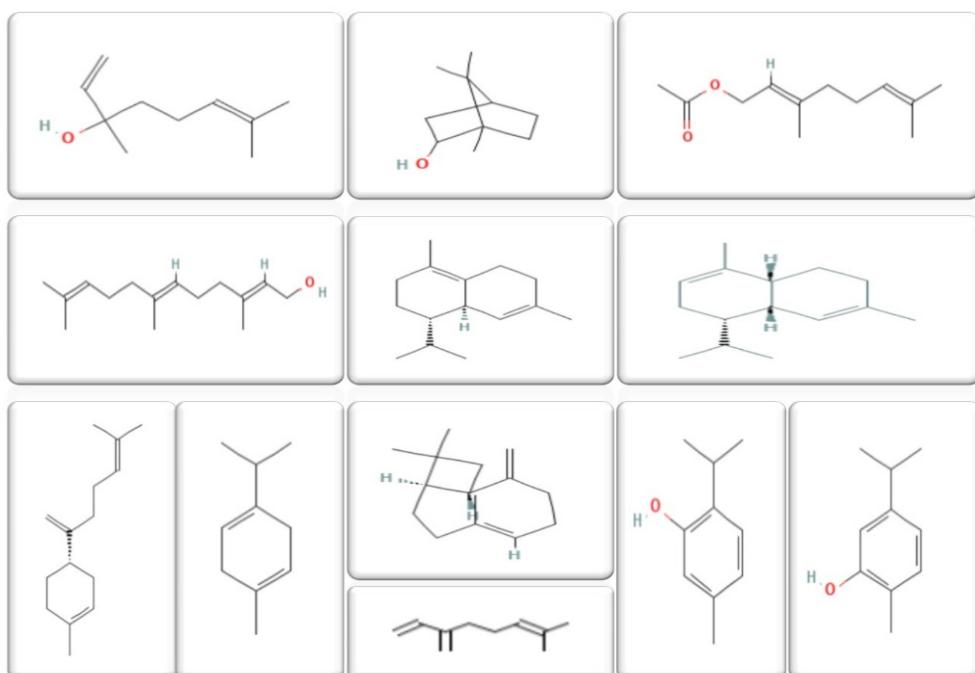


Fig. 4.The structure of essential oils

3.2. Study of phenolic compounds composition by LC-MS-MS

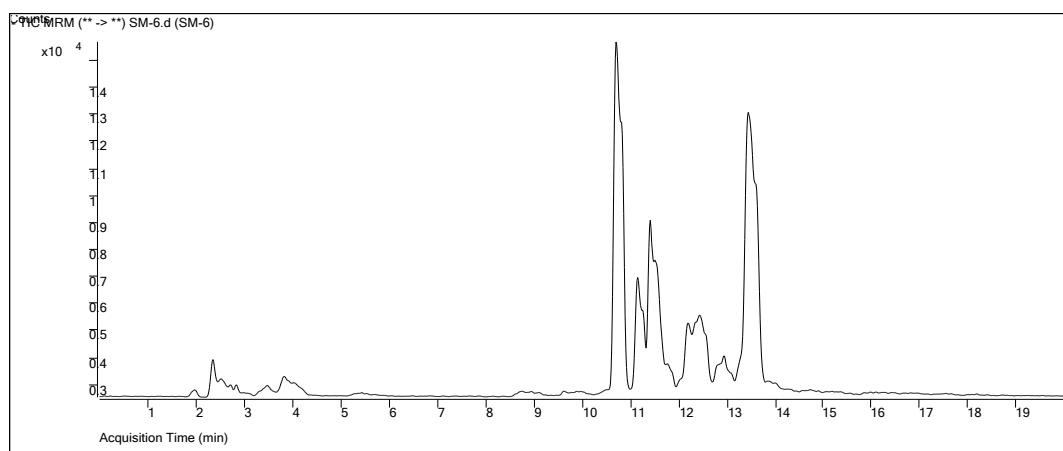


Fig. 5. Grossheim's thyme (*Thymus grossheimi*) chromatograms

Table 3.
Phenolic compound content of *Thymus grossheimi*

| Compound | RT | Response | Conc |
|------------------------|--------|----------|-----------|
| Quinic Acid | 2,361 | 9106 | 3464,3576 |
| Fumaric Acid | 3,843 | 14008 | 8384,4378 |
| Gallic Acid | 5,451 | 3099 | 85.0942 |
| Keracyanin Chloride | 10,443 | 499 | 149.2963 |
| Cyanidin-3-o-glucoside | 10,546 | 387 | 39.0190 |
| Chlorogenic Acid | 10,708 | 156590 | 5955,7599 |
| Peonidin-3-o-glucoside | 10,952 | 31 | 6,1704 |
| 4-OH-Benzoic Acid | 11,153 | 5351 | 246.2755 |
| Vanillic Acid | 11,340 | 300 | 561,2318 |
| Caffeic Acid | 11,426 | 75693 | 1289,2278 |
| Syringic Acid | 11,700 | 106 | 115.0038 |
| p-Coumaric Acid | 12,211 | 22195 | 403.7838 |
| Ferulic Acid | 12,354 | 5054 | 1129.9053 |
| Rosmarinic Acid | 12,448 | 24564 | 6098,1035 |
| Sinapic Acid | 12,483 | 65 | 5.0488 |
| Quercetin | 13,480 | 1778 | 6.7570 |

3.3. Microbiological analysis results

Based on the conducted research and obtained results, it was found that the essential oil of plant has antibacterial and antifungal effects.

Thymus grossheimi essential oil of the plant had a moderate antimicrobial effect against the selected microbial test cultures, as the zone of inhibition formed around the cultures varied between 5-14 mm. The maximum effect was recorded on *K. pneumoniae* (14 mm), and the minimum effect on *E.coli* and *P.aeruginosa* (5 mm).

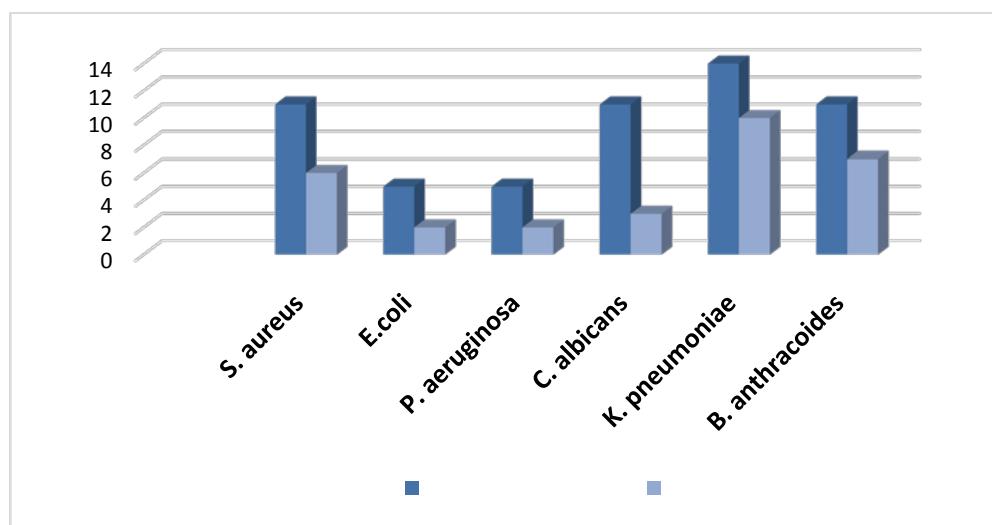
Sweet almond oil was used as a control.

Relatively different active antimicrobial effects of essential oils have been recorded in *Thymus serpyllum*. Maximum effect of all three essential oils

and selected almond oil as a control was recorded against *Klebsiella pneumoniae* culture. A weak effect was recorded against *Escherichia coli* and *Pseudomonas aeruginosa* strains from Gram-negative bacteria (*Table 3*).

Table 4.
Antimicrobial analysis results

| Test-culture | The substance under study | |
|------------------------|--|------------------|
| | Essential oils of <i>Thymus grossheimi</i> | Sweet almond oil |
| <i>S. aureus</i> | 11 | 6 |
| <i>E.coli</i> | 5 | 2 |
| <i>P. aeruginosa</i> | 5 | 2 |
| <i>C. albicans</i> | 11 | 3 |
| <i>K. pneumoniae</i> | 14 | 10 |
| <i>B. anthracoides</i> | 11 | 7 |



Thus, as a result of phytochemical and microbiological research, it was determined that *Thymus grossheimi*, which is widespread in Azerbaijan, has a similar effect to *Thymus serpyllum*, which is an official species and is used in medical practice, in terms of chemical composition and antibacterial effect.

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INNOVATIVE APPLICATION OF WHITE MULBERRY LEAVES IN THE DEVELOPMENT OF FUNCTIONAL AND SPECIALIZED PRODUCTS

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Abstract

Preparation and study of functional food compositions for special-purpose products from non-traditional sources of plant raw materials, incl. for medical nutrition is one of the most important tasks facing food specialists and food industry enterprises. In this aspect, this work is relevant.

The article studied the morphological and some basic physical and chemical indicators of fresh leaves and dry powder from white mulberry (*Morus alba*) growing in the village of Fatmai, Absheron district of Baku. A literary analysis of folk and modern medicine, as well as other scientific sources related to the research and use of the above-ground parts of the mulberry (mulberry tree), primarily the leaves of the white mulberry, was carried out. Justifications are given for obtaining food powder compositions from white mulberry leaves as an additive for creating products for functional and specialized purposes. The issues of obtaining and studying the quality indicators of yogurt (kefir) with the addition of powder from white mulberry leaves are considered. It has been shown that white mulberry leaf powder is rich in protein, fat, carbohydrates and other food components, as well as valuable biologically active substances, incl. vitamin C and organic acids. In addition, it has been established that white mulberry powder combines well with milk, which allows you to obtain traditional yogurt (kefir) with better organoleptic characteristics. The main physicochemical parameters of cow's milk yogurt with the addition of white mulberry leaf powder in an amount of 5% were determined. The temperature regime for mixing the powder with milk and its pasteurization before fermentation is proposed. Some physical and mechanical properties of dry white mulberry powder have been determined, such as hygroscopicity, density, density after sifting, wettability and swelling, which open up wide opportunities for its use together with bulk products in various fields of food technology. From a microbiological point of view, the powder is also safe. In a word, the wealth of chemical composition, the presence of

biologically valuable active substances in concentrated form after drying white mulberry leaves, as well as information from traditional and modern medicine, the huge raw material potential of the republic for collection allows us to recommend mulberry powder as a food additive for multifunctional purposes. Certain physical and mechanical characteristics of the powder from the leaves of local white mulberry, namely hygroscopicity, swelling, wettability and others, make it possible to use it in food technologies in order to obtain a new range of therapeutic and preventive food products not only in the food industry, but also in public catering establishments for culinary purposes. Some physical and morphological parameters have been determined, as well as the chemical composition of fresh leaves, the general chemical composition and some important functional and technological properties of dry white mulberry powder, such as water absorption capacity, fat retention capacity, foaming ability, foaming stability and density, which open up wide possibilities for its use together with bulk products in various areas of food technology. The study showed that from a microbiological point of view, the powder is also safe.

The richness of the chemical composition, the presence of valuable food and biologically active substances in concentrated form after drying leaves from white mulberry, as well as information from folk and modern medicine, the huge raw material potential of the republic for collection allow us to recommend mulberry powder as a food additive for multifunctional purposes. All this, as well as certain functional and technological parameters of the powder from the leaves of the local white mulberry, allow it to be used in food technologies in order to obtain a new range of therapeutic and preventive food products not only in the food industry, but also in catering establishments for culinary purposes. The proposed technology of yogurt (kefir) with the addition of powder from white mulberry leaves and its high-quality characteristic confirm this.

Key words: White mulberry leaves, powder from mulberry leaves, physical and chemical composition of the powder, yogurt (kefir) with mulberry powder, chemical composition

Introduction

Relevance of the Topic and Contemporary Approaches to the Utilization of Mulberry Leaves

The strategic utilization of unconventional resources within the agricultural sector, including underexploited components of fruit and vegetable plants, presents an additional avenue for the production of novel, multipurpose

food products and therapeutic agents [Nusrat Gurbanov, 2022]. Furthermore, the development of functional food compositions and specialized products derived from non-traditional plant-based raw materials is recognized as a critical priority within the food industry and public catering sectors [Bobreneva I. V., 2012].

In this context, the production and scientific investigation of fresh and powdered samples from the leaves of white mulberry species, both as raw material and food additives, in the research laboratories of our country, is of significant current interest. Accordingly, the raw materials market within our republic could witness expanded opportunities for the creation of innovative product types. Due to its geographic location, Azerbaijan experiences a wide range of climatic conditions. These diverse environmental settings create favorable circumstances for cultivating a variety of fruits. Among the fruits grown here, berries hold a particularly significant place. One of the fruits cultivated in many regions of the country, rich in biologically active substances and essential nutritional components, is the white and black mulberry, belonging to the genus *Morus*.

The existence of natural silk in the world is owed to this plant, as the leaves of the white mulberry serve as food for silkworms [Karomatov, 2018]. Currently, white and black mulberries are extensively utilized as food raw materials and for the production of medicinal preparations [Karomatov I., 2012, 2018, 2019; Babajanova I., 2015, et al.]. Extracts prepared from various components, including leaves, roots, flowers, fruits, and seeds, are also applied across multiple domains [Pirinc F., 2020; Fareed A., 2021; Yang X.; Karomatov I., 2018, et al.]. The distribution range of mulberry as a plant is globally extensive. In Azerbaijan, three species of mulberry are cultivated: white, black ("Xartut"), and red, which are grown throughout the republic, from the southern to northern regions [Akhmadov, 2014; Damirov I. A., et al., 1983]. Mulberry trees can be easily distinguished from other plants by their wood color, leaf shape (ovate, heart-shaped, with long petioles), and flower structure. Mulberries are cultivated across nearly all regions of our country, from Lankaran to the Nakhchivan zone, and from the cool Guba district to Ganja city. The significance of the mulberry tree for Azerbaijan has been recognized since the medieval period and even earlier due to the utility of its berries for consumption and its green leaves for silkworm rearing. Sheki silk was known to

people from the time of the famous Silk Road to China. Despite this, mulberries have established their place in the diet of the population due to their delicious white and red berries, both fresh and dried. In the pre-war Soviet period, in the absence of sugar for tea and other needs, dried berries ("tut qurusu") were used as a sugar substitute and sweetener in the diets of the republic's population. The fruits and leaves of the mulberry tree exhibit unique characteristics depending on the species. White mulberry leaves are relatively small and predominantly ovate, black mulberry leaves are large, firm, asymmetrical, and heart-shaped, while red mulberry leaves exhibit slight variations. The mulberry tree (silkworm tree) grows in Asia, Europe, and both South and North Africa, and is found in both cultivated and wild forms [Ince C., 2019; Pirinc F. T., 2020; Sheikh S., 2023; Venkatesh Kumar, 2008; Chen C., 2021; Mohammadi J., 2012; Srivastava S., 2006; Dhiman S., 2020; Gryn-Ryynko, 2016]. Numerous sources in the scientific literature indicate that mulberry fruits and leaves are rich in biologically active components, including organic acids and phenolic compounds [Eva Maria Sanchez-Salcedo, 2017; Karomatov I., 2018; Babajanova Z., 2015; Fareed Afzal, 2021]. In China, Korea, Japan, and Thailand, mulberry herbal powders, candies, and tablets are openly sold and utilized [Jang X., 2010]. In the Balkan countries, mulberry leaves are used to prepare infusions aimed at reducing blood sugar levels [Karomatov I., 2018]. In Japan, mulberry flowers are used in creams to treat skin blemishes [Babajanova Z., 2015]. In traditional medicine across its regions of distribution, both the aerial and subterranean parts of the mulberry plant, including its roots, are employed in the form of decoctions and alcoholic tinctures for the treatment of various ailments. Scientific sources from Tajikistan, Russia, India, and Pakistan particularly highlight the positive role of mulberry leaves in nutrition. Literature from Azerbaijan, Tajikistan, India, and other countries reports that mulberry leaves contain 0.74% organic acids, 56.3 mg% of vitamin C, 1.6% sugars, and 2.3% tannins, while the fruits contain 23.0% sugars and 2.4% organic acids. Additionally, mulberry leaves are rich in amino acids, flavonoids, vitamin B, and a substantial amount of calcium carbonate, and its seeds contain 23–24% dry oils. Despite these benefits, it is regrettable that the full potential of mulberry trees for fruit growing and the food industry has not yet been realized in our country. Historically, mulberries were primarily cultivated for silkworms, a practice that continues to this day. Consequently, at the state level, efforts

have been made to expand the supply of mulberry leaves for cocoon production, and a series of decisions have been implemented to support this. Notably, in recent years, more than 1 million young mulberry seedlings have been imported from China to increase cocoon production in our country. Based on the review provided, it can be concluded that mulberry leaves, due to their therapeutic and preventive properties, warrant application in food technologies.

Therefore, considering the literature and our own research, this study explores the development and assessment of certain quality indicators for mulberry leaf powder and the technology for producing yogurt (kefir) with mulberry leaf powder additives for specialized and functional purposes. Given the constraints of the proposed material, only the key results of the research are presented below.

Materials and Methods

The study utilized fresh and dried leaves from the white mulberry tree (*Morus alba*), which were sourced from the village of Fatmai in the Absheron District of Baku. The leaves from the white mulberry tree were collected from garden plots in the village during April and May 2022. Concurrently, laboratory samples of yogurt (kefir) were produced using traditional methods with the addition of mulberry leaf powder.

The mulberry samples studied comprised fragile leaves from 20-year-old mulberry trees cultivated under the conditions of the village of Fatmai. The leaves were collected two days after three consecutive days of rainfall (see Fig. 1). The study was conducted on ground and dried samples of white mulberry leaves. Drying of fresh white mulberry leaves was carried out using a convection dryer model POL-EKO, manufactured in Poland, at a temperature of $60 \pm 10^\circ\text{C}$ for 6–8 hours. Subsequently, the dried material was pulverized into a powder and sifted through a sieve with a mesh size of 0.8–10.0 mm, then stored in an airtight desiccator at room temperature. The moisture content of the fresh and dried leaves (powder) was measured using a Radwag MAC device, manufactured in Poland, at a temperature of 130°C.



Fig. 1. General Appearance of Black and White Mulberry Leaves

The measurement was conducted in five replicates with 5 g of powder for each sample. Experimental samples of yogurt (kefir) were prepared using natural cow's milk according to traditional technology in three variations, with the amount of mulberry leaf powder added being 1%, 3%, and 5%, respectively. The mulberry powder was initially held in a water bath with the milk at 90°C for 10 minutes, with periodic stirring. The mixture was then fermented at 40°C for 10 hours. Quality was assessed organoleptically and through physicochemical parameters. The content of dry matter in the milk and the new yogurt, measured as Brix percentages, was characterized using a refractometer. The quality indicators for the milk and the final yogurt with mulberry leaf powder were established by determining the acidity using a pH meter with titration according to GOST 3624–92, utilizing a 0.1 N sodium hydroxide solution. For measuring the morphological and physical parameters of mulberry leaves, a ruler and caliper were used, and for weighing, electronic scales were employed. Average measurements were taken from a minimum of three samples, and calculations were refined using arithmetic methods. For each fresh sample, 100 leaves of various sizes were selected. The chemical composition and physicochemical parameters of fresh mulberry leaves and their powder were determined using established standard methods, including protein content assessed by the Kjeldahl method for plant biochemical studies (Yermakov A. I., 1987).



Fig. 2. Dried Powdered Samples of White Mulberry Leaves

To determine the water absorption capacity (WAC) of the powder, a centrifugation method was used. The fat-holding capacity (FHC) and foam-forming ability (FFA), as well as foam stability (FS) of the mulberry leaf powder samples, were characterized using methods outlined in [Gruener I., 1997]. Microbiological parameters in the mulberry leaf powders were also determined using standard methods.

Results and Analysis

The physical and morphological parameters of the freshly collected mulberry leaf samples are presented in Table 1, Tables 2, 3, and 4 provide the overall chemical composition, microbiological characteristics, and some key functional-technological indicators of the white mulberry leaf powder, respectively. Table 5 presents the results for the quality indicators of milk and kefir (yogurt) based on the addition of white mulberry leaf powder. The data presented in Table 2 clearly demonstrate that mulberry leaves are nutritionally rich and contain biologically active compounds. According to the information in Table 3, the powder derived from white mulberry is microbiologically safe. The drying process, which concentrates the nutritional components and removes moisture, imparts the dried mulberry leaf powder with distinctive functional properties, as detailed in Table 4. This presents significant potential for the utilization of white mulberry powder compositions, in combination with other formulation components, across various food systems.

Table 1.**Physical and Morphological Parameters of Fresh White Mulberry Leaves**

| indicators | Mulberry Species and Leaf Collection Time | | | | | |
|------------------------------------|---|-------|-------|------------|-------|-------|
| | White, April | | | White, May | | |
| Samples | 1 | 2 | 3 | 4 | 5 | 6 |
| Mass of One Leaf (g) | 1,7 | 2,9 | 2,4 | 2,8 | 2,4 | 2,8 |
| Width of One Leaf (mm) | 70,3 | 93,8 | 88,2 | 101,9 | 103,9 | 85,1 |
| Length of One Leaf (mm) | 112,1 | 127,1 | 131,5 | 142 | 143,6 | 125,1 |
| Length-to-Width Ratio | 1,6 | 1,3 | 1,4 | 1,4 | 1,4 | 1,4 |
| Average Length of One Petiole (mm) | 48,6 | 52,5 | 56,6 | 53,4 | 42,4 | 38,4 |

Thus, the research findings and the data presented in Tables 2, 3, and 4 provided the basis for the development of kefir with the addition of white mulberry leaf powder using traditional technology. Laboratory experiments and subsequent studies yielded the best results when the white mulberry leaf powder was used as a 5% additive to natural cow's milk. The results of the quality assessment of fresh milk and experimental samples of the final yogurt (kefir) are compared and presented in Table 5. Thus, the data presented in Table 5 indicate that during the fermentation of milk, the acidity of the kefir decreases to a pH level of 4.45, which is advantageous from a dietary perspective.

Table 2.**Overall Chemical Composition of Fresh White Mulberry Leaves and Its Dry Powder Collected in May 2022**

| Established | Type of White Mulberry | | | | | |
|------------------------|------------------------|--------------|--------------|-------------------------------|--------------|--------------|
| | Fresh | White | Mulberry | Dried Powdered White Mulberry | | |
| | (Morus alba) | (Morus alba) | (Morus alba) | (Morus alba) | (Morus alba) | (Morus alba) |
| Samples | 1 | 2 | 3 | 4 | 5 | 6 |
| Proteins, % | 1,42 | 1,64 | 1,38 | 20,42 | 21,52 | 21,48 |
| Moisture, % | 54,2 | 58,2 | 53,7 | 5,3 | 5,9 | 5,1 |
| Carbohydrates, % | 10,4 | 12,6 | 13,2 | 20,8 | 25,2 | 26,4 |
| Fats, % | 1,2 | - | 1,3 | 2,1 | 2,34 | 2,25 |
| Phenolic Compounds, % | 3,7 | - | 3,5 | 7,5 | 7,7 | 7,8 |
| Ascorbic Acid, mg/100g | 80,4 | 65,5 | 75,4 | 56,8 | 66,4 | 58,6 |
| Organic Acids, % | 0,65 | 0,68 | 0,72 | 1,2 | 1,3 | 1,3 |

The addition of white mulberry leaf powder (extract) also resulted in improved protein composition and increased dry matter content in the final fermented dairy product. Moreover, it was found that the pH of the beverage remains stable between 3.97 and 4.45 due to the influence of the mulberry powder components. This suggests that the optimal concentration for adding the powder is 5% in the milk used for fermentation. The proposed kefir formulation, considering the amount of added powder, meets satisfactory standards based on organoleptic and physicochemical parameters for both functional and specialized nutrition. Kefir can be easily produced in cold sections of catering enterprises.

Table 3.
Microbiological Parameters of Dry Powder from White Mulberry Leaves

| Samples | Detected Microorganism Concentration in Ground Powder | Requirements for Powdered Products |
|---|---|------------------------------------|
| Microorganisms (CFU/g): Up to 2 per unit mass of raw material | Absent | По OCT-у 1 |
| Bacteriophages, ≤ 5 | Absent | По OCT-у 1 |
| Pathogens, including: | | |
| Salmonella | Not Found | По OCT-у 1 |
| Mold, CFU/2 | Not Found | По OCT-у 1 |

Table 4.
Functional and Technological Parameters of White Mulberry Leaf Powder

| Powder Samples | Density, g/cm ³ | UPU, % | ZHUS, % | pos, % | PS, % (via 2 hours) |
|----------------|----------------------------|--------|---------|--------|---------------------|
| 1 | 1,52 | 54,75 | 69,24 | 62,25 | 30,15 |
| 2 | 1,54 | 56,82 | 72,54 | 56,24 | 28,45 |
| 3 | 1,51 | 52,05 | 70,56 | 54,36 | 32,24 |
| 4 | 1,49 | 64,3 | 71,34 | 57,18 | 31,16 |
| 5 | 1,52 | 52,75 | 68,36 | 61,16 | 29,25 |

Table 5.**Comparative Quality Indicators of Milk and Yogurt (Kefir) with the Addition of White Mulberry Leaf Powder**

| Quality indicators | Natural milk | Yogurt (kefir) with 5% powder added. |
|--------------------|--------------|--------------------------------------|
| Ph | 6,4±0,23 | 4,45±0,22 |
| Titrated acidity | 0,14±0,12 | 3,64±0,21 |
| Dry substances, % | 11,7±0,23 | 15,77±0,78 |
| Fats, % | 2,98±0,34 | 2,5±0,21 |
| Proteins % | 3,68±0,44 | 6,07±0,56 |

Ultimately, based on the data from Tables 4 and 5, it can be concluded that mulberry leaves, when processed into powder, are suitable for extensive use and can be effectively applied in various food systems with different dispersions (in dough, liquid medium, meat mince). Due to its hygroscopic nature, good wetting, water-absorption, and swelling properties, as well as appropriate particle size and other beneficial attributes, this powder represents a promising food additive for functional and specialized applications.

Conclusions

1. The current state of literature regarding the use of mulberry fruits and leaves in various applications has been analyzed.
2. The potential of using white mulberry leaves, cultivated in the village of Fatmai, Absheron District, Baku, in food technologies has been explored. Fresh local mulberry leaves have been studied from both morphological and physicochemical perspectives, with an analysis of their chemical composition. Based on this, conditions for producing a powdered food additive with a rich chemical composition from white mulberry leaves and its applications have been proposed.

3. A series of physicochemical and functional-technological parameters of the powdered form have been determined.
4. The obtained data substantiate the potential use of white mulberry leaf powder as a food additive for the production of traditional kefir (yogurt) in food technologies, with the aim of incorporating it into diets for functional and specialized nutrition.

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EARTH SCIENCES, ECOLOGY

CLIMATE CHANGE: CAUSE, CONCLUSION AND PERSPECTIVES

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Summary

It is already known to everyone that since 2016, global temperature, hydro meteorological measurements have been remembered with a new record every year, and December 17, 2023, once again broke the historical record. Our periodic studies show that traditional climate parameters are changing rapidly and dramatically compared to previous norms. If, in 1991-2005, air temperature increased by 0.5°C , compared to 1961-1990, this indicator increased 2.4 times and reached 1.2°C in 2006-2020. The amount of atmospheric precipitation continues to decrease up to 7% (21 mm) in both periods (1991-2005, 2006-2020). The highest increase in air temperature across the country is recorded in May and June. The effects of climate change have caused the Caspian Sea to shrink and its water to warm by 1.2°C . Along with adaptation and mitigation, measures to combat climate change should be turned into an ecological debate, and the transition from fossil fuel to biological energy should be accelerated.

Key words: *Climate changes, atmospheric precipitation, air temperature, anomaly, greenhouse effect, gas concentration in the atmosphere.*

Introduction

From the time of its formation until now, several periods of glaciation and warming have been observed on the Earth. These cycles occurred due to natural causes. However, climate changes, which are currently showing harsh effects in different regions of the world, remain a scientific problem today, and the causes of their formation are not clear [2, 11].

Climate changes lead to the disruption of the direction and trajectory of ocean currents, the melting of glaciers, the shortening of the flood season in

rivers, the repeated increase of the flow volume, the subsidence in the areas where the current passes, the increase in the volume and intensity of torrential rains, the expansion of droughts and salinization, the melting of glaciers, fluctuations in the level of the oceans, greater extremes. led to time-space repetitions with indicators [10, 12, 13]. In the last 150 years, a long-term cooling period has occurred twice in less than 10 years, while each cycle of two warming periods is about 35-40 years.

Material and methods

The study provides information on the current situation of climate change in the background of the world and the country, its effects, and the problems caused by them. The results of our research conducted so far are brought to your attention. Mathematical, statistical and cartographic methods were used in the researches. With the application of GIS technology, the modern distribution of precipitation and air temperature on the surface was determined in areas without observational data.

The purpose of the study

The purpose of the article is to assess the causes of global climate changes, their effects and consequences in a specified context. As the effects of climate change, both in the global context and in the territory of Azerbaijan in recent times, are a common human problem, drawing attention to this issue and achieving the implementation of planned research and combat measures is our main goal for COP 29.

Discussion of the case. Along with global environmental problems, global climate changes are also clearly understood by the public and scientific community. In 1992, the UN Framework Convention on Climate Change recognized the relevance of climate change problems, and the Paris Protocol approved concrete solutions for mitigating these changes and ways of adaptation. Earth's climate changes over time. Centennial changes have been observed during the cycle of glaciation and warming. These cycles are caused by natural causes. The alternation of warm and cold periods throughout history is more evident on the island of Greenland [8, 11].

When the Vikings sailed to the island of Greenland in the 10th century, they saw "green land" and named the island "Greenland". But now most of Greenland is covered with ice and snow. The reason for alternating hot and cold periods was natural processes and this happened millions of years ago. But global climate change is *ascientific problem*.

The cause of the problem is not entirely clear, and from a scientific point of view, this concern is still unresolved. There is no scientifically based exact

answer to the degree of influence of natural and anthropogenic factors on global climate changes.

A systematic analysis shows that the following are the natural factors that shape climate changes:

1. The displacement of the Earth's tilt angle and orbit;
2. Variability of solar activity;
3. Volcanic eruptions and changes in aerosols in the atmosphere

Water vapor, as one of the main greenhouse gases, absorbs long-wave radiation at all frequencies of infrared radiation. However, between $(8 \mu\text{m} < \lambda <)$ the absorption rate of water vapor is minimal and this wavelength is called the "*transparency window*" in science. Other greenhouse gases absorb infrared radiation more effectively within the "transparency window".

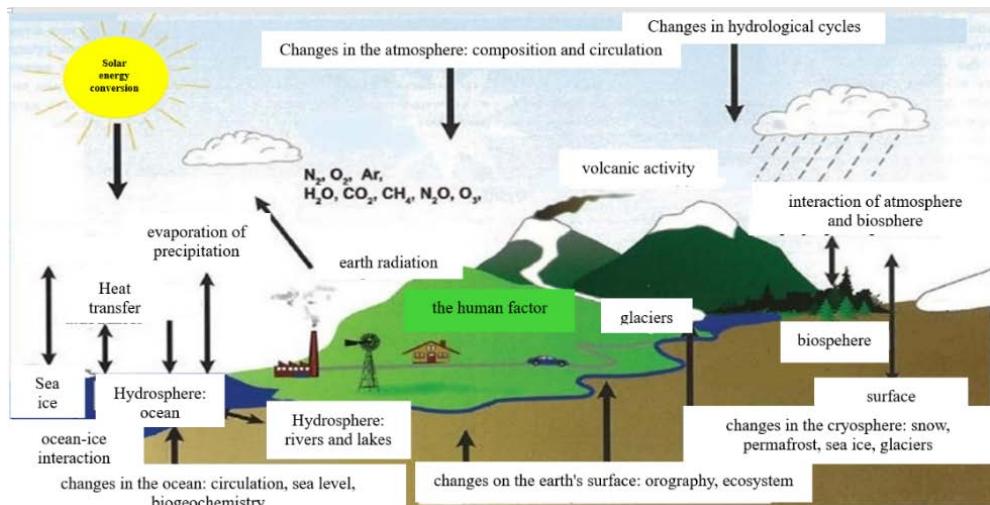


Fig. 1. Causes of climate change formation

Since 1960, when hydro meteorological measurements began, a new record in the increase in air temperature has been recorded every year, starting from 2016. The last such peak was recorded on 17-18.12.2023. The air temperature anomaly recorded on December 17, 2023 reached 2.06°C , exceeding the maximum predicted increase of 2.0°C compared to climate norms.

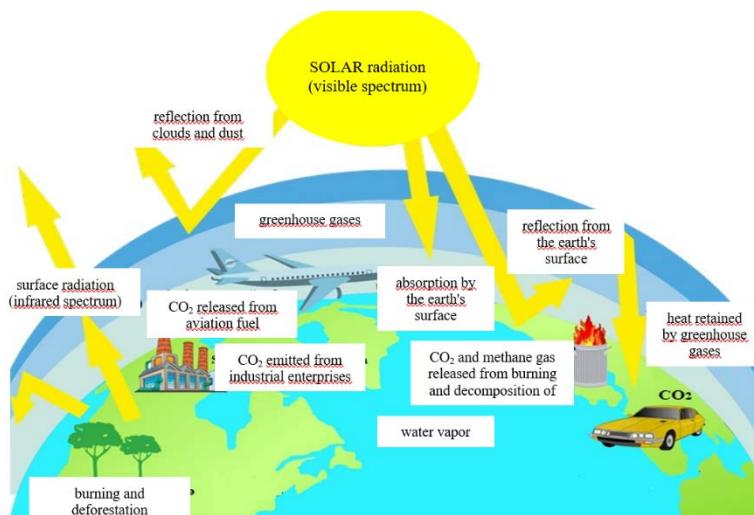


Fig. 2. Source of solar radiation and greenhouse gases

According to the HadCRUT (2007) climate model, several short-term fluctuations in air temperature have occurred over the past 150 years (Fig. 3). If the two periods of decline of these fluctuations last 80 years, the two cycles of the growth period are about 100 years.

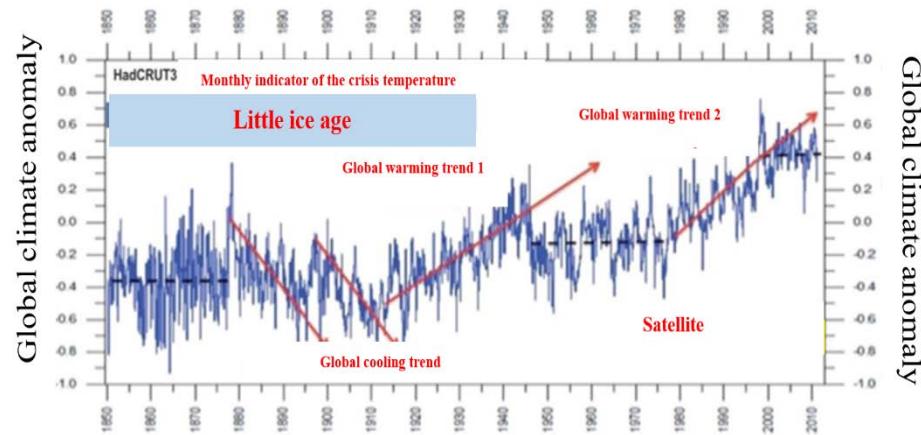


Fig. 3. Dynamics of air temperature on Earth

From 1860 to the present, the global air temperature increased rapidly in 1910-1945, remained stable with small fluctuations in 1945-1975, and steadily increased from 1976 to the present.

It is assumed that the aggravation of climate changes due to the influence of anthropogenic factors is caused by the disturbance of gas concentration in the atmosphere, especially the increase of CO₂ [11, 12].

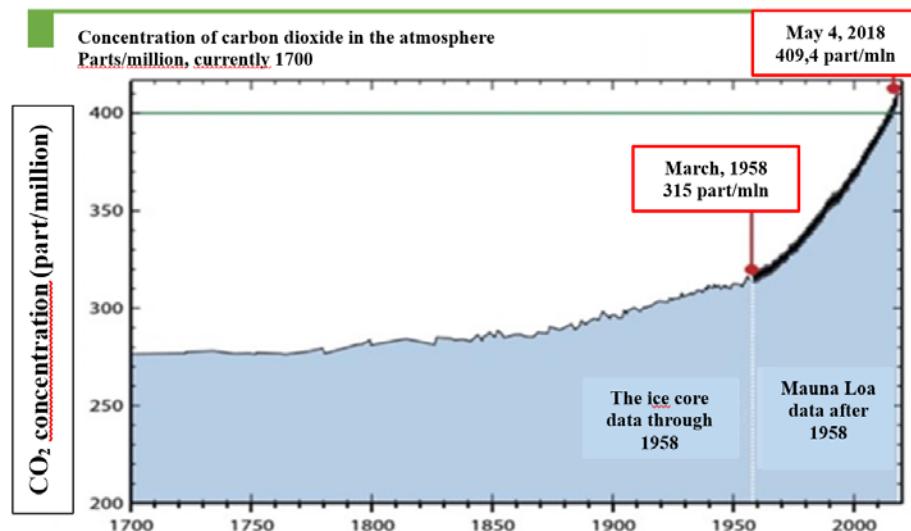


Fig. 4. Concentration of carbon dioxide (CO₂) in the atmosphere

The graph of changes in the concentration of CO₂ in the atmosphere over the last 320 years shows that this gas remained stable until the end of the 18th century. Over the next 100 years, the concentration of this gas begins to gradually increase. At the beginning of the 20th century, this growth rate is slightly sharper. Since 1950, the growth of CO₂ has been increasing sharply and rapidly moving towards large numbers. More precisely, after 1958, the concentration of CO₂ in the atmosphere increased rapidly from about 315 to 410 parts per million. That is, the annual indicator of this growth is close to 1.5 parts/million.

After the temperature anomalies in the northern hemisphere in the last 1000 years were established by the American climatologist geophysicist Michael Mann and published in the journal "Geophysical Research Letters", the problem of global warming was raised to the international level and became one of the main priority issues of modern world politics and climate science.

Currently, climate change is considered a global environmental problem, and a number of reputable organizations are taking serious steps in this regard.

Providing a long-term forecast of climate changes is of particular importance against this background. Currently, it has become popular to make future predictions of the main factors shaping climate changes based on mathematical, statistical and cartographic models created by a number of well-known climate institutes. The most famous of such prediction models are different versions of the RCP model [12, 15]. According to those models, the global temperature anomaly may even reach 2.5°C by the middle of this century (Fig. 5).

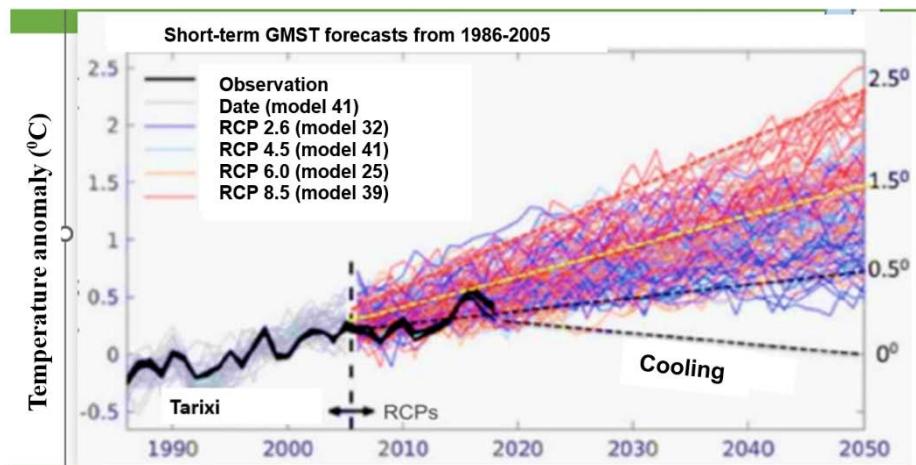


Fig. 5. Forecast of climate scenarios

However, model predictions based on CO_2 emissions and extrapolated measurements show a large gap as the prediction window increases.

This shows us that climate change science is highly biased and far from perfect. As well as it is not clear whether the cooling process is completely excluded.

Changes in air temperature in the territory of the Republic of Azerbaijan in 1991-2020 compared to 1961-1990 show that the highest growth anomalies are observed in warm months.

This indicator was 0.8°C in the country as a whole. If air temperature increased by 0.5°C in 1991-2005 compared to 1961-1990, this indicator increased 2.4 times in 2006-2020 and reached 1.2°C (Fig. 6).

In 1991-2020, atmospheric precipitation anomalies have a different feature throughout the year. In general, atmospheric precipitation has two maximum regimes during the year.

The decrease of atmospheric precipitation increases from April to June. In August and October, a sufficient decrease in precipitation is observed.

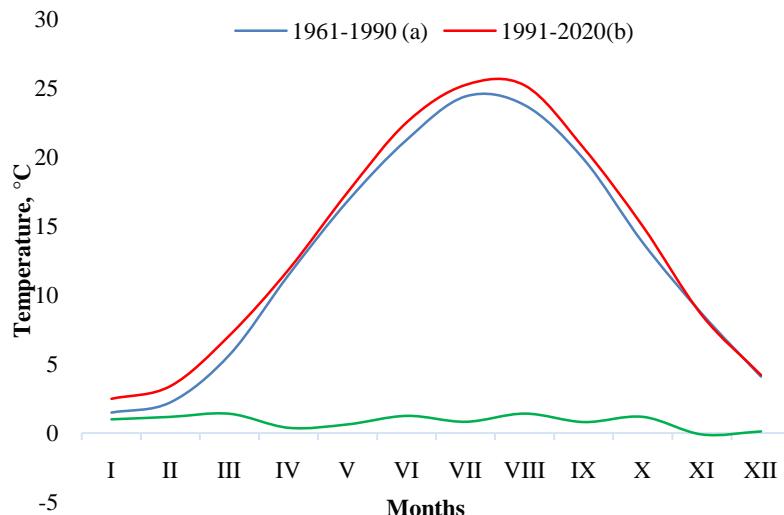


Fig. 6. The average annual trend of air temperature in the territory of Azerbaijan for the years 1961-2020

In addition, a slight increase in precipitation was recorded in January, February, September and November (Fig. 7).

The map of the surface distribution of the multi-year amount of atmospheric precipitation in the territory of Azerbaijan shows that the regularity of the distribution across the country remains unchanged, but the average annual indicators have changed.

Compared to the climate norm, the change of atmospheric precipitation in the country was 7% (31 mm) in 1991-2020. Climate changes increase air temperature, increase the amount of evaporation, and decrease atmospheric precipitation [3, 4]. This process is observed with the melting of glaciers and shrinking of their area in mountainous regions. The decline of glaciers will lead to a decrease in freshwater reserves and changes in the flow characteristics of rivers. Such changes affect the water of large rivers that feed the Caspian Sea.

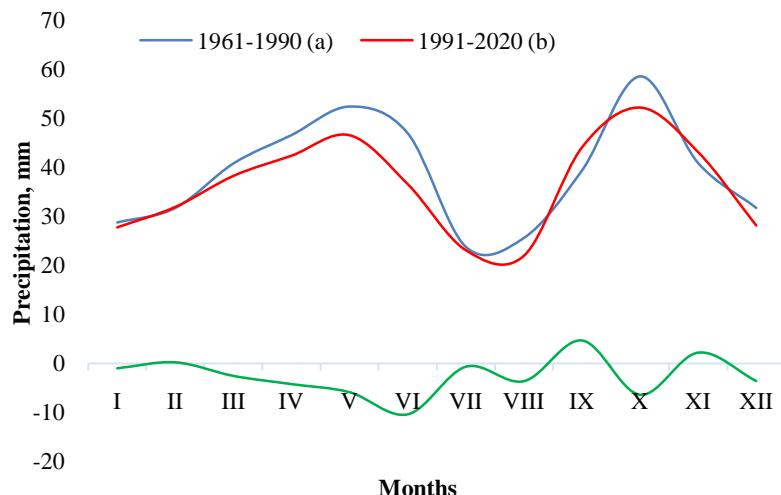


Fig. 7. Multi-year trend of precipitation in the territory of Azerbaijan for the years 1961-2020 (mm)

This change is observed with a decrease (Fig. 8).



Fig. 8. Distribution of precipitation (mm) in the territory of Azerbaijan

Against the background of modern climate changes, the level of the Caspian Sea has decreased sharply [1, 5, 6]. In 2016 and 2017, the level of the Caspian Sea was -27.9 m. In 2021, the water level in the Caspian Sea decreased by 30 cm and decreased up to 119 cm compared to 2005 (-28.1 m). Scientific studies conducted in 2021 showed that the temperature of the Caspian Sea water increased up to 1.2°C :

- Pollution of the sea (oil and oil products, phenol, metal)
- Sturgeon, sprat, etc. diseases of fish and sea urchins
- Poaching and overhunting
- Reduction of river flows
- Eutrophication

One of the most damaging effects of climate change in recent years has occurred in Pakistan. The floods and landslides that occurred in Pakistan in late June-July of 2022 led to catastrophic results. 33 million people were damaged, more than 1.000 people were killed, and 1,600 people were injured. 300.000 houses were completely destroyed, 650.000 houses were damaged. Crops were destroyed on 2 million hectares, and 735.000 domestic animals perished. 3,500 km of highways and 150 bridges were completely destroyed. These happened mainly in Khyber-Pankhtunkhwa and Baluchistan provinces. This devastating flood event was caused by monsoon rains and melting glaciers. 160 million US dollars have been allocated by the UN to eliminate the consequences of this incident.

One of the extreme effects of climate change is salinization in the Kura-Aras plain, which is the main agricultural region of Azerbaijan. The retreat of the Caspian Sea is observed by the coastal sand dunes conquering the more central regions by means of Ambrosia (Fig. 9).

The increase of the average annual air temperature to $16-16.5^{\circ}\text{C}$ is causing the expansion of droughts. This has led to an increase in possible evaporation indicators [7, 9].

The result

Assessment of the effects of global climate changes allows us to draw several general conclusions:

1. The increase of global temperature is observed with the increase of air temperature in the territory of Azerbaijan in 1991-2020 up to 0.8°C .
2. Climate changes have led to a decrease of 7% (31 mm) of precipitation in the territory of Azerbaijan.
3. Fluctuations in the level of the Caspian Sea are the consequences of climate change.
4. Climate changes increase the recurrence of extreme events in space and time.

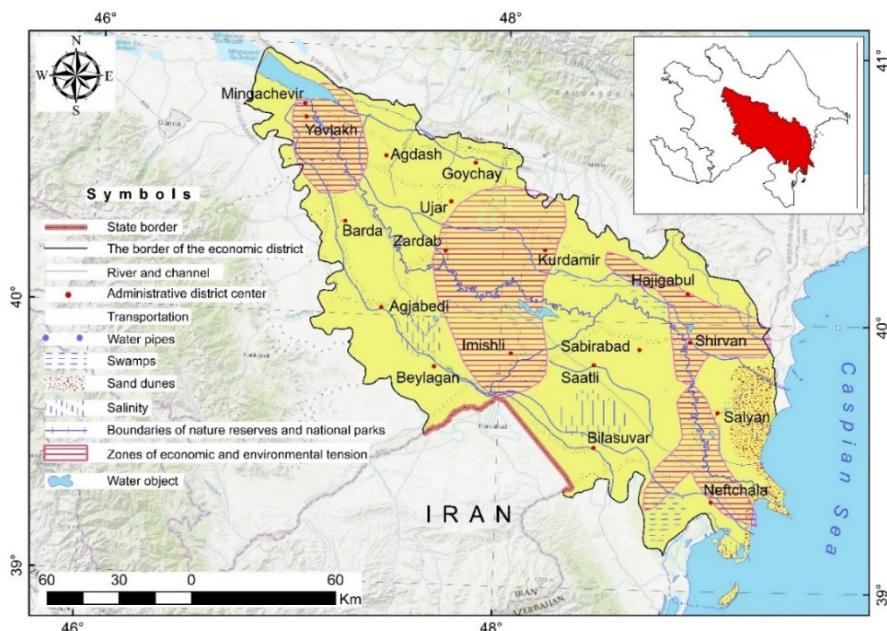


Fig. 9. Environmental problems in the Kura-Aras plain

The studies, general summaries and examples show that the fight against climate changes must be continuously developed in all segments. Scientific research and policy on global climate changes should be conducted on reducing the amount of carbon dioxide (CO_2) emitted into the atmosphere and finding ways to adapt to changing climate conditions.

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SCREENING ECOSYSTEMS HEALTH STUDIES OF MARINE AND FRESHWATER COASTAL AREAS BASED ON AN OPERATIONAL HEALTH ASSESSMENT OF LOCAL SHELLFISH BY THE METHOD OF FUNCTIONAL LOAD

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Abstract

The data obtained during the study of the ecosystems health of several recreational coastal areas of the Black Sea, the eastern part of the Gulf of Finland, several channels of the Volga delta are considered. An operational assessment of the health of coastal waters ecosystems was carried out using innovative biomonitoring technology by testing the health of adult bivalve mollusks living in them by the functional load method based on the analysis of their heart rate, measured using the BioArgus bioelectronic fiber-optic system. It has been established that the functional state of mollusks can serve as an

indicator of excess pollution of coastal waters by objects that discharge insufficiently treated domestic wastewater from their local treatment facilities, including household wastewater. It is concluded that, taking into account the rather high rapidity and ease of use, this technology can be effectively used to solve the problems of screening studies and early diagnostics of the state of coastal waters ecosystems as well as serve as an information basis for developing regionally oriented, science-based environmental management decisions.

Key words: biomonitoring, biomarkers, physiological animals state, bioindication, coastal waters ecosystems health, heart rate of bival molluscs

Introduction

Against the backdrop of growing anthropogenic impact all over the world the value of many marine and freshwater areas, including recreational water bodies, is decreasing. One of the main problems, meanwhile, is penetration of a significant amount of untreated or inadequately treated wastewater from local and diffuse sources into water areas. Biogens, heavy metals, synthetic surfactants, chlorine- and fluorine-containing compounds and other pollutants entering water areas change their both quantitative and qualitative ecological characteristics.

At present, it is almost impossible to find water bodies on most continents that are not subject to anthropogenic changes, while high water quality is a prerequisite for preserving not only public health, but also the biodiversity of aquatic ecosystems, which inevitably reduces the level of ecosystem services for humans.

This requires the creation and implementation of express methods for diagnosing the ecological state of surface waters on the basis of development and use of so called «Biological Early Warning Systems» (BEWS), allowing operatively (within a few minutes or even in online mode) to reveal areas of "ecological ill-being". The latter can be most reliably determined by the level of anthropogenic impact on the functional state and health of local species of hydrobionts as the most objective and reliable ecological indicators of their habitat quality.

In order to competently manage water use of anthropogenically affected ecosystems, it is very important, first of all, to have the fullest possible information about the health of these systems. For such purposes, it is important to identify appropriate ecological tools, including a number of bioindication methods at different sites, which will allow to provide adequate information on the condition of coastal marine and freshwater areas, the possibility of their use

for recreational purposes in compliance with relevant norms of ecological safety.

Despite the great interest of many scientific teams in different countries in the development of methods, instrumental systems and technologies for assessing the health of water area ecosystems, it should be noted that so far not only are there no generally accepted instrumental methods, but even an internationally accepted scientific definition of ecosystem health is lacking.

1.1.A brief overview of approaches to defining the concept of “ecosystem health”

The idea of the concept of “ecosystem health” in its most general form is to translate the complex behavior of a system into a broadly and intuitively understandable explanation, which is why it is increasingly used in assessing the health of ecosystems and managing them for the purposes of conservation and rational use of resources [1, 2].

The concept of ecosystem health was first proposed in [3], in which the health of an ecosystem was defined as its stability and sustainability, the ability to maintain its organizational structure, self-regulation and ability to recover from stress.

Since then, many definitions of this concept have been developed: ecosystem health has been defined as the constancy of homeostasis, as the absence of disease, as biodiversity or complexity, as stability or sustainability, as energy or capacity for growth, and as balance between system components [2]. Ecological health of ecosystems can be defined as the ability to maintain or restore optimal system function [4, 5]. In other words, optimal efficiency for maximum power when faced with a disturbance, which can be used as an indicator of the environmental sustainability of the system [5, 6]. That is, ecosystem health describes the state in which all processes operating in an ecosystem function at the level of optimal efficiency to maximize the system capacity.

It is clear that ecosystem health depends on the physiological health of the organisms that inhabit it, the interaction between the species present and the emergent properties of the system, which include biota and the environment [7]. Therefore, some aspects of ecosystem health can be understood in terms of the health of living organisms. From this perspective, indicators for measuring ecosystem health are analogous to body temperature, blood pressure or organism's blood chemistry [2]. That is, symptoms of physiological changes and pathological states of organisms, functional and structural disorders of populations and communities reflect unfavorable ecosystem health, which causes, for example, unfavorable water quality. In this case, favorable water

quality is considered as such if it meets the requirements of preserving the health of aquatic organisms and reproduction of the most sensitive species, adapted in the process of evolution to the conditions of the ecosystem of the water body in question [8].

Due to different understandings of ecosystem health and different research objectives, many different research methods and indicators, including instrumental ones, have already been proposed to reflect and assess their health status.

1.2.Modern instrumental, biomarker methods for assessing the health of aquatic ecosystems

At present, the system for assessing the state of a water body consists of two main parts: instrumental-analytical physico-chemical analysis and biodiagnostics. Physico-chemical analysis is used to determine the concentrations of pollutants in the aquatic environment, while biodiagnostics, which includes biotesting and bioindication, is used to assess the degree of impact of a single stress factor or their combination on biota by its reactions at different levels of life organization [9, 10]. The object of tracking in biodiagnostics is in any case the state of a living organism.

Biotesting of water is aimed at assessing the toxicity of pollutants entering a reservoir based on laboratory research data. It allows you to experimentally determine the concentrations of substances that cause the most significant and easily determined biological reactions in laboratory test organisms - mortality, survival, fertility, motor activity, growth, etc. Laboratory cultures of various systematic groups (microorganisms, algae, invertebrates, eggs, fry, adult fish, etc.) are used as test organisms.

The advantages of biotesting include the relatively quick acquisition of information (from several hours to several weeks) about the toxicity of individual substances. However, the behavior of pollutants in natural water bodies and their toxic properties may differ significantly from their effect on laboratory living organisms, since laboratory test organisms are adapted to live only in a specific aquatic environment with a small range of changes in its physicochemical characteristics. Therefore, biotesting can only characterize the possible consequences of environmental pollution for the biota of a specific natural water area.

Another method of biodiagnostics - bioindication - involves the detection and determination of the ecological significance of anthropogenic loads on a water body based on the determination of qualitative (species composition) and quantitative (abundance, biomass, species diversity) characteristics based on the state of communities or indicator species living in

the particular water body being studied [9]. And thus, bioindication at the level of the organism, population and community characterizes, as a rule, precisely the result of pollution for the biota of the studied water area.

Benthic organisms often act as bioindicators, which, due to their long life expectancy, can reflect the ecological state over a longer period of time, integrating the living conditions in a given environment. One of the most common bioindicator organisms when assessing the ecological state of a water body are shellfish, since they are widely distributed, confined to a specific biotope, lead a sedentary lifestyle, have a high population, relatively large sizes and long enough life cycles to accumulate pollutants [11].

A developed set of indices (to describe the response of a community to changing environmental conditions, e.g., Shannon-Wiener index, Simpson index) combine three components of community structure - richness (number of species present), equability (uniformity in the distribution of individuals between species) and number (total number of individuals present). An undisturbed environment is assumed to be characterized by high diversity, an even distribution of individuals between species, and a moderate to high number of individuals [12]. However, such indices are often subjective and their value depends on the homogeneity of the biotope and the season of the year.

Bioindication of a water body allows to adequately and reliably assess changes in ecosystems that have occurred over a long period of time (from several weeks to several years) of a negative factor, as well as to predict options for further development of ecosystems. In this case, an important element of biodiagnostics is biomarking - assessment of the impact of anthropogenic and natural factors on the health of hydrobionts using biomarkers [9].

Biomarkers are body responses to biologically significant exposures of different nature, which indicate either the presence of pollutants (exposure biomarkers) or the magnitude of the biological response to exposure to pollutants (effect biomarkers) [13]. However, there is no clear differentiation between biomarkers of impact and effect, since stress is a nonspecific reaction, therefore the same biomarker can simultaneously relate to different types of impacts [14].

The main limitation for the free practical application of biomarkers is the difficulty of interpreting the results in terms of assessing the biological consequences of the identified changes for the individual and higher levels of organization, since the direct link between the processes at different levels of biological organization is not always obvious [14].

It is easier to distinguish between normal and pathological conditions in individuals, because molecular-cellular and morphophysiological changes appear in organisms much earlier than structural and functional changes in

populations and communities occur [8]. This is what determines the effectiveness of the use of biomarkers recorded at the suborganismal and organismal levels of biological organization: molecular genetic, biochemical, histological and physiological.

Integrating answers to the question about the state of the body is the basic approach to assessing the health of the environment [15]. In addition to the fact that the use of such methods makes it possible to assess and minimize the degree of negative consequences of impacts on aquatic ecosystems, they can also be used in regulating the content of pollutants in the aquatic environment, carrying out environmental monitoring and predicting environmental risks [16]. And the prospect of using environmental health assessment methods for background monitoring is determined by their ability to identify stress-causing impacts not only from environmental pollution, but also from natural factors (temperature, salinity, food sufficiency, etc.) [15].

Thus, biomarkers provide a general picture of the health of the environment, so in recent years they have been integrated into ecosystem health indices to make it easier for society to understand their significance [11]. Recommendations for the use of biomarker indicators were given in international environmental documents such as the ICES Working Group on Biological Effects of Contaminants and the EU Directive [17].

However, it should be noted that one of the disadvantages of most of the considered biomarker biochemical methods is that most of them are invasive, not adapted for automated on-line and/or in situ monitoring.

1.3.Fiber-optic non-invasive method for studying the cardiac activity of benthic invertebrates

A direction based on the use of physiological and behavioral ecotoxicological biomarkers to measure the reactions of living organisms is of great interest for the development of automated biodiagnostic non-invasive methods for assessing the health of aquatic ecosystems [18].

Technological advances in biology and analytical science over the last 20-30 years have enabled the development of sufficiently fast, reliable and sensitive physiological and entological diagnostic tests (biomarkers) that can be used to monitor the impact and biological consequences of pollution of aquatic and terrestrial ecosystems. For the first time it became possible to assess the health of individual organisms in the same way as human health is assessed. Based on the analysis of recent achievements in this field, British scientists M. Depledge and T. Galloway from the Plymouth Marine Biological Research Laboratory put forward and substantiated a very important paradigm: «Healthy animals - healthy ecosystems» [19].

According to this paradigm, biomarker studies conducted on individual organisms (randomly selected from the natural population) allow to extend conclusions to the state of the population as a whole and, thus, indirectly judge the ecological state (health) of the the water area ecosystem, where inhabit the studied animals - biological "targets" of the integral toxic impact of pollutants.

In connection with the above, we focused on solving problems that led to the development of an original fiber-optic method and system for non-invasive measurement and real-time analysis of the heart rate of macrobenthic invertebrates with rigid outer cover - the highest crayfish and shell mollusks [20, 21]. This invention allowed us to design and develop a bioelectronic system BioArgus for real-time early biological warning about the dangerous levels of general toxicity of water entering the water intake facilities of water supply stations [22, 23] and biologically treated wastewater [24] discharged into natural marine or freshwater areas.

Bioelectronic systems are information-measuring systems in which living organisms are included in the primary transducers and are part of an electronic system of recording certain physiological or behavioral biomarkers [18, 25].

The search for a method to assess the health of aquatic ecosystems was espacially stimulated by the participation of our laboratory in 2009-2013 in the major EU project BONUSBEAST 114. The main focus of the project was the development of new and promising biological methods for assessing the ecological status of coastal areas in the Baltic Sea. The project involved 17 scientific teams from all 9 European countries within the Baltic region.

By the beginning of the project, we had at our disposal a tool set for non-invasive measurement of the heart rate of higher crayfish and shell mollusks, as well as practical experience in using it as real-time early biological warning systems about dangerous level of general water toxicity at urban water supply and wastewater disposal stations of the State Unitary Enterprise "Vodokanal of St. Petersburg". In the course of research within the EU project BONUS BEAST 114, based on non-invasive measurement of the heart rate of invertebrate animals, a method of assessing the level of their adaptive capacity (health) by using the original functional load was developed.

When selecting a method for assessing the health of aquatic animals, we turned to the methods of the space medicine, which aim to determine the health level of apparently healthy people using the circulatory system as an indicator of the adaptive reactions of the entire organism. While the functional reserve of the circulatory system is traditionally determined on the basis of the cardioactivity analysis using functional effort tests.

The authors have developed an active bioindication method that allows assessing the health of aquatic ecosystems based on the results of testing the

health of benthic invertebrates with a hard outer covering inhabiting them, using the functional load method. The method is based on analyzing the heart rate of mollusks, measured using the original fiber-optic bioelectronic system called BioArgus [17, 18, 26, 27].

The starting positions of the proposed method of active bioindication for assessing the state (health) of aquatic ecosystems using the BioArgus bioelectronic fiber-optic system are as follows:

- chronic pollution of the habitat of hydrobionts affects their adaptive capacities (health);
- invertebrates have a quite high sensitivity to chemical stress in their aquatic habitat;
- the health of animals from habitats with different levels of anthropogenic load can be assessed using standardized test effect based on the analysis of the recovery time of measured physiological and/or behavioral characteristics of the tested organisms after short-term functional loads.

During a series of studies conducted in the waters of the Black, White, Baltic, Mediterranean and North Seas, the Danish straits, rivers, lakes, and reservoirs of Russia, as well as in several foreign countries, it was discovered that mollusks and crustaceans taken from relatively clean areas differ from animals from polluted water areas in terms of recovery time of cardiac activity and behavior patterns after standardized test effect [17, 26 - 35].

It should be noted that macrobenthic invertebrates with a rigid external skeleton (higher crayfish and mollusks) are the most convenient test organisms for bioelectronic systems [18]. Macrofauna invertebrates respond quickly to changes in habitat conditions, so they are able to reflect short-term impacts and sudden changes in the environment. This is because benthic invertebrates (e.g., some species of bivalves) are often attached to the substrate and their growth and development can directly respond to many physical, chemical, and biological changes occurring in the water body, including temperature, nutrient levels, salinity, and so on [12]. Therefore, when pollutants are introduced into the aquatic environment, benthic organisms can be considered as an objective indicator of aquatic ecosystem health [25, 26].

When bioindicating, it should be borne in mind that even in a homogeneous group of test organisms taken from the same natural micropopulation, significant differences in reactions to the same influences can be observed. Typically, test organisms for ecotoxicological studies must meet the following criteria: be of the same genetic line, the same age and sex, have similar morphometric characteristics and have no external or internal damage [18].

In the wild, only the healthiest organisms live for a long time, while sick animals die rather quickly: either due to diseases or they are eaten by predators.

Therefore, the probability that the local species selected for testing will be healthy is high [25]. Furthermore, the use of local animal species as test organisms ensures an «ecological concordance» between the state of the biota and the state of the ecosystem.

The adaptive capacities of the cardiorespiratory system reflect the intensity of physiological processes, allowing us to assess the overall functional state of the organism. A decrease in the organism's adaptive capacities, which are manifested in the ability to recover after a short-term load, can serve as a prognostic sign confirming the onset and progression of the disease. Using the method of functional load method to cause a short-term stress effect on the test organism, it is possible to assess the health of hydrobionts long before the manifestation of signs of serious illness. The speed of cardiac rhythm recovery after standardized effects characterizes the organism's ability to compensate for changes caused by the impact of external factors, which is an important indicator of health [26, 36]. The method we have developed is most appropriate for practical use in screening studies of the health of aquatic ecosystems, as it can potentially detect at early stages deviations in the functioning of the ecosystems under study from the ecosystems of reference and to classify this or that water area as deserving the attention of more in-depth analytical and biological studies or not.

The procedure for testing the health of benthic invertebrates (according to the method of functional loading developed under the guidance of the author) is quite simple, does not require the involvement of highly qualified specialists and consists of the following. Saddles are attached to the hard outer cover (after its preliminary cleaning from contamination) to the heart projection area without disturbing the outer cover, in which miniature fiber-optic sensors designed to record the heart rate of the test organism are then fixed. The total mass of such a construction does not exceed 2 g, so it does not interfere with the normal functioning of the organism. Usually, for statistical reliability, the cardiorhythm of 8-16 benthic invertebrates is simultaneously measured. The registration of the cardiorhythm is performed using a laser fiber-optic photoplethysmograph, from where the formed infrared beam of a semiconductor laser is fed with the help of an optical fibre from the outer side of the shell (without disturbing it) to the area of the pulsating heart of the test organism. The beam, passing through the shell sash of the mollusk, is reflected from the pulsating heart and then, going back outside through the shell with the help of a second optical fibre containing information about periodic changes in the heart volume, is directed to the photodetector located in the photoplethysmograph, where it is converted into an analogue signal containing information on heart rate (HR), which is then fed through an analogue-to-digital

converter (ADC) into a personal computer for archiving and analysis using the original VarPulse software [17, 26].

When exposed to loads (stress factors of various modalities), the body's energy costs increase and the reactions of the cardiorespiratory system change significantly compared to the normal state [18]. Therefore, the indicator of the speed of recovery of the heart rhythm indicates the functional reserves of the body, and in the case of slow recovery of the rhythm or the absence of such recovery, it is an early sign of deterioration in health [26].

The assessment of the functional state is carried out on the basis of measuring the time of adaptive recovery of heart rate (T_{rec}) to the background level after removing a short functional load (Fig. 1), that is, the period of time after the restoration of the initial salinity of the water and before the stabilization of the heart rate to the background values observed before the change in salinity water [17, 26].

Hydrobionts taken from clean zones differ from those from polluted zones in that they demonstrate a higher adaptive capacity, which is expressed in a shorter recovery time of HR values. Thus, it was found that the HR recovery time of mollusks from conditionally clean areas is 30-50 minutes, while from polluted areas it can reach several hours [26].

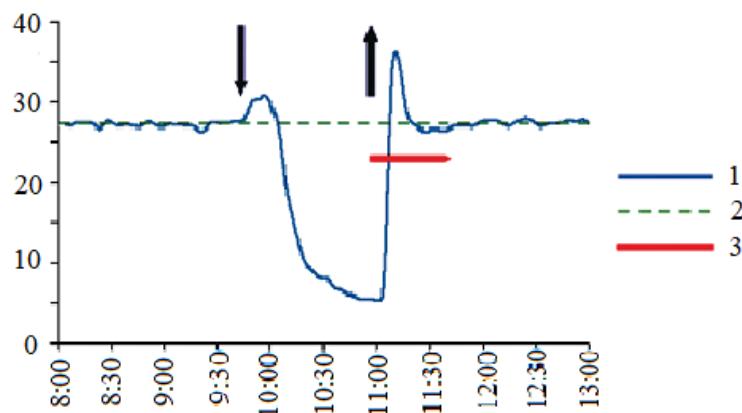


Fig. 1. Change in heart rate during testing based on hypoosmotic stress exposure

(1 – trend of average heart rate before, during exposure and after restoration of initial water salinity; 2 – average heart rate for a group of mussels in a calm, background state; 3 – recovery time background heart rate after returning to initial water salinity).

On the abscissa axis - time, hours: min, on the ordinate axis - heart rate, beats / min

The arrows indicate the time of the beginning of the salinity change (down arrow) and the beginning of the restoration of the initial water salinity (up arrow) [26].

According to the recommendations of the European Water Framework Directive, the assessment of the ecological state of water bodies as a deviation from natural undisturbed conditions can be carried out using a dimensionless Ecological Quality Ratio (EQR), which is defined as the ratio of the background value to the observed value for different groups of pollution biomarkers.

The main purpose of using EQR to classify the ecological status of freshwater or maritime areas is to ensure the comparability of different assessment methods, mainly biological. In this approach, ecological status is a dimensionless quantitative assessment of the deviation of a monitored aquatic ecosystem from its natural (background, «undisturbed») state.

In this case, EQR values close to one mean a high degree of similarity between observed and reference (background) conditions and, as a consequence, a good ecological status, while values close to zero mean a bad one.

According to the European Water Framework Directive, the entire range of ecological status of a water body, which depends in some way on the nature of the relationship between load and impact on biota, is recommended to be divided into five quality categories: high, good, middling, bad and very bad (Directive 2000/60/EC).

Based on a preliminary series of expert procedures, differentiated for different types of aquatic ecosystems, EQR values are established, corresponding to a certain water quality class.

It is recommended that the entire range of the ecological status of a water body be numerically divided from 0 to 1 into five quality categories, with EQR values close to one indicating a high degree of similarity between observed and reference conditions and, consequently, a healthy ecosystem, and values close to zero indicating a bad ecosystem.

For example, Table 1 shows the categories of marine ecosystem quality used in a number of European countries, as well as those proposed by us [26] according to the numerical values of EQR for biomarkers T_{rec} .

Table 1.

Ranking of the ecological status of aquatic ecosystems in accordance with the EQR gradations for T_{rec} biomarkers adopted in EU countries (Directive 2000/60/EC) and proposed by us

| Ecological status | Denmark | Norway | Spain | Great Britain | Our suggestion |
|-------------------|-------------|-------------|-------------|---------------|----------------|
| High | ≥ 0.80 | ≥ 0.83 | ≥ 0.83 | ≥ 0.80 | ≥ 0.80 |
| Good | 0.60–0.80 | 0.72–0.83 | 0.62–0.83 | 0.64–0.80 | 0.60–0.80 |
| Middling | 0.40–0.60 | 0.60–0.72 | 0.41–0.62 | 0.43–0.65 | 0.40–0.60 |
| Bad | 0.20–0.40 | 0.48–0.60 | 0.20–0.41 | 0.20–0.43 | 0.20–0.40 |
| Very bad | ≤ 0.20 | ≤ 0.47 | ≤ 0.20 | ≤ 0.20 | ≤ 0.20 |

In [27] the following ranking of range of ecological status of a water body according to the biomarker T_{rec} (Table 2) was proposed.

Table 2.

Ranking of the ecological status of water bodies according to EQR and T_{rec}

| Ecological status | EQR | T_{rec} |
|-------------------|-----------|-----------|
| High | > 0.80 | < 50 |
| Good | 0.60–0.80 | 50–70 |
| Middling | 0.40–0.60 | 70–100 |
| Bad | 0.20–0.40 | 100–200 |
| Very bad | < 0.20 | > 200 |

1.4. Examples of screening studies of the status (health) of aquatic ecosystems using bioelectronic systems

Biomarker studies implementing the functional load method with the use of fiber-optic sensors, conducted on individual organisms randomly taken from the natural population, allow us to extend the conclusions to the state of the population and, thus, indirectly assess the health of aquatic ecosystems [26]. The analysis of the ecological status of water areas was carried out using the recommendations for status ranking recommendations outlined in the works of [37] on the basis of a large number of approbations of this method during ten years on freshwater, brackish and marine water areas of different countries and

continents [1, 19, 38]. After the experiments, all mollusks were returned back to the habitat without damage.

For the first time, practical testing of the method was carried out in the process of conducting “caging” (cage) studies of pollution in the waters of the Gulf of Finland and the Gulf of Bothnia within the framework of the EU project BONUS BEAST 114. At the same time, an assessment of the ecological state of these waters was carried out in parallel using many other biological methods available to all countries EU Baltic region. A correlation was established between the results of assessing the ecological state of the studied water areas, obtained by biological methods of European scientists, with the physiological method of functional testing we proposed. In addition, it was found that one of the important conditions for the correct use of the cage method is that its use is possible only with a comparative study of only water areas with similar biotopes.

Below, as an example of screening studies of aquatic health status using the methodology discussed above, we present data obtained during a study of ecosystem health status in a number of recreational waters of the Black Sea and eastern Gulf of Finland. The main purpose of the conducted research was to test the prospects of using the above bioindication technology in regional programs of ecological monitoring of the state of ecosystems of coastal marine and freshwater recreational water areas (on the example of a number of water areas of Sevastopol, as well as Kurortny district of St. Petersburg).

Six Sevastopol water areas (in the area of Cape Khrustalny, Kruglaya Bay, Kazachya Bay, Matyushenko Bay, Balaklava Bay and the Grafskaya Pier water area) with different levels of recreational load were selected as objects of study of the Black Sea coast (Fig. 1, Table 1). The subject of research was the Mediterranean mussel *Mytilus galloprovincialis* (Lam.).

Mytilus galloprovincialis (Lam.) is a typical representative of the Black Sea malacofauna. Mussels were collected before the beginning (in mid-May) and at the end (in early October) of the swimming and tourist season. Experiments were carried out on bivalve mollusks selected in the coastal zone at a depth of 0.5–2 m. The selection of organisms was carried out manually. A total of approximately 250 individuals were collected from local populations of the mollusk *M. galloprovincialis*.

Testing of the functional state of mussels was carried out similarly to that described at the beginning of this section and is clearly presented in Fig. 2.

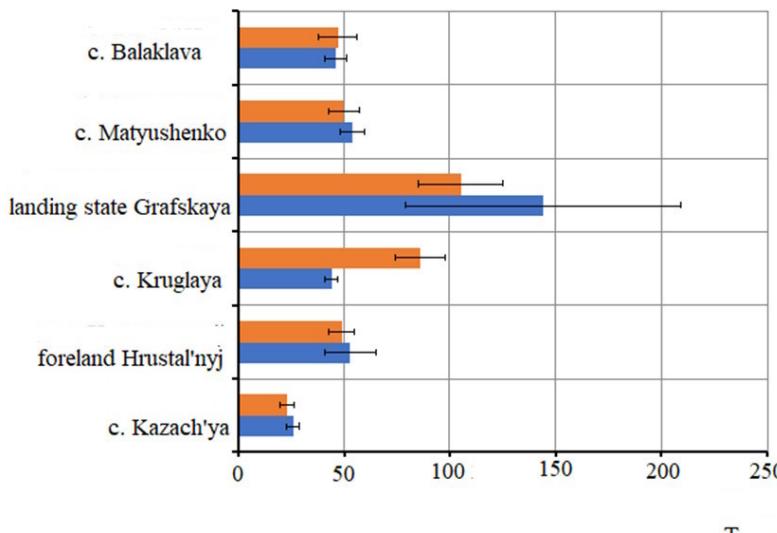


Fig. 2. Histogram of T_{rec} values measured in May (blue bars) and October (red bars) 2019 in the studied water areas of Sevastopol [17].

The final results (after appropriate statistical processing) of testing mussels from various water areas of Sevastopol using the functional load method and analyzing the status of these water areas before and after the 2019 holiday season are presented in Table 3 and in Fig. 2. It is shown that, regardless of the season, the status of the ecosystems of the water areas of the Kazachya, Matyushenko, Balaklava bays and near Cape Khrustalny remains at least “good”. At the same time, Kazachya Bay is the most ecologically safe throughout the year, therefore it can be considered a reference one, and the mussels living in it can be used as reference animals in cage studies of the waters of the Crimean coast.

Ecosystems in the area of Matyushenko Bay, Balaklava Bay and Cape Khrustalny apparently have a fairly high self-cleaning ability, so they remain in good ecological condition throughout the year, despite their fairly intensive recreational use.

The ecosystem of the Kruglaya Bay water area apparently has insufficient self-cleaning ability for the season with the peak intensity of operation of coastal catering establishments. Despite its fairly good ecological condition in the autumn-winter period, with the beginning of the holiday season (and not under the influence of any local industrial enterprises), its ecological condition deteriorates sharply. This certainly reduces the recreational attractiveness of the bay during the holiday season.

The water area in the area of the Grafskaya pier is especially ecologically unfavorable throughout the year, so it cannot be recommended as a recreational area, including for recreational fishing and the use of local fish and mussels for food.

Table 3.

| Site | T _{rec} , min in 10-20 May, 2019 year | Water area status in May 2019 year | T _{rec} , min in 5-11 October 2019 year | Water area status in October 2019 year |
|-------------------------|--|------------------------------------|--|--|
| Kazachya Bay | 26±3 | high | 23±3 | high |
| Cape Khrustalny | 53±12 | good | 49±6 | good |
| Kruglaya Bay | 44±3 | high | 86±12 | middling |
| Grafskaya landing-stage | 144±65 | bad | 105±20 | bad |
| Matyushenko Bay | 54±6 | good | 50±7 | good |
| Balaklava Bay | 46±5 | good | 47±9 | good |

Similar studies in the same year were carried out in a number of popular recreational water areas of the Kurortny district of St. Petersburg [17]. Four water areas of the sandy beaches of the Kurortny district of St. Petersburg were selected as objects for studying the coast of the eastern part of the Gulf of Finland. The salinity of the waters in all of them is almost the same and does not exceed 1.7‰.

The resort area of St. Petersburg is one of the most environmentally friendly areas of the Northern capital. It stretches along the coast of the Gulf of Finland in a strip 6–8 km wide and 45 km long. There are more than 40 permanently operating sanatoriums, health centers, boarding houses, holiday homes, ski and tourist complexes here.

However, in recent years, city and regional services of ROSPOTREBNADZOR are increasingly banning swimming in coastal waters due to water pollution above acceptable sanitary standards. This is due to the fact that the level of anthropogenic load on these water areas apparently exceeds their assimilation capacity.

The authors [17] selected the following recreational areas for the study:

1. the water area adjacent to the park «Dubki» (Sestroretsk).
2. The beach «Chudny» in the village of Repino, which is a place of recreation for a large number of people. There are 3 restaurants, a hotel and an administrative building in the immediate vicinity of the beach.

3. «Zolotoy Beach» in the town of Zelenogorsk, also adapted for recreation of the population. In the immediate vicinity of the water area are located catering enterprises.

4. Near the beach «Detskiy» in the village of Ushkovo. It is not so crowded. There are no operating retail outlets and catering enterprises on the adjacent territory, and boarding houses and suburban residential houses of the settlement are located quite far from the shore - on a high sandy hill.

The main objects of research were local bivalves *Unio pictorum*, which were collected manually at depths of 0.5-1 m. Testing the functional state of mussels by hypersalinity exposure for an hour (increasing salinity to 6‰) was carried out similarly to that described in [26, 27]. The results of ranking the water areas of the Gulf of Finland in accordance with the established average T_{rec} are presented in table 4.

The results obtained are in accordance with the results of sanitary and chemical studies of Rospotrebnadzor specialists in St. Petersburg (see Table 5), according to which (in particular, in terms of COD and BOD_5 indicators), the characteristics of organic water pollution of the investigated beaches of Repino and Zelenogorsk do not comply with sanitary rules and norms. At the same time, the Dubkovskiy (Sestroretsk) and Detskiy (Ushkovo settlement) Beaches are water areas, the ecosystems of which are at a fairly high level.

The contrast between characteristics of the ecological state of the water areas of the beaches in Sestroretsk and Repino and in Zelenogorsk indicates that they are not affected by wastewater from urban areas of St. Petersburg.

And their difference from the state of the ecosystem of the beach water area in Ushkovo reveals the main source of excess pollution - the insufficiently efficient operation of local treatment facilities of boarding houses and catering enterprises located close to the coast.

We have the same picture as in the case of Round Bay in Sevastopol. At the same time, in our opinion, the increased value is due to pollution associated with the presence of high concentrations of detergents in the water, and BOD_5 is due to the discharge of untreated wastewater from domestic sewage.

The latter is also indicated by the data of ROSPOTREBNADZOR, demonstrating the excess content of coliform bacteria in the water of the water areas of Repino and Zelenogorsk.

It should be noted that these types of surface water pollution typical for domestic wastewater have a negative impact not only on the quality of bathing water, but also on the health of organisms living there. This effect, for example, we also observed on Mediterranean mussels of the Boka-Kotor Bay of the Adriatic Sea [27, 35] and, as indicated above, in the mussels of the Kruglaya Bay in Sevastopol [17].

Table 4.
Final results of testing *Unio pictorum* mollusks from various water areas of the Kurortny district of St. Petersburg using the functional load method and subsequent analysis of the status of these water areas in the summer period June-August 2019–2020 years

| Ecological status of the water area | Indicators T_{rec} , min | t. Sestroretsk T_{rec} , min | v. Repino T_{rec} , min | t. Zelenogorsk T_{rec} , min | v. Ushkovo T_{rec} , min |
|-------------------------------------|----------------------------|--------------------------------|---------------------------|--------------------------------|----------------------------|
| High | ≤ 50 | 45 ± 11 | - | - | - |
| Good | 50–70 | - | - | - | 70 ± 8 |
| Middling | 70–100 | - | - | - | - |
| Bad | 100–200 | - | 120 ± 10 | 180 ± 14 | - |
| Very bad | $>> 200$ | - | - | - | - |

Thus, mollusks can be considered as good indicators of excess pollution of coastal waters with household wastewater, and the technology used in this work for the assessment of functional state of local species of mollusks may be used as an effective, most relevant method for the rapid detection of objects located near coastline that dispose of insufficiently purified wastewater from their local treatment facilities into this water area.

In the study [39], the main focus is on the possibility of identifying sources of additional, regionally determined, anthropogenic load on the water areas of rivers with a significant level of pollution in the upper reaches (using the example of the Volga River delta). The water of the Volga River in its lower reaches, even before entering the territory of the Astrakhan region, is characterized as «dirty». [40]. On the territory of the Astrakhan region, the Volga River channels may have, and have, additional local sources of anthropogenic load, different in terms of levels and types of pollution. The identification of their additional biological effects against the background of the effects present in the upper reaches of the Volga River is of interest from the point of view of delimitation of transboundary ecological responsibility of water pollution of the Volga River between the regions located in the upper and lower reaches of the river.

The aim of this work was to carry out comparative bioelectronic diagnostics of the ecological state of selected channels with different local anthropogenic load, both in terms of type and magnitude. The assessments were based on the functional state (health) of *Anodonta anatina* bivalves mollusks living there, estimated on the basis of the analyses of their cardiac rhythm. It

was found that *Anodonta anatina* mollusks sampled from different water areas, after a one-hour functional load, recover the initial heart rate in different times, but within the range from 117 to 166 minutes. This time T_{recons} , as follows from Table 2, is characteristic of mollusks living in polluted water bodies of ecological status - "Bad". This characterization of water areas fully coincides with the characterization of the ecological status of the Volga River delta channels indicated in the state report «On the state and environmental protection of the Russian Federation in 2017».

However, the authors [39] drew attention to the fact that the biomarker T_{recons} of mollusks from the Gandurino River indicates a significantly better functional state (health) of the mollusks living in it, compared to the mollusks of the sleeve Gorodskoy and the channel Maliy (Table 5). This is due to the fact that, unlike the other two channels, the water area of the Gandurino River is relatively clean.

Table 5.
Values T_{recons} for mollusk populations in the channels of the Volga delta
[Kholodkevich et al., 2021]

| Channel | T_{recons} |
|------------------|--------------|
| Gandurino River | 117 ±4 |
| Channel Maliy | 166±6 |
| Sleeve Gorodskoy | 141±5 |

In this work, attention was drawn to the fact that the analysis of the data obtained can also be approached based on the use of the environmental quality coefficient EQR, recommended by the EURD for ranking the ecological state of water area ecosystems.

The EQR value is defined as the ratio of the reference (background) value of the measured biomarker to the observed one. EQR values close to one mean a high degree of similarity between observed and reference (background) conditions, and as a consequence, a good ecological state. At the same time, in accordance with the WFD, the entire range of a water body can be divided into five quality categories: high, good, mediocre, bad and very bad. For the biomarker T_{rec} , such a quantitative division into categories was first proposed by the authors [27].

An important advantage of the possibility of ranking the status of water areas by EQR is the following. Not in all regions (especially where there are no specially protected natural areas nearby) it is possible to find conditionally clean water areas, which are known to be inhabited by conditionally healthy

animals. In this connection, for differentiation of water areas in such regions, in our opinion, conditionally reference water areas can be used as background water areas, namely, water areas with historically established conditions of absence of anthropogenic impact caused by local nearby pollutants.

Taking into account the minimal local anthropogenic impact on the Gandurino River, it can be considered as a background, conditionally reference water area for the specific region of the Volga Delta. In this case, based on the use of the EQR value, the water areas «Sleeve Gorodskoy» and «Channel Malyi» from the point of view of assessing the local anthropogenic load can be attributed to the regional ecological status «Good» (Table 6).

Table 6.

**Comparative ecological status of the channels of the Volga delta,
determined by the value of the ecological quality index EQR**

| Channel | The value of the ecological quality indicator EQR for the Volga Delta | Relative ecological status |
|------------------|---|----------------------------|
| Gandurino River | 1.0 | high |
| Channel Malyi | 0.70 | good |
| Sleeve Gorodskoy | 0.83 | good |

Thus, although all three investigated channels corresponded to the level «Bad» based on the T_{rec} biomarker value, if we use the assessment of the ecological status of the studied water areas based on the regionally oriented Ecological Quality Ratio (EQR) for the Volga Delta, the «Sleeve Gorodskoy» and the «Channel Malyi» can be referred to the regional ecological status «Good», while the water area of the Gandurino River can be classified as «High». Moreover, the Gandurino River can be used as a conditionally reference water area for the Volga Delta region. Such an approach allows to objectively separate the levels of watercourse pollution caused by local sources of anthropogenic load from their pollution caused by anthropogenic load of watercourses in the upper reaches.

The considered examples of comparative screening studies of ecosystem health in water areas with the use of BioArgus systems as a measuring tool when analysing the cardioactivity of native and/or local species of benthic invertebrates tested on the basis of the functional load method can be an effective means of obtaining objective and sufficient information on the dynamics of changes in the current state of ecosystems for making informed

management decisions not only in regions with low but also with high ecosystem health [39].

In particular, based on the results of screening studies using the considered method of functional load of recreational water areas of Sevastopol and Kurortny district of St. Petersburg, it was shown that this method can be considered as an informational basis for the development of science-based management decisions to ensure environmental safety of recreational water areas [17].

Conclusion

Insufficiently treated wastewaters from settlements, boarding houses and public catering establishments located close to the coast affects not only the sanitary-chemical and microbiological characteristics of coastal waters that are unfavorable for humans, but can also lead to disruptions in the health of coastal ecosystems and accelerated degradation.

Local mollusk species can serve as indicators of above-normative pollution in coastal waters caused by domestic wastewater. The technology for assessing the functional state of local mollusk species can be used as an effective and maximally objective means of rapid identification of objects located near the coastline that discharge inadequately treated effluents from their local treatment facilities into this water area.

Taking into account the rather high speed and simplicity of the use of the discussed technology, which does not require the involvement of highly skilled specialists for its practical implementation, it can be effectively used to solve the problems of screening studies and early diagnosis of the state of aquatic ecosystems and also serve as an informational basis for developing regionally oriented scientifically justified environmental management decisions.

The technology of comparative screening studies of the health of ecosystems in water areas using BioArgus systems as a measuring tool in the analysis of cardioactivity of tested native and local species of benthic invertebrates allows obtaining objective information about the dynamics of changes in the state of ecosystems for making informed management decisions not only in regions with low, but also with a high level of anthropogenic load.

The technology used in these studies complements modern methods of bioindication of the quality of surface waters as habitats for hydrobionts. It can be considered as an informational basis for developing scientifically justified management decisions to ensure the ecological safety of recreational water

areas. With some further refinement and appropriate testing, it can be recommended for use in regional environmental monitoring programs for coastal, marine, and freshwater areas.

The recent metrological certification of the BioArgus biomonitoring measuring system for type (ROSSTANDART Order No. 2702 dated October 27, 2022 on the approval of types of measuring instruments acceptable for use in Russia) opened up the legal right to use this measuring system at urban water supply and sewerage enterprises, as well as to develop various regional certified methods and technologies for assessing the ecological state (health) of aquatic ecosystems, based on the use of BioArgus systems as a measuring tool.

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AZERBAIJAN'S GREEN ENERGY CONCEPTS AND COP29 DIARY

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Abstract

The growing energy power of Azerbaijan contributed to the green transition in the country and conditioned the preparation of appropriate strategies and programs in this direction. These topical issues have strengthened research in the scientific community. In this regard, the article is devoted to the study of Azerbaijan's green energy concepts and issues related to the agenda of the 29th Session (*COP29*) of the Conference of the Parties to the Framework Convention on Climate Change. Proceeding from this, here the relevant issues such as global energy security, world green energy potential, green energy civilization, national energy system retrospectives, modern situation and prospects, Azerbaijan's green energy agenda, as well as new energy concepts and their multiplier effects have become the object of research. The conducted analyzes and evaluations also covered the concept of green energy implemented in the Karabakh region, which has been declared a green energy zone, and the construction projects of "Caspian-Black Sea-European Green Energy Corridor" undersea cables, which will realize the export of green energy.

Key words: energypotential, green transition, green economy, green growth concepts, COP29.

JEL Classification Codes: D01, E2,F62, L94, N7, Q32, Q42, Q47

UOT: 338.24:620.98 - 332.122:620.9 (479.24).

Introduction

In the modern world, it is difficult to imagine the economic life of people, the development of society, the economy without electricity. This reality was on the same basis in all the industrial revolutions that took place.

And the Second Industrial Revolution, conditioned by the increase in the scale of mass production and the expansion of its development, owes precisely directly to electricity. The third industrial revolution based on the use of electronics and information technologies to automate the production we are experiencing and the driving force of the new fourth industrial revolution ("Industry 4.0"), characterized by the wide application of robotics and artificial intelligence, which is currently taking shape, is closely related to electricity. The reality is that the production of electricity is considered an important indicator of the strength of the country's economic potential. Trends in the globalized world show that the demand for electricity continues at a rising pace. This growth will exceed the current indicators of production and consumption by another 25-30% on average over the next two decades [12].

Looking at today's statistics, we can see that 80% of the world's energy balance is still based on the excavation fuel. More than half of it is hydrocarbon resources. This means that in the coming period, about 50 billion tons of global greenhouse gas emissions will annually be emitted by 36 billion tons of carbon dioxide energy, and environmental problems arising from the burning of fossil fuels will continue. Therefore, in order to reduce the severity of the problem and eliminate it, along with the use of traditional energy sources, the involvement of alternative non-traditional energy resources in a wide economic cycle is an important condition. Meanwhile, the focus is more on the concept of green energy. In the extraction of green energy as any type of energy produced from natural resources such as sunlight, wind or water, unlike fossil fuel, the emission of greenhouse gases into the atmosphere is not directed. In this regard, environmental damage is not caused during its creation [6, 17].

This green energy potential of Azerbaijan stimulates the construction of a green economy in the country on the basis of new global challenges. Proceeding from this, important steps are being taken, and the green economy takes an important place among the state priorities. Due to the growing energy capacity of the country, the reforms carried out in the energy sector are deepening, and the formation of a green economic system is becoming conceptual. Thus, the president of the Republic of Azerbaijan, the victorious Supreme Commander-in-chief Ilham Aliyev declared the Karabakh and East Zangazur economic regions, which make up the majority of the liberated territories after the great Karabakh victory, a Green Energy Zone, and by 2050 it is planned to turn these territories into a "net zero emission" zone. By his order on "Approval of Azerbaijan 2030: national priorities for socio-economic development", development priorities as a country of clean environment and "green growth" have been identified in the liberated territories. It should be noted that these priorities are of particular importance for the implementation of the UN's obligations arising from the "transformation of our world: the agenda

for Sustainable Development by 2030" [10, 14].

In general, as a result of the purposeful green energy policy pursued in the country, it was decided to hold the 29th Session of the Conference of parties to the UN Framework Convention on climate change-the COP29 international conference in Baku and Azerbaijan Economic Cooperation Organization - ECO has been approved as the host of the Clean Energy Center. It should be emphasized that in his congratulatory letters to President Ilham Aliyev on Independence Day and Baku Energy Week, US President Joseph Biden said that Azerbaijan has paved the way for global energy transformation as an important pillar of energy security in Europe and is ready to support Azerbaijan in the successful holding of COP29.

All the above mentioned are also among the important researches of the scientific field. From this point of view, realities reflecting the global energy threat, World green energy potential, green energy civilization, retrospectives of the national energy system, its current state and prospects, green energy potential in Azerbaijan and the green energy agenda, as well as new energy concepts and its multiplicative effects, UN Climate Change Conferences and Baku COP29 summit have become objects of study.

1.Global energy security and world green energy potential

Energy resources are of great importance for expanding opportunities to improve the quality of life in the face of individual countries. In this regard, energy security and energy security measures around the world are becoming more unified and organized. In the modern era in which we live, energy requirements demonstrate greater global growth both in the range of primary resources and in terms of electricity supply. For all this, in the modern world, the supply of the economy with fuel and energy resources and energy efficiency are among the important indicators of the level of development of each state. According to forecasts, in our world, where the population exceeds 8 billion and the demand for energy carriers reaches 9 billion tons of oil equivalent, the need for energy will increase by another 20% in the next 30 years. Although the green energy strategy dominates in this circle, 80-90% of energy needs will still be covered by mining resources, including $\frac{2}{3}$ of oil and gas [7, 12, 13].

It seems that the excavation fuel will still be in demand for many years to come. Yes, the world will still have to remain in its monopoly for a long time. This is also due to the fact that the world economy, especially industry, is not ready for the absence of fossil fuels. Therefore, the world order must create synergy and advance along the evolutionary path [8, 14]. Nevertheless, the process of searching for non-traditional energy carriers has been accelerated and a large-scale transition to green energy has been formed. Statistics show

that the world's green energy potential has grown on average since 2000 by 3,2% per year. And the growth of traditional energy during this period was 2 times less, about 1,4% per year. At present, in the modern world, when large HydroelectricPower Station are excluded, the share of the use of alternative energy source is within 8%. In this share, the sun is 55%, the wind is 28%, the biomass is 10% and the others are 7% in volume. This area is constantly invested, and its payback period takes 7-8 years [9, 12, 13]. It should also be emphasized that over the past 10 years, investments in green energy have averaged 250-300 billion US dollars.

Looking at the development scenarios of the next two decades in the field of green energy, we can see that if there are no drastic strategic changes, the world's demand for energy carriers will increase by 20% in the next 45 years, with 87% of this growth coming from developing countries, more than half from China and India. As a result, CO₂ emissions will also increase accordingly (*by 2030 by about 40-45%*), which will be accompanied by a rise in the total temperature of the Earth to 6 C°. Three-quarters of CO₂ growth will come from China, India and the Middle East, with 97% from developing countries. In contrast to the world trend, only in Japan and the European Union will there be a decrease in the volume of waste [11, 13].

Development in the field of green energy in 2025-2030 will increase its share in energy consumption to 5,8%, and this share will be equal to the limit of 20% in the USA, Great Britain and other developed countries. In this scenario, it is predicted that the green energy will create 2,8 million new jobs and provide a 1,1% growth in global GDP. Also, the global energy balance will change, as domestic fuel-powered motor transport, which consumes twice as much energy as energy produced at all power plants, will give way to electric cars. In addition, the transformation of finished oil fields into energy farms with the aim of obtaining ethanol will be expanded. In addition, a major transition to hydrogen-based energy will take place, and the idea of installing solar power plants in space will also come true.

2.Green energy potential and new energy concepts in Azerbaijan

The national energy system of Azerbaijan has passed a long glorious stage path. It is difficult to find a story related to the history of oil, in which the name of Azerbaijan is not found. Thousandsof years of production here have made an unprecedented contribution not only to the world economy, but also to the Chronicle of the oil economy as a whole. The name of Azerbaijan, which means “land of fire”, is undoubtedly derived from the natural combustible gases spontaneously emanating from the subsoil in this geography and from the expanse of oil-bearing areas with energy effect. Looking at the history, we can

see that the construction of the first oil well in the world by mechanical means, the introduction of a deep pump used in oil production, the start of the refinery, the industrial development of the field, the creation of an oil transportation system, the establishment of a transnational oil company, the oil tanker, the use of natural gas it was connected with Azerbaijan [1, 2, s. 105-108].

The development of the oil and gas industry in Azerbaijan contributed to the formation of the first electric power systems in the country, and at present an advanced infrastructure has been created in this area. The electric power complex currently acts as the main factor and necessary condition for the development of the population and other spheres of society as the main sector of the economy of Azerbaijan. Its industrial age in Azerbaijan has exceeded 130 years [3, 16].

Despite the abundance of fossil fuels in the country and the sufficiency of these resources, especially natural gas, a fundamental transition to green energy is currently taking place here. Numerous strategies and state program documents have been adopted in this direction, a comparable infrastructure has been built, the structure has been ensured, measures have been taken to balance the potential of green energy and expand its use.

As a result, Azerbaijan has turned from an importer to an exporter of electricity. Now, an average of 1-1,5 billion kWh of electricity is exported from the country to Turkey and from there to European markets every year. Export geography has already covered Romania and Hungary.

At the international forum on “COP29 and green vision for Azerbaijan” at ADA University, President Ilham Aliyev said: “Azerbaijan has always separated energy projects from politics. But, at the same time, he integrated them only in a positive way. All our energy projects lead to cooperation. Azerbaijan has been cooperating with international oil companies for 30 years. We were the first country to invite foreign companies to the Caspian Sea, and I think our future is even brighter. We will not stop using fossil fuels, we will not do it. But, at the same time, we will focus on the green agenda” [14].

According to the latest estimates, the economically viable and technically feasible Green potential in the country is estimated at about 27000 MW, including solar energy 23000 MW, wind energy 3000 MW, bioenergy potential 400 MW, mountain rivers potential more than 500 MW. Adding to this the 157 GW wind power community calculated in the Azerbaijan water area of the Caspian Sea, there is an even greater potential.

The liberated territories of Azerbaijan have large reserves of green energy. The construction of Thermal power plant on these lands, which have been under occupation for a long time, has not been carried out. And now there is no particular need for it yet. This is because the great green energy potential of this place draws such an approach to the background. It should be

emphasized that the use of sufficient green energy potential in the territories liberated from occupation as a result of the 44-day Patriotic War has also been resolved.

According to preliminary estimates, there are 7200 MW of solar, 2000 MW of wind, 457 MW of hydro and 100 MW of bio-energy in the liberated territories, with a total capacity of about 10000 MW. The use of the energy of the rivers here has already begun.

The number of small hydroelectric power plants operated, built and designed is 29, and the energy potential is 325 MW [4, 16].

Below is a table characterizing the green energy potential of Azerbaijan:

Table
Green energy potential in the Republic of Azerbaijan(MW)

| Classification | Solar | Wind | Bio | Hydro | Total |
|---------------------------------------|-----------|-----------|---------|---------|-----------|
| Economic potential | | | | | |
| On land - Total | 23 000,0 | 3 000,0 | 1 000,0 | | 27 000,0 |
| <i>including:</i> | | | | | |
| In the liberated territories | | 2 500,0 | | | 2 500,0 |
| Nakhchivan Autonomous Republic | | 1 500,0 | | | 1 500,0 |
| Technical potential | | | | | |
| Total | 115 000,0 | 172 000,0 | - | 5 000,0 | 292 000,0 |
| At sea | - | 157 000,0 | - | - | 157 000,0 |
| On land | 115 000,0 | 15 000,0 | - | 5 000,0 | 135 000,0 |
| <i>including:</i> | | | | | |
| In the liberated territories | | 1 000,0 | | | 10 000,0 |
| Nakhchivan Autonomous Republic | | 5 000,0 | | | 5 000,0 |

Currently, the level of use of the existing green energy potential in the country is 1,2 per cent in the energy balance. The volume of electricity generated by green energy in the country in 2023 was 359,0 million kWh, of which 56,6 million kWh were wind, 79,4 million kWh were solar, and the remaining 223,0 million kWh were bioenergy sources. In addition, the non-public sector generated 37,6 million kwts of electricity at the expense of green energy, of which 35,1% were generated by SolarPowerPlant, 25,5% by wind SolarPowerPlant and 39,4% by other sources [5, 15, 17].

It should be noted that the use of the energy potential of the Caspian Sea

occupies an important place in the implemented “green energy” policy. In the future, this potential will provide a large-scale export of electricity from the country, as well as the national economy will receive added value through the production of “green hydrogen” here. In this regard, the country is developing export plans for liquid hydrogen, which is one of the components of green energy. As you can see, Azerbaijan's green energy agenda also includes the realization of the country's “green” hydrogen potential as renewable energy. In this regard, in 2022, an agreement was signed between the Ministry of energy of the country and the Australian company “Fortescue Future Industries”.

By 2030, increasing the share of green energy in the country's electricity generation to 30% was a strategic goal, and now this figure has exceeded 20%. An important role in the growth of this capacity was played in 2023 by the United Arab Emirates - UAE “Masdar” company, which commissioned the largest solar power plant in the Caspian region SolarPowerPlant “Garadagh” with a capacity of 230 MW. With the production of 500 million kWh of electricity annually, the plant will save 110 million cubic meters of natural gas, which will be accompanied by a reduction in carbon emissions into the atmosphere by 200 thousand tons. Also, “ACWA Power” Company of the Kingdom of Saudi Arabia is building a 240 MW “Khizi-Absheron” plant in Absheron and Khizi districts, which has an annual production capacity of 1 billion kWh of electricity, which is expected to be put into operation within the next two years.

At the same time, by the relevant orders of the president of the country, the implementation of pilot projects related to the construction of power plants for green energy was started, a Coordinating Commission was established on this basis, and memoranda of Understanding were signed with a number of leading international companies in order to attract private investments in the field. In addition, in the near future, projects related to the construction of additional 400-500 megawatt stations and “Shurabad” WindPowerPlant with a capacity of 84 MW are also being considered. Also, about 4 thousand hectares of land were allocated in order to stimulate and expand the use of renewable energy sources in the Republic and attract private investment in the field.

Currently, the Government of Azerbaijan and the UAE “Masdar” company on green energy 1000 MW 3 projects in the country have signed an investment agreement on the onshore wind energy project in Neftchala (315 MW) and Bilasuvar (445 MW) regions SolarPowerPlant, Absheron and Garadagh (240 MW) regions. In addition, a memorandum of Understanding on the implementation of renewable energy projects with an investment capacity of 2 GW was signed with the Chinese company “China Gezhouba Overseas Investment”, and an agreement on cooperation between the company “Energy

China International” and SOCAR on the implementation of renewable energy projects.

The work carried out in the field of transition to green energy is also being carried out in the liberated territories. The construction of “Shafag” SolarPowerPlant with a capacity of 240 MW in Jabrayil district and 100 MW WindPowerPlant in Kalbajar district is carried out as major projects here. Other major projects in these areas include the construction of “Khudaferin” on the Araz river with a total capacity of 200 MW (*100 MW for each of the Azerbaijani and Iranian sides*) and “Giz Galasi” HydroelectricPower Station with a capacity of 80 MW (*40 MW for each of the Azerbaijani and Iranian sides*). It should be emphasized that 170 small hydroelectric power plants with a total capacity of 8 MW have already been built here. It is aimed that in the next few years this capacity will reach 500 MW, in total 10 GW of renewable energy [4, 15, 16].

The green pass should not only count on domestic production and consumption. Here is the concept of green growth and its export potential as its multiplicative effects. Thus, important steps are being taken in the field of green energy export. The concept of “Caspian-Black Sea-European Green Energy Corridor” is a mega project here. The European Commission has allocated 2,3 billion euros for the construction of the cable. In addition, the possibility of transporting electricity from Central Asian countries to Europe is also a subject of serious discussion. To do this, it is planned to lay a cable for the transmission of electricity from the bottom of the Caspian Sea, which will pass through Azerbaijan.

All this once again shows that the green transition in Azerbaijan continues to be dynamic in the strategic plan. The introduction of green growth concepts gives rise to new institutional multiplicative effects.

3.UN Climate Change Conferences and Baku COP29 summit

Before summarizing our views on the UN Climate Change Conferences and the Baku COP29 summit, a review of history and structural issues is needed. So, in 1988, by the decision of the UN, the Intergovernmental panel on climate change (*IPCC*) was created. IPCC experts presented the results of their research to prevent global climate change by detecting its anthropogenic nature. In 1992, the UN Framework Convention on Climate Change (*UNFCCC*) was signed by 154 States at the UN Conference on Environment and development (*UNCED*) in Rio de Janeiro, Brazil [6, 17].

After that, in 1997, an international agreement was signed in Kyoto, Japan, aimed at reducing greenhouse gas emissions into the Earth's atmosphere, based on the scientific consensus that global warming is fueled by human-

induced CO₂ emissions. And in 2015, another agreement was reached in the French capital, which, according to the UNFCCC, regulates measures to reduce carbon dioxide in the atmosphere from 2020. The purpose of this agreement is to “activate” the implementation of the UN Framework Convention on climate change, in particular to “make an effort” to keep the global average temperature rise “significantly lower” than 2 C° and limit the temperature rise to 1,5 C°.

It should also be noted that one of the recommendations of the IPCC was the holding of the World Conference on global warming. For this purpose, the conference of the parties of the UN Framework Convention on Climate Change - COP (*Conference of the Parties*) was established.

The COP includes 198 countries, being the highest legislative body that oversees the implementation of the climate change Framework Convention. COP is the only international platform for centralized discussion of the problem of global climate change. COP is held annually if there is no other decision of the parties.

The first event of the COP, whose secretariat is located in Bonn, Germany, began in Berlin, Germany in 1995. Its 33 conferences have been held so far. Based on the results of the conference, the final document is signed. In order for it to become a full-fledged UN pact, all the countries participating in the summit must sign it [14].

The choice of Azerbaijan as the venue for the next session of the conference by the unanimous decision of the Eastern European group is an indicator of high confidence in the country. Although it is a traditional oil country, Azerbaijan is among the least polluting countries in terms of CO₂ emissions, with an average of 0,1 percent. Against the background of these indicators, the holding of the COP29 conference in Azerbaijan should be regarded as an important event that gives a new impetus to its green energy strategy.

The image of Azerbaijan as an organizer of major international events is constantly growing. The decision to hold COP29 in Baku is also important because it was adopted two and a half months after the local anti-terrorist actions of Azerbaijan. This factor once again shows that the world community supports the steps taken by the country. The event of COP29 in Baku will prove that Azerbaijan is not only an oil and gas country, but also a founding state that attaches great importance to the “green” economy as a priority area. The holding of this event in Baku will also give a powerful impetus to the further

growth of Azerbaijan's influence in the world and direct and unhindered communication of the country's realities to the international community. President of the Republic of Azerbaijan Ilham Aliyev said: "it is a great honor for us to be elected by unanimous decision as the host country of COP29. We consider it a sign of the international community's respect for Azerbaijan and the work we do, including our activities in the field of green energy" [14].

It seems that Azerbaijan proves the country's importance to "green" energy by its practical activities derived from the green energy agenda. The country also joined the global methane Commitment initiative and set as its goal by 2030 to increase the share of green energy in electricity investment to 30%. Compared to the base - 1990, Azerbaijan aims to reduce the emissions of thermal gases by 2030 by 35%, and by 2050-by 40%. All this shows once again that the "green transition" is among the national strategies of Azerbaijan.

Green energy, the use of waste-free technologies, the problem of a clean environment also act as an integral part of the national priorities announced in 2021 in the strategy for sustainable development of the economy in the Republic of Azerbaijan.

What should be the expectations of the world community from the COP29 conference? What will be the contribution of the Republic of Azerbaijan to the full realization of the global green energy transition, the problem of climate change, increasing joint activities in the direction of decarbonization in accordance with the principles of environmental efficiency and emission economy?

These goals occupy an important place in the agenda of the COP29 Conference of the Republic of Azerbaijan. In this regard, taking into account the scale of global climate changes, issues such as the introduction of environmentally friendly technologies, waste recycling and promoting the restoration of contaminated areas are also of great importance. It is considered important to expand the use of "green" technologies in all spheres - in particular, the use of environmentally friendly vehicles, digitalization to the green economy, the introduction of artificial intelligence and "Industry 4" achievements. It is also believed that the COP29 conference will outline new human contours related to global climate change and aim for a more formal strategic line for the benefit of the international community.

Results

Our analysis and assessments on Azerbaijan's green energy concepts and the COP29 agenda lead us to conclude that World Energy is in a new phase of revolutionary transformation. This characterizes the entry of human civilization into a new qualitative stage, which is based on more environmentally friendly development. Energetic development is painted green. This conceptual direction is no exception for Azerbaijan. Therefore, the improvement of the country's energy policy in the context of green energy has become a necessity. In this regard, based on the current realities and the analysis carried out, the following are characterized as green energy concepts for the development of green energy in Azerbaijan in a more advanced way:

- developing the concept of national energy security from the context of the green energy strategy;
- building a new national circular economy model in an inclusive scenario by consolidating the concepts of green energy potential and green growth, forming a more modern institutional system and infrastructure with energy efficiency;
 - increasing activities in the direction of decarbonization in accordance with the principles of environmental efficiency and emission economy;
 - development of a strategy to expand the use of electric cars;
 - Increasing joint efforts to lay seabed cables on the “Caspian-Black Sea-European Green Energy Corridor” project;
 - Development of conceptual proposals to achieve the specific result of the COP29 agenda;
 - increasing the use of green technologies and digitalization in the energy sector, ensuring the wide application of artificial intelligence resources and “Industry 4” achievements;
 - transformation of the region into a continuously developing green energy cluster by applying advanced technologies based on the consolidation of resources in the liberated territories.

At the same time, Azerbaijan, proceeding from new global trends, must implement appropriate transformations in building a green economy, develop concepts of green growth that bring multiplicative effects, and further strengthen its energy security.

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THE RESULTS OF STUDIES OF THE INFLUENCE OF MAGNETIZED WATER ON THE PHYSIOLOGICAL STATE OF CANCERS BASED ON THE FIBER-OPTICAL METHOD OF STUDYING THE CARDIHYTMUS

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Abstract

For the first time, an experimental assessment was conducted on the impact of magnetized water on the functional state of widely distributed Chinese river crayfish, *Procambarus clarkii*, using a non-invasive method to study their heart rate. The main goal of the research was to determine any possible negative effects of magnetized water used in reclamation, aquaculture, industry, and other fields on the functional state of macro-benthic animals in freshwater bodies.

A bio-electronic fiber-optic system, BioArgus, developed in Russia, was used to study the heart rate of animals. The MagVortex device was used to magnetize the water. The experiments showed that magnetized water does not have a negative effect on the functional state of crayfish, either acutely or over a period of at least five days. The results indicate that magnetized water is not toxic to multicellular freshwater animals and can therefore be used in aquaculture areas, particularly rice fields also used for cultivating freshwater shrimp and crayfish.

Key words: magnetized water, biomonitoring, biomarkers, physiological state, crayfish, bioindication, aquatic ecosystem health, heart rate.

Introduction

In recent years, the use of magnetized water in reclamation has become widespread in Asian, African, Middle Eastern countries, and this trend is actively developing in other regions of the world. As a result of the large-scale reclamation practices using magnetized water, and its discharge into industrial wastewater and water bodies, there is a significant need to assess the impact of magnetized water on aquatic flora and fauna. In work [1], both experimental research results of various authors on magnetized water in agriculture, industry, medicine, ecology, and other fields, as well as attempts to theoretically substantiate numerous changes in the physicochemical, structural, and biological properties of water under the influence of constant and alternating magnetic fields, are presented. There is information in the literature about the beneficial effects of magnetized water on the yield of various plants. For example, works [2-3] present research results showing that irrigation with magnetized water increases the yield and quality of tomatoes and wheat. In [4], positive results are reported regarding the use of magnetized water to mitigate the inhibitory effects of hard water on plant growth, using Japanese cabbage and rice as examples. Studies [5-6] note that irrigation with magnetized water improves both the quantitative and qualitative growth and development of plants, increases seed germination, ensures early vegetative development of seedlings, and increases mineral content in seeds and fruits.

Recent studies have also highlighted the bactericidal properties of magnetized water and its ability to suppress the growth of certain pathogenic bacteria and microorganisms. For instance, the effect of magnetic fields on the growth of *Pseudomonas aeruginosa* in autoclaved tap water has been studied, concluding that external magnetic fields create an antibacterial effect in drinking water [7].

Given that magnetized water enhances rice yield and quality [4] and can suppress bacterial microorganisms' growth [7], this study aims to assess whether magnetized water negatively affects the functional state of multicellular aquatic animals using the widely distributed and cultivated freshwater crayfish *Procambarus clarkii* in China. This is particularly relevant

in China, where freshwater mollusks, crayfish, and shrimp are grown in irrigation water on many rice farms. Therefore, understanding the acceptable limits of magnetized water use in natural conditions, particularly in integrated rice-crayfish farming technology, is of important applied agro-technological and ecological significance.

Materials and methods

Experimental studies on the effects of magnetized water on the functional state of widely distributed Chinese freshwater crayfish, *Procambarus clarkii*, were conducted in April 2024 at the ZEOMAG Laboratory, Wenzhou University, China. The MagVortex device, made according to patents [8-9], was used to magnetize the water. The MagVortex device included two sequentially placed three-dimensional magnetic matrices, the first with a magnetic induction of 3000 Gauss, and the second with 1500 Gauss.

The impact of magnetized water on the functional state of *Procambarusclarkii* was evaluated based on their heart rate analysis before and during their stay in water over several days.

The technology for measuring and analyzing the functional state of crayfish was similar to that described in [10-12].

Before the experiment, four freshwater crayfish *Procambarus clarkii* (12-13 cm in length) were placed in four isolated aquariums with settled tap water at a temperature of 22°C. The water in the aquariums was continuously aerated, and food remnants (crushed carrots) were removed daily.

For the comfort of the crayfish, the aquariums were also equipped with special shelters. All crayfish were connected to fiber-optic probes of the BioArgus bio-electronic fiber-optic system to enable non-invasive heart rate measurements, allowing continuous monitoring of their heart rate trends during adaptation to aquarium conditions and their response to magnetized water.

The testing procedure involved comparing the heart rate trends of crayfish exposed to magnetized water with a control crayfish exposed only to original non-magnetized water as follows: in the aquarium with 5 liters of water containing the crayfish, 15 liters of magnetized tap water were added. In the control aquarium, the same amount of non-magnetized tap water was simultaneously added.

Results and discussion

In the first 24 hours, all animals in all four aquariums had a high heart rate in the range of 80-110 bpm, indicating that the crayfish were stressed. On the second day, the heart rate of the crayfish in two aquariums gradually decreased and stabilized at 26.7 ± 2.7 bpm in aquarium No. 1 and 28.1 ± 3.1 bpm in aquarium No. 2. These levels remained stable for the following five days of the experiment. The crayfish in these aquariums mostly stayed in shelters, coming out only at night to feed on crushed carrots. In the other two aquariums, the crayfish's heart rate remained high, characteristic of high-stress conditions, and they mostly roamed the aquarium, trying to escape, indicating possible internal damage as both died by the end of the third day. On the second day, the crayfish in aquariums No. 1 and No. 2 demonstrated a calm state with a low heart rate, characteristic of these animals adapted to aquarium conditions in a calm state. (Fig. 1) Therefore, the experiment could only be carried out with these crayfish.

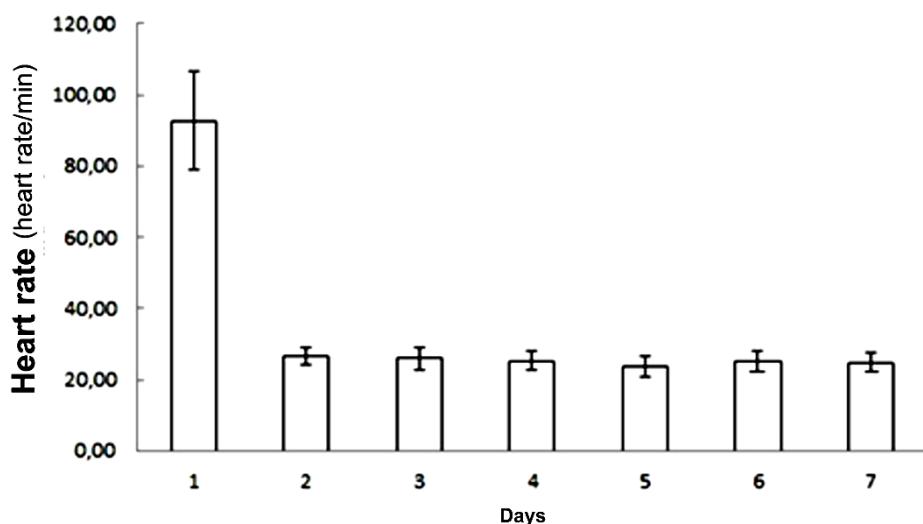


Fig. 1. Heart rate of crayfish *Procambarusclarkii* at rest during daylight from 10:00 to 18:00 over seven days. (On the 3rd day, heart rates were measured throughout the day minus the time for heart rate reaction to water addition).

During testing, magnetized water was added to aquarium No. 1, and non-magnetized water to aquarium No. 2. Before adding the water, the crayfish's heart rates in both aquariums No. 1 and No. 2 were stable with minor fluctuations in frequency and amplitude. As a result of adding magnetized water, the heart rate of the crayfish in the first aquarium gradually increased from 25 bpm to 50 bpm over 1.5 hours, remained at this level for 5-10 minutes, and then decreased back to the original level within 0.5 hours (see Fig. 2), remaining stable for the following four days until the end of the experiment (see Fig. 1).

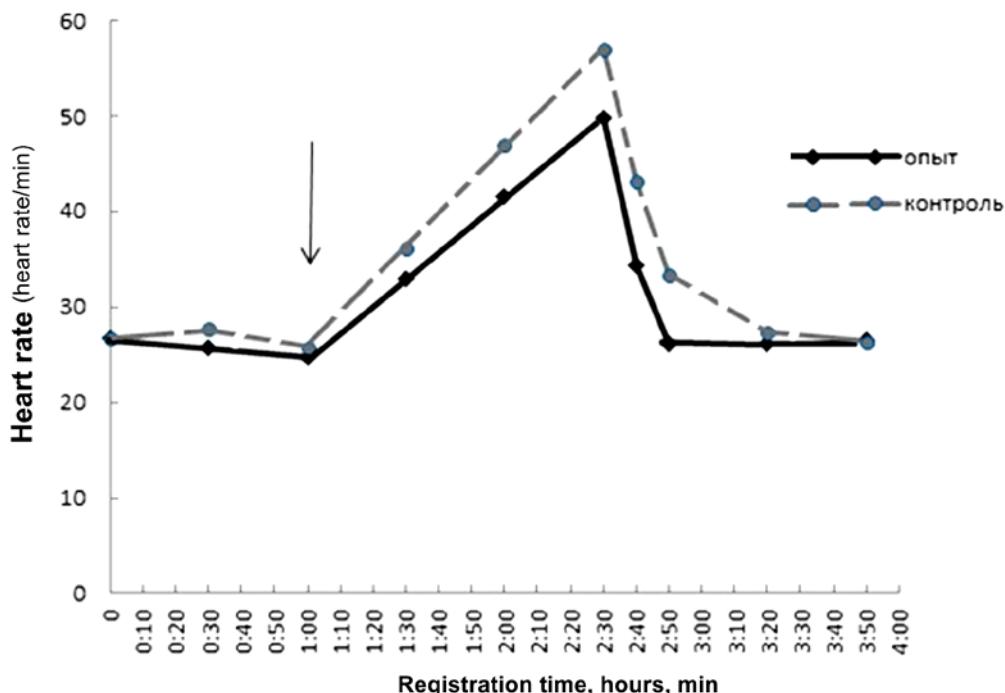


Fig. 2. Crayfish *Procambarus clarkii* heart rate response to simultaneous addition of magnetized water (black line) and control water (gray line). The arrow indicates the time of water addition.

In the control aquarium, the crayfish's heart rate trend showed a similar pattern, indicating that the short-term stress response was due to the addition of the extra water volume, not specifically the magnetized water.

The recovery and maintenance of the crayfish's heart rate

Fig. 2. Response of crayfish *Procambarus clarkii* to simultaneous infusion of magnetized water (black line) and control water (gray line). The arrow indicates the time of water addition.

In the control aquarium, the heart rate trend of the crayfish demonstrated a similar dependence, indicating that the short-term stress response in crayfish in aquariums No. 1 and No. 2 was associated only with the process of adding additional water volume to these aquariums, rather than with the addition of magnetized water specifically to aquarium No. 1.

The recovery of the crayfish heart rate in aquarium No. 1 and the maintenance of this level over the following days allow us to assert that magnetized water does not have any negative impact on the physiological state of freshwater crayfish, at least over a period of 120 hours of continuous exposure.

Conclusions

As a result of the conducted experimental studies on the impact of magnetized water on the functional state of *Procambarus clarkii* crayfish using a non-invasive method to study their heart rate, it was preliminarily established that magnetized water does not have any acute, short-term, or prolonged negative effects on the physiological state of aquatic animals, using the example of freshwater crayfish, over at least 120 hours.

Nevertheless, it is necessary to further verify the impact of magnetized water on a larger number of aquatic animals over a longer period, such as several months, correlated with an irrigation program on an experimental rice field. Such studies should be conducted during irrigation on an experimental rice field. The authors also plan to study the impact of magnetized water on marine species of aquatic animals, particularly mussels and crabs.

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EXPERIMENTAL STUDIES OF MAGNETISED WATER EVAPORATION USING MAGVORTEX TECHNOLOGY

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Abstract

The problem of annual reduction of fresh water reserves on our planet has serious negative consequences for sustainable development of many countries. The issue of fresh water consumption is especially relevant for agricultural countries. Therefore, the study of magnetised water evaporation is of great practical importance for saving fresh water. The experimental studies conducted by the authors using MagVortex water magnetisation technology allowed us to establish that magnetised water with an open surface evaporates less than non-magnetised water. This result is of great importance in melioration, especially when planting rice and other plants grown in flooded plantations.

Key words: water evaporation; melioration; magnetized water; MagVortex technology; rice cultivation; aquatic plants.

Overview of existing technologies for saving irrigation water

A number of technologies are currently used, the main purpose of which is to save irrigation water. A method for saving irrigation water is known, in which a plastic film is used as a protective layer (mulch) on furrows to reduce water evaporation /1/. However, this method of soil protection is too expensive and complicated for large areas of cultivation. This is due not only to the large financial costs of purchasing a waterproof film, but also to the complexity of its attachment to the soil surface, which is necessary in windy conditions.

Another method for reducing irrigation water consumption is based on irrigating the cultivated soil with a solution of an alkaline derivative of carboxymethyl cellulose. This method involves applying an aqueous solution of alkaline derivatives of carboxymethyl cellulose (CMC) to the soil surface. The content of the alkaline derivative of CMC in water ranges from 10 to 30 mg/l with a specific consumption of 6 to 18 kg/1 ha. Sodium, potassium, and at least 6 parts potassium to 1 part sodium solution can be used as CMC derivatives /2/. The disadvantage of this method is its complexity and relative high cost, which is associated with the need to apply an aqueous solution of alkaline derivatives of carboxymethyl cellulose (CMC) to the soil surface.

The most environmentally friendly solution to this problem is a method of reducing water consumption by adding natural zeolite to the soil /3/. Natural zeolite is an adsorbent capable of retaining moisture. The introduction of natural zeolite into the soil reduces water evaporation by retaining water in the pores of the mineral. Thus, adding natural zeolite to the soil allows increasing soil moisture by 3.3 - 3.9% and, accordingly, reducing the consumption of irrigation water by the specified percentage.

Meanwhile, the disadvantage of this method is its complexity, which is associated with the need to introduce natural zeolite into the soil and its high cost, associated with the high cost of natural zeolite introduced into the soil. The purpose of the experimental studies was to study the effect of water magnetization on its evaporation on open surfaces. These studies are necessary for the development of an effective and inexpensive method for saving irrigation water, for example, on rice plantations.

Methodology

The experiment was conducted in the ZEOMAG laboratory of Wenzhou University (China).

Before the experiment, six Petri dishes were taken and weighed on high-precision laboratory scales "JJ324BF" with an accuracy of 10^{-4} g. After that, for the experiment, 100 ml of tap water were poured into three Petri dishes. These samples were control. Then, samples of magnetized tap water were poured into the other three Petri dishes. All water samples were weighed on high-precision laboratory scales with an accuracy of $\pm 1 \times 10^{-4}$ g. Water magnetization was performed using a two-matrix laboratory device "Hexa" MagVortex, shown in

Fig. 1. All polymer elements of this device were made using a professional laboratory 3D printer QIDI “X-CF Pro”.



Fig. 1. Two-matrix device for water magnetization MagVortex.

After that, all Petri dishes were placed in a biochemical incubator of the SPX-350B brand at a temperature of 15°C. The incubator door was isolated from light from external sources. The experiment was conducted with the light turned off inside the incubator. Every day, at the same time at 15:00, the weight of water in all Petri dishes was measured.

The difference in the weight of evaporated water ΔM between the previous day M_1 and the following day M_2 was calculated. After that, an indicator reflecting the dynamics of water evaporation was determined: $\Delta M/M_i-1$. The amount of water evaporation in mg The results of the experiment are shown in the graph in Fig. 2. As can be seen from the graph in Fig.2, during the first 18 days, there is no difference in the evaporation of the control and magnetized water. Starting from the 19th day, there is a slight difference in the evaporation of the control water and magnetized water, which continues to grow in the following days, reaching a maximum value on the 23rd day of evaporation. That is, the evaporation of magnetized water decreases compared to the control. Starting from the 23rd day, the process stabilized and the difference in the evaporation of the control and magnetized water practically did not change over time. The next experiment was conducted at a temperature of 20°C.

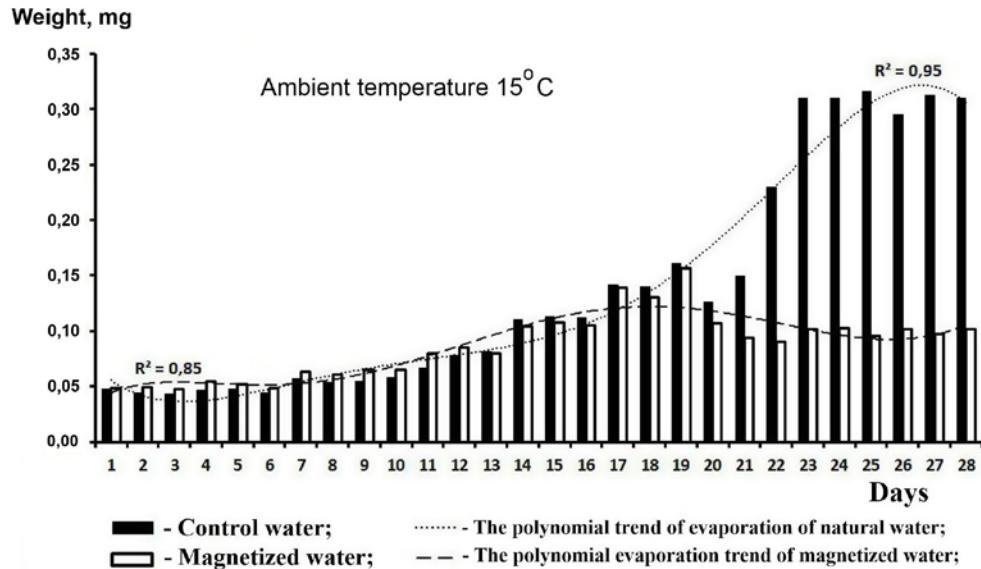


Fig. 2. Graph of evaporation of control and magnetized water at 15°C .

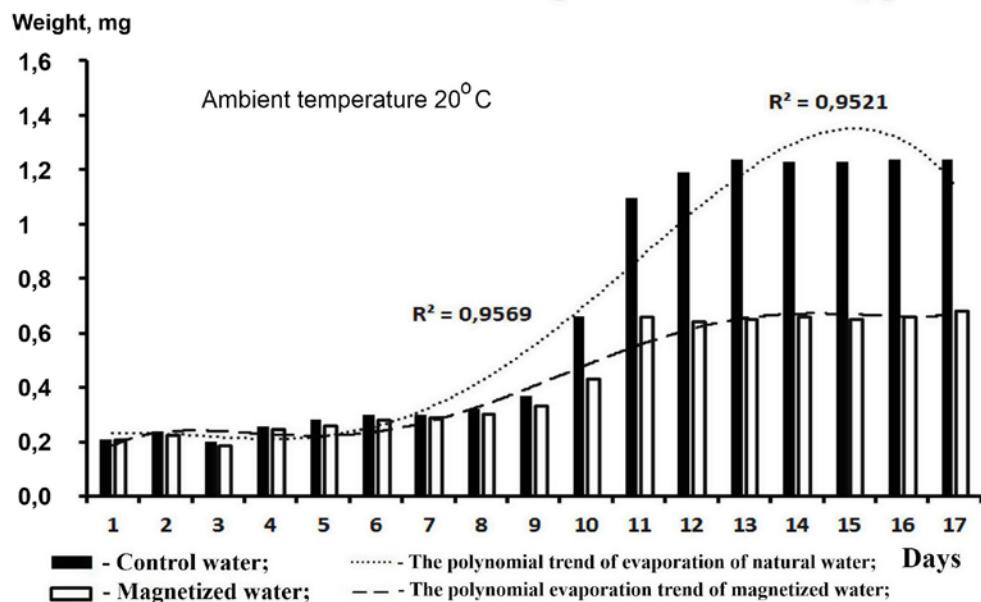


Fig. 3. Graph of evaporation of control and magnetized water at 20°C .

As can be seen in the graph in Fig. 3, during the first 7 days, there is no difference in the evaporation of the control and magnetized water. Starting from

the eighth day, there is a slight difference in the evaporation of the control water and magnetized water, which continues to grow in the following days, reaching a maximum value on the 13th day of evaporation. That is, the evaporation of magnetized water decreases compared to the control. Starting from the 13th day, the process stabilized and the difference in the evaporation of the control and magnetized water practically did not change over time. The third experiment was conducted at a temperature of 25°C. The results of the experiment are shown in Graph Fig.4.

As can be seen from the graph in Fig. 4, during the first 6 days, there is no difference in the evaporation of the control and magnetized water. Starting from the seventh day, there is a slight difference in the evaporation of the control water and magnetized water, which continues to grow in the following days, reaching a maximum value on the 10th day of evaporation. That is, the evaporation of magnetized water decreases compared to the control. Starting from the 10th day, the process stabilized and the difference in the evaporation of the control and magnetized water practically did not change over time.

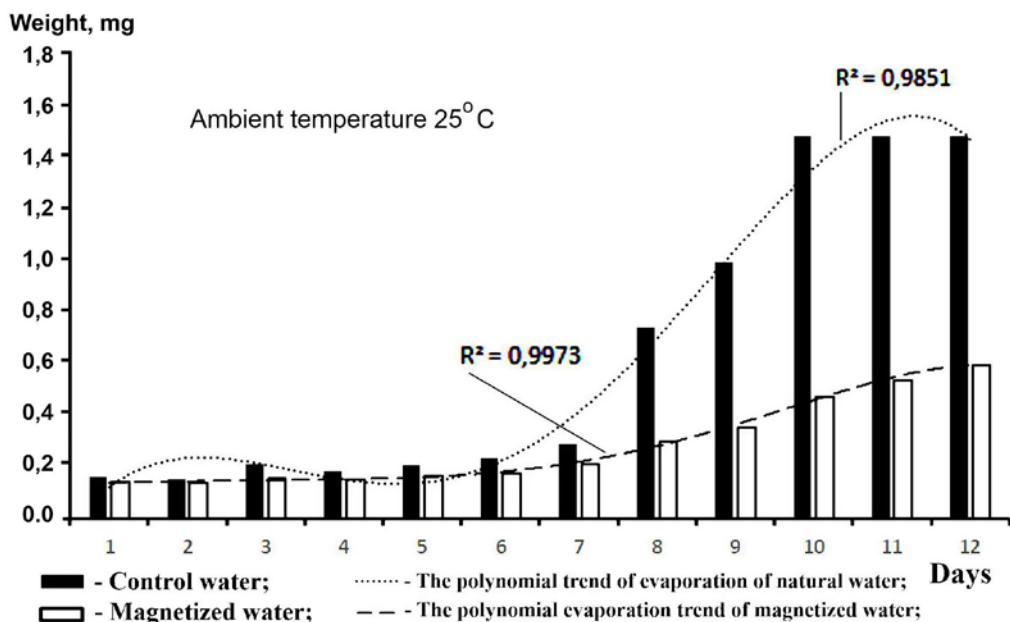


Fig. 4. Graph of evaporation of control and magnetized water at 25°C.

Let us consider the physical mechanism explaining the experimentally registered phenomena, on the basis of which the present method of reducing water consumption when watering plants was compiled. Fig. 3 schematically shows the distribution of clusters and individual molecules of ordinary (non-magnetized) water. In ordinary water, the water molecules that form clusters are linked to each other by hydrogen bridges and individual water molecules are located separately, which helps to reduce the density and viscosity of water, as well as surface tension. In such (non-structured) water, there is a large number of individual molecules with kinetic energy exceeding the bond energy of hydrogen bridges in water clusters at a specific temperature. The average kinetic energy of water molecules is:

$$\bar{E}=3/2kT,$$

where Boltzmann constant:

$$k = 1,38 \cdot 10^{-23} \text{ J/K},$$

For example, in accordance with /7/, the energy of the hydrogen bond between molecules in a cluster of two molecules at a temperature of 20°C is 0.485 eV. When water is heated by one degree, this bond energy decreases by 0.00078 eV. That is, water molecules in which the kinetic energy exceeds the energy of hydrogen bonds in the cluster fly out from the surface of the water, as shown in Fig. 5. Thus, the higher the water temperature, the weaker the hydrogen bonds between water molecules in clusters and the easier it is for bonds to break and free molecules to appear, possessing high kinetic energy, allowing them to escape from the surface of the water. Therefore, based on the presented experimental studies, it can be concluded that the manifestation of the difference in evaporation between the control and magnetized water directly depends on the temperature of the external environment and occurs the earlier, the higher the temperature of the external environment. Meanwhile, magnetized water is structured, that is, in the process of exposure to an alternating magnetic field with a high level of magnetic induction, under the influence of nuclear magnetic resonance, hydrogen bonds between water molecules are broken and most clusters are destroyed, while a more ordered molecular structure of water with significantly more stable hydrogen bonds is formed.

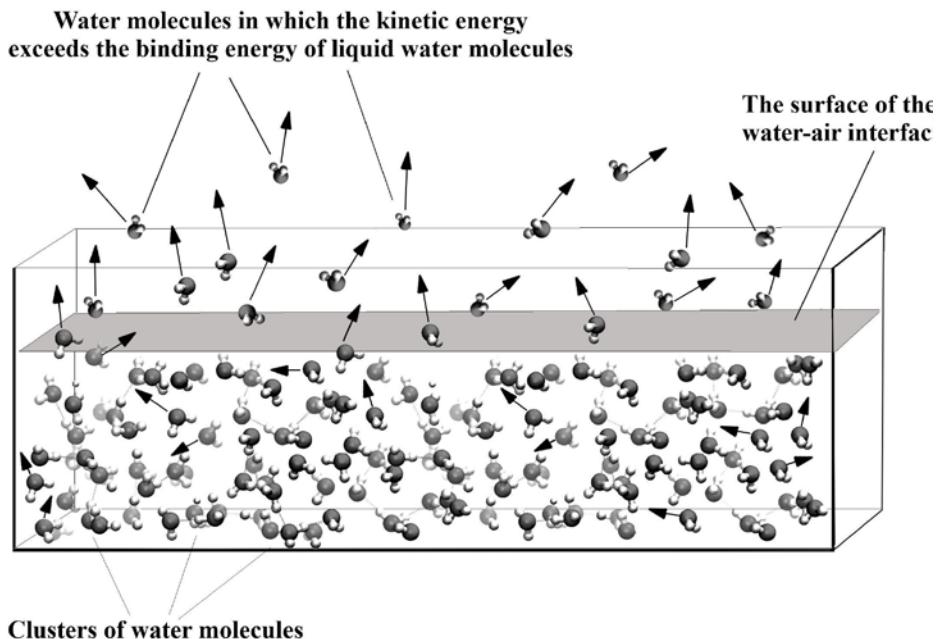


Fig. 5. Distribution of clusters and individual molecules of ordinary (non-magnetized) water

The formation of such a water structure is facilitated by a complex-structured magnetic field of a three-dimensional magnetic matrix. This is evidenced, in particular, by an increase in the surface tension of water /11, 12/ and a decrease in the evaporation rate of magnetized water /11/. Fig. 6 shows the structure of molecular bonds of water after magnetic treatment. We used the model of the hexagonal structure of water proposed by Finney and Bernal in /13/. Structuring of water under the influence of a magnetic field leads to the creation of stronger hydrogen bonds and a more homogeneous structure, as shown in Fig.6.

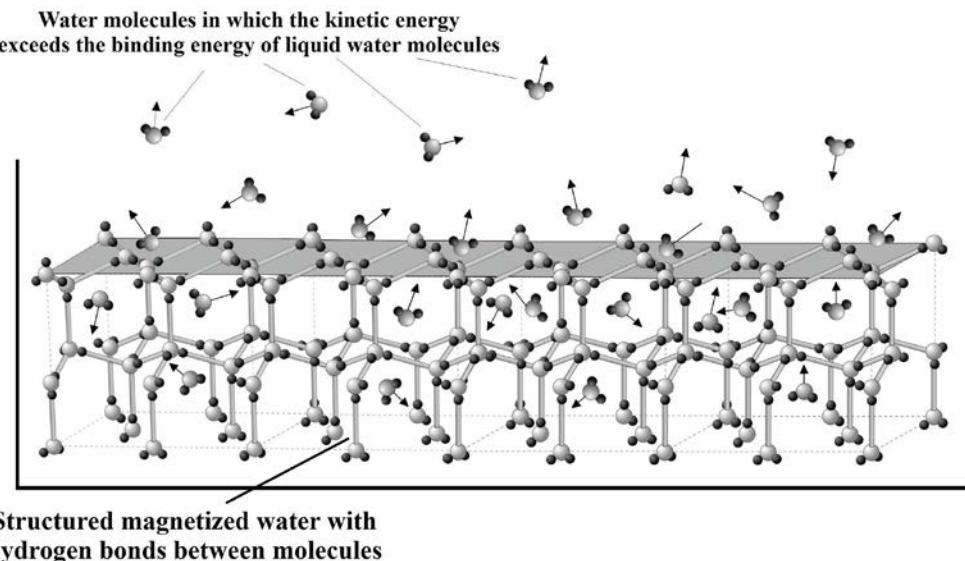


Fig. 6. The structure of molecular bonds of water in the process of evaporation of magnetized water at the initial stage of evaporation, which lasts until the moment when a difference in evaporation between the control and magnetized water begins to appear.

Fig. 6 shows the process of evaporation of magnetized water at the initial stage of evaporation, which lasts until the moment when a difference in evaporation between the control and magnetized water begins to appear. Magnetized water has a relatively uniform structure with hexagonal hydrogen bonds of water molecules. At the same time, along with the bound molecules, there is also a fairly large number of free molecules not bound by hydrogen bonds, which have high kinetic energy. The kinetic energy of these molecules exceeds the energy of hydrogen bonds between water molecules, as a result of which they can fly out of the liquid. However, after a certain time, the number of free water molecules with high kinetic energy decreases, as a result of which the magnetized water becomes more structured.

Thus, at the first stage of the evaporation process, the difference between the evaporation of the control and magnetized water is not observed or is insignificant. At the second stage, which is characterized by an increase in the difference in evaporation in the control and magnetized water, there is a decrease in the number of free water molecules with high kinetic energy, which

is reflected in an increase in the difference in the evaporation rate of the control and magnetized water. This process continues until the moment when the difference in evaporation of the control and magnetized water reaches a maximum and stabilizes. The process of stabilizing the difference in evaporation of the control and magnetized water is associated with a decrease in the number of free molecules to a minimum in magnetized water at a specific temperature. Meanwhile, an increase in temperature leads to an increase in the kinetic energy of free molecules, which fly out of the water much faster and their number decreases much faster. This is evidenced by a decrease in the time until the moment the difference between the control and magnetized water begins to appear. Thus, at 15 °C this time is 18 days, at 20 °C - 7 days and at 25 °C - 6 days. In Fig. 7. The process of evaporation of magnetized water is shown at the final stage of evaporation, which begins from the moment of stabilization of the difference in evaporation between the control and magnetized water.

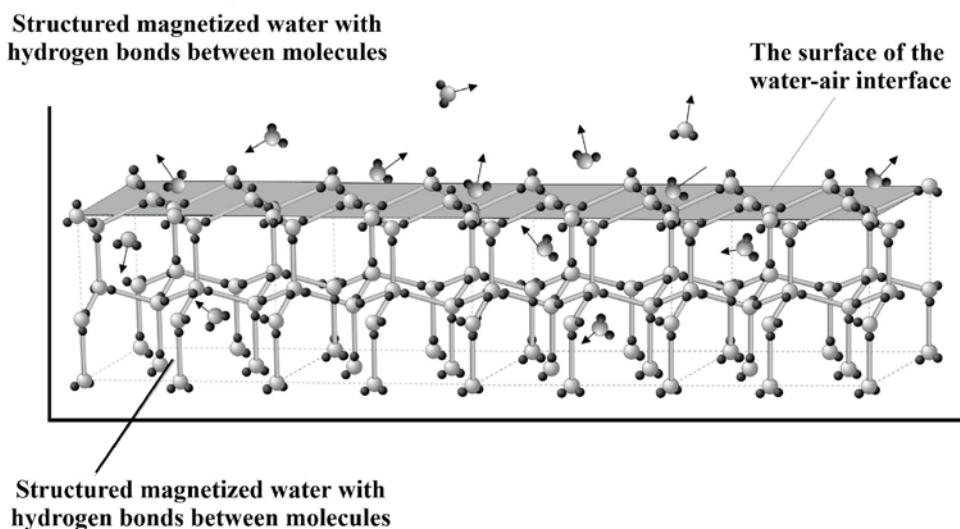


Fig. 7. The structure of molecular bonds of water in the process of evaporation of magnetized water at the final stage of evaporation, which begins from the moment of stabilization of the difference in evaporation between the control and magnetized water.

It should be noted that the use of magnetized irrigation water simultaneously contributes to an increase in plant productivity /11, 14, 15/, which allows us to recommend the use of magnetized water to reduce water consumption when watering plants while simultaneously increasing their productivity.

Conclusions

The experimental studies conducted by the authors allowed us to draw the main conclusion that magnetized water using MagVortex technology evaporates significantly less, compared to non-magnetized water with an open evaporation surface. Based on the experimental studies, we can also conclude that the manifestation of the difference in evaporation between the control and magnetized water directly depends on the temperature of the external environment and occurs the earlier, the higher the temperature of the external environment. The obtained research results allow us to recommend the use of water magnetization in the process of melioration under the condition of an open water surface, for example, when growing rice and other aquatic plants.

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MANAGEMENT OF MULTIDISCIPLINE GREEN TECHNOLOGIES ON THE EXAMPLE OF APPLICATION OF MAGVORTEX LIQUID MAGNETIZATION SYSTEMS

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Abstract

The article considers the problem of management of multidisciplinary green technologies in solving environmental protection issues. The existing approaches to environmental management and the fundamental principles of international environmental policy are considered. The key role of the UN in coordinating international environmental policy and promoting the green agenda is shown. Using the example of the development and implementation of the MagVortex green technology for liquid magnetization, an attempt was made to analyze the practical tasks in the implementation of management of multidisciplinary green technologies. It is shown that with properly organized management of green technologies, innovative green technologies can contribute to multidisciplinary and large-scale solution of problems in various areas of environmental protection and improvement.

Key words: Environmental management, management of multidisciplinary green technologies, environment, ecology, environmental monitoring, MagVortex technology.

Green technology management

Environmental problems have been growing exponentially in the last half century. This fact has led to the need to consolidate the efforts of many countries to reduce the effects of environmental pollution. Thus, in 1992, the UN conference was held in Rio de Janeiro, in which 179 countries took part. The result of this forum was the development of the action plan program "Agenda for the 21st Century". The program, in particular, states that a safer and more prosperous future can only be achieved through joint global efforts

for sustainable development /1/. Subsequent development of the situation showed that without a well-thought-out and balanced management system in solving environmental problems, it is impossible to effectively combat anthropogenic pollution of the environment. This factor is the basis for setting the task of developing and implementing effective green technology management. The basis of green technology management is, first of all, the environmental policy of industrial enterprises and their organizational structure, economic aspects of development and communication with the state and the public. To these principles we can add environmental culture, corporate policy, information support and a management system /2/. Environmental management implies a management system based on the development of society by reducing the negative impact of human activity on the ecosystem, preventing environmental pollution, and complying with laws in the environmental sphere. The work /3/ proposes to distinguish several levels of environmental management. The first level is based on the analysis of the environmental situation at the enterprise and includes activities aimed at improving it. The second level is regional, aimed at solving issues of conducting scientific research in the field of environmental protection and rational use of natural resources. The third level involves the expansion and improvement of laws and regulatory documents in the field of ecology. The fourth level is international and is aimed at improving the environmental situation on a global scale through international monitoring and the development of mechanisms and recommendations for different countries /3/.

The main functions of environmental management are [4]:

- development and implementation of environmental policy at enterprises;
- reduction of the negative impact of enterprise operations on the environment and control over the use of natural resources;
- analysis and evaluation of the results of the implementation of environmental policy of enterprises;
- raising the level and modernization of the environmental management system.

The UN Mission in Environmental Protection and the Green Agenda

One of the first large-scale initiatives to protect the environment can safely be called the UN Stockholm Conference on the Environment in 1972

(Sweden). The main achievement of this forum is the creation of the UN Environment Program (UNEP) /5/. The next step in this direction is the report of the World Commission on Environment and Development "Our Common Future", which for the first time gave a clear definition of "sustainable development" /6/. A fundamental and qualitative leap in the formation of an effective mechanism for combating global warming as a result of anthropogenic factors, based primarily on uncontrolled emissions of CO₂ into the atmosphere, is the adoption of the Kyoto Protocol, which took place in Japan in 1997. The Kyoto Protocol established legal obligations of states to reduce greenhouse gas emissions, regulating waste trading limits /7/. The Millennium Summit held in the United States in 2000 defined the directions for reducing the gap in living standards in developing and developed countries, reducing the economic gap between rich and poor countries /8/. The World Summit on Sustainable Development held in Johannesburg from August 26 to September 4, 2002 focused on attracting the private sector, civil society and non-profit organizations to solving important global development problems /9/.

In his report, Nicholas Stern convincingly showed that the negative environmental consequences associated with climate change will cost humanity more than timely investments in measures to reduce greenhouse gases /10/.

The analytical report of UNEP - the United Nations Environment Program "Global Green New Deal" was presented in 2009 and defined the goals and objectives of transforming the economies of countries, changing international trade relations, taking into account expert opinion in the "green" economy /11/.

The UN Conference on Sustainable Development, held in Rio de Janeiro on June 20–22, 2012, identified the following as its main objectives: creating a "green" economy, improving the standard of living of the population, and establishing international cooperation in the field of sustainable development /12/.

Held in New York on September 25–27, 2015, the UN Summit on Sustainable Development adopted the "2030 Agenda for Sustainable Development in order to find new ways to improve people's lives, eradicate poverty, and combat climate change" /13/.

The next step in the fight against CO₂ emissions was the Paris Agreement, which was adopted on December 12, 2015, at the 21st Conference

of the Framework Convention on Climate Change in Paris; it was signed by 197 states. Under the Convention, states agreed to combat the increase in the average temperature on Earth and to ensure that by 2100 it does not rise by more than 2 degrees Celsius compared to the pre-industrial era /14/.

The confirmation of the goal of the Paris Agreement, the definition of the importance of reducing carbon dioxide emissions by 45%, the agreement on the gradual abandonment of coal energy and the gradual termination of subsidies for hydrocarbon production were the results of the Conference of the Parties to the UN Framework Convention on Climate Change in Glasgow (COP26), UK /15/.

On November 18, the annual COP27 - the UN conference on climate change - ended in Sharm el-Sheikh, Egypt /16/. One of the key topics of COP27 was "climate injustice", which is so relevant for the entire African continent. The essence of the problem is that developed countries produce more greenhouse gas emissions, but at the same time, underdeveloped states suffer more from climate disasters, since they are not able to independently adapt to new conditions and develop sustainably. Based on this, poor countries require financial support from industrialized countries to cover losses from disasters and adapt to new conditions. The analysis of the rate of reduction of CO₂ emissions according to UNEP was not encouraging - the gradual introduction of new solutions is no longer acceptable, there are practically no opportunities to contain global warming - we need to act quickly and effectively /16/.

The 2023 UN Climate Change Conference COP28 - the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change was held in Dubai, UAE, from November 30 to December 12, 2023. It also included the 18th meeting of the parties to the Kyoto Protocol and the 5th meeting of the parties to the Paris Agreement /17/.

The COP28 outcome document provides a report on the results of the first Global Stocktake (GST). This report analyzes the results of previous work to achieve the goals of the Paris Agreement. It also outlines a plan for the next steps to phase out fossil fuels by 2050. An important outcome of the conference was the creation of a Climate Change Compensation Fund for Developing States with an 800 million dollar fund. The 2024 UN Climate Change Conference COP29 - the 29th Conference of the Parties to the United Nations

Framework Convention on Climate Change is scheduled to be held in Baku, the capital of Azerbaijan, from 11 to 22 November 2024.

Stimulating the development of "green technologies" as a factor in the development of scientific and technological progress and sustainable development

The progressive growth of sources and types of environmental pollution has led to the formation of a whole class of technologies, which has been given the term "green technologies". The class of green technologies includes technologies in which the negative impact on the environment is minimized or completely absent. The creation of "green technologies" should be stimulated by both the state and the social environment.

In recent years, the transition from a linear to a circular economy (closed-loop economy) has been increasingly developing, with much attention paid to taking into account ESG factors (Environmental, Social, Governance), accepting the circular economy as an effective mechanism for the implementation of "Green Technologies" in various sectors of the economy to achieve sustainable development goals. In the work /18/, using a set of methods including systemic, comparative and semantic analysis, a method for identifying taxonomic features, a comprehensive interdisciplinary, historical and holistic approach, the basic features of the circular economy in industry were identified, a taxonomy of factors was developed and a version of the concept of strategic management of sustainable ESG development of industrial ecosystems in the circular economy was proposed.

Enterprises that neglect measures aimed at reducing the negative impact on the environment in modern conditions are exposed to a significant financial risk associated not only with the loss of reputation, but also with the application of harsh legal and economic consequences in the form of large fines and other measures. In the work /19/, the prospects for improving the management of green technologies at industrial enterprises in accordance with the ESG principles in terms of environmental components are associated with the renovation and modernization of fixed assets, resource conservation, reducing the negative environmental impact on the environment, creating conditions for investing part of the costs of introducing "green technologies" that contribute, for example, to reducing CO₂ emissions and recycling raw materials and

materials for reuse. The author of the work /20/ indicates that the limits of environmental responsibility of business entities should be established, control over which should be carried out using modern technologies, such as remote space sensing, bioindication and biotesting sensors for pollution, warning, monitoring and express control. On the other hand, "green technologies" can become a useful resource for industrial enterprises, allowing them to increase competitiveness and promote economic development. It is currently becoming a serious trend that "green technologies" enhance brand attractiveness for customers and allow attracting long-term public investment in the development of innovative energy and resource-saving technologies.

Multidisciplinary innovative "green technologies" and their features using the example of MagVortex technology

As a rule, "green technologies" are understood as specific areas of technological development that reduce the negative impact on the environment, such as:

- Technologies that help reduce CO₂ emissions;
- Recycling and secondary use of materials;
- Wastewater treatment;
- Energy saving;
- Renewable energy sources;

One of the specific areas in the energy sector is the use of "hydrogen technologies". Hydrogen technologies include a range of various technical solutions based on the use of hydrogen as an energy carrier. They are considered to be one of the most promising ways of energy development in the future. The operating principle of hydrogen technologies is based on the process of electrolysis - the decomposition of water into hydrogen and oxygen under the influence of electric current /21/. Technologies based on the use of natural energy - wind, sun, water, hydrothermal sources, etc. are classic examples of the application of "green energy".

Meanwhile, along with the well-known classic directions of development of "green technologies", in recent years innovative "non-traditional" multidisciplinary technologies have begun to appear, which also belong to the class of "green technologies" and are breakthrough in many areas at the same time: industry, ecology, agriculture, medicine, biology, ecology,

etc. One of such multidisciplinary green technologies is the "MagVortex" technology, for which a series of patents have been issued /22, 26, 27, 28/.

The main difference between multidisciplinary green technologies and single-profile ones is the presence of a "base technology", from which branches off into various areas of their application. Usually, multidisciplinary technologies are based on fundamental scientific discoveries. A striking example of multidisciplinary technologies are technologies based on such fundamental scientific discoveries as, for example: the Doppler effect, the photo effect, the discovery of a nuclear reaction, the discovery of X-ray radiation, the discovery of nuclear magnetic resonance, the discovery of the laser, the discovery of Graphene - a two-dimensional allotropic modification of carbon formed by a layer of carbon atoms one atom thick, etc. MagVortex is a technology for magnetizing liquids, which differs from all existing technologies in its physical principle based on the use of so-called three-dimensional magnetic matrices, which allow you to purposefully change certain properties of liquids. Thus, one of the areas of application of MagVortex technology is its use to reduce CO₂ emissions into the atmosphere by internal combustion engines (ICE) by up to 15%, as well as increasing power (ICE) by up to 5-7% and saving hydrocarbon fuel within 15-17%, which has been proven experimentally /23, 24/. Another area of application of MagVortex technology is the magnetization of irrigation water, which allows increasing the yield of various crops, including vegetables and grain crops /29-30/. In addition to the areas indicated, water magnetization technologies, including MagVortex technology, are also used in healthcare, in particular, in the treatment of various diseases /31-35/.

Recent results of experimental studies conducted at Wenzhou University (China) made it possible to inactivate toxic cyanobacteria that pollute many bodies of water in the world with no effective method of combating them using MagVortex technology. At the same time, it was experimentally proven that MagVortex technology is safe for other types of marine organisms, in particular for crayfish and mussels /36, 37/.

Experiments conducted at Wenzhou University (China) have shown a reduction in the evaporation of magnetized water, which has led to the development of a method for saving irrigation water during the land reclamation process, for which a patent has been requested.

In addition, as is known, magnetization of water and oil is effectively used in the oil industry to reduce scale deposits in water injection pipes, pumps and other oil production and refining processes, as well as to reduce paraffin deposits on the inner walls of oil pipelines and oil pumps. Magnetic technologies for water treatment are also widely used in boilers and other water heating and heating systems to reduce scale formation on the walls of pipes, boilers and other water heating systems. In Azerbaijan, MagVortex technology was introduced at a mineral water and soft drink plant to reduce water hardness AKVAVITA /38/. MagVortex technology belongs to the class of "green technologies", primarily based on a number of its important characteristics:

- MagVortex technology does not use external energy sources and is based on the use of the effect of the complex-structured magnetic field of three-dimensional magnetic matrices on the formation of a special structure of liquids;
- MagVortex technology has no negative impact on the environment;
- MagVortex technology is used to reduce the harmful impact of man-made and natural processes on the environment;
- MagVortex technology does not require disposal and can be used for a long time, while its efficiency decreases by only 1% over 10 years;
- MagVortex technology can be effectively used in a circular economy (closed-loop economy) /23/.

Management of multidisciplinary innovative green technologies MagVortex

Multidisciplinary innovative green technologies are a more complex subject of management, compared to monotechnologies. First of all, this is due to the need to classify multidisciplinary green technologies, depending on the scope of their application. Thus, it becomes obvious that multidisciplinary green technologies require the development of a completely new type of multidisciplinary management, which will be based on a flexible basis, focused on a multifactorial analysis of the management system. Management of a multidisciplinary green technology using MagVortex as an example should be multi-level and include the following main aspects:

- Multidisciplinary production with a focus on basic technology;
- Multidisciplinary marketing;
- Multidisciplinary logistics;

- Multidisciplinary economy;
- Multidisciplinary assessment of environmental efficiency from the use of MagVortex technology;

The first level of MagVortex green technology management is an industrial enterprise and its management system, which provides for the implementation of the ISO 14001:2015 environmental management system in the production process.

The second level of MagVortex multidisciplinary green technology (MGT) management is regional, which implements a set of measures to expand the scale of multidisciplinary industrial production and implements a regional marketing policy. Regional marketing policy involves consumer marketing, which provides for the sale of products to individual consumers, industrial marketing focused on the sale of products to industrial and institutional consumers, and government marketing, in which the end consumers are government agencies.

Regional government marketing involves working with municipal and provincial government agencies that coordinate and stimulate the implementation of innovative technologies to protect the environment, including the purification of water in natural reservoirs from cyanobacteria and other microbiological contaminants. Government marketing is a set of efforts that the government takes to support and develop enterprises operating in a given state. The third level of MZT management is national and involves the development and implementation of activities for multidisciplinary industrial production of products on a national scale. The national level includes the development of a strategy for the development of green technology on a national scale and the development and adoption of relevant regulatory legal acts stimulating the multidisciplinary implementation of technology at the national level for a specific purpose. The fourth level of MZT management is international and includes the development of criteria and mechanisms for the implementation of MZT at the international level in various countries. This level also includes the implementation of an international marketing policy. The international level may also include close interaction with relevant international organizations, such as the United Nations Environment Program - UNEP, Greenpeace, UNESCO target programs, IAEA, the International Social and Ecological Union (ISEU), the International Union for Conservation of Nature

and Natural Resources (IUCN), etc. The international level of MZT also involves the preparation and adoption of international regulatory legal acts regulating and stimulating the use of multidisciplinary green technology at the international level.

Conclusion

Thus, using the example of MagVortex technology, we have demonstrated that the development and implementation of a management system for multidisciplinary green technologies in addressing environmental protection issues should be based on a multifactorial approach. The multifactorial approach should include the classification of MZT into a basic technology and related technologies branching off from it, divided by their application profiles. Meanwhile, along with the multifactorial approach, the implementation of MZT management also has a multi-level nature, including the following levels:

- Local;
- Regional;
- National;
- International;

The management of MZT technologies is fundamentally different from the management of single-industry technologies and requires a detailed study and creation of a set of criteria and mechanisms, as well as guidelines and an International Standard for its successful development and application.

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THRESHOLD ASSUMPTION APPLIED BY THE JPN SUPREME COURT IN THE TEPCO FUKUSHIMA 1ST NPP ACCIDENT LAWSUIT

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Abstract

This study aims to critically analyze the decision of the Japanese Supreme Court in the TEPCO NPP accident evacuee lawsuit. This was the first decision, regarding the health effects of low-dose radiation exposure, that was based on scientific, rather than international studies. The current international authority has not established a threshold for the effect of low-dose radiation exposure on health maintaining that even doses of 100 mSv or less may be harmful. However, the Japanese Supreme Court, established a threshold, rejecting the increased risk of cancer at doses of 100 mSv or less. The question arises as to why the Japanese Supreme Court applies a rationale that ignores international studies. This is because it was necessary to underestimate the Fukushima Accident in order to advance nuclear power, which is a national policy in Japan. This paper summarizes how the Supreme Court intentionally applied threshold assumption to underestimate the damage caused by the Fukushima Accident.

Key words: Fukushima Accident, Evacuee Lawsuits, Low-Dose Radiation Exposure, Black Rain Lawsuit, 100 mSv Threshold Assumption

Introduction

Thirteen years have passed since the accident at TEPCO's Fukushima-1st NPP (Fukushima Accident), on March 11, 2011. It resulted due to the Tsunami triggered by the Tohoku-Pacific Ocean Earthquake. On June 17, 2022, the Supreme Court announced the first decision in a civil lawsuit filed by the victims (evacuees) of the Fukushima Accident to hold the company, TEPCO, and the government, responsible for the accident.

The purpose of this study was to critically consider the Court's decision not to comprehensively examine international studies on which it relied while assessing the health effects of low-dose radiation exposure. This study

considers it unreasonable that the Supreme Court blindly applied the 100 mSv threshold assumption as the basis for its decision, without sufficiently verifying its validity. This is because international studies on the health effects of low-dose radiation exposure differ from the scientific findings adopted by the Supreme Court. In the Japanese judicial system, theoretically, Supreme Court decisions strongly influence the lower courts. The extent to which the Supreme Court recognizes the low-dose radiation exposure caused by the Fukushima 1st NPP accident to be responsible for the victims' (evacuees') health damage significantly effects the compensation for the damages. Therefore, if the Supreme Court were to adopt and rule on an erroneous scientific finding, it would significantly impact similar lawsuits in the future. Consequently, there is a strong concern that the scope of relief for victims (evacuees) will be limited. In fact, a pending lawsuit [1] on children's thyroid cancer raises the health effects of low-dose radiation exposure as a point of contention, with a concern similar to that raised in this paper.

Japan used the Chornobyl NPP accident (Chornobyl Accident) as a reference point when the Fukushima Accident occurred, learning from it. Although we hope that it never happens, if a similar nuclear accident occurs anywhere in the world in the future, the Fukushima Accident will be used as a reference. Therefore, this paper emphasizes the importance of considering international research from a legal perspective to contribute to actual remedies not only for the Fukushima Accident, but also for potential victims (evacuees) of nuclear accidents around the world.

Materials and Methods

1. Scientific Findings of the Japanese Supreme Court Decision on Low-Dose Radiation Exposure

In this case, 3,864 residents of Fukushima and adjacent prefectures (Miyagi, Ibaraki and Tochigi), who were forced to evacuate due to the accident at the Fukushima 1st NPP, caused by the Tsunami following the Great East Japan Earthquake, filed a lawsuit against TEPCO and the Japanese government. They demanded that the air dose rate in their former residential areas be restored to the pre-accident value (restoration of the original condition) and that they should be compensated for the damages, owing to the violation of their right to live in peace and tranquility.

In the Japanese judicial system, the appellate court considers primarily whether a case conforms to the Constitution or whether a precedent is applicable. Therefore, the health effects of low-dose radiation exposure, the focus of this study, were examined by the Sendai High Court, the fact-finding court in the original case, and the Supreme Court, which affirmed the decision.

Therefore, the scientific basis for low-dose radiation exposure adopted by the court was based on the arguments of the Court of Appeal. The Sendai High Court's decision, dated September 30, 2020, held that the scientific findings on low-dose radiation exposure enumerated the following:

Effects of Radiation on the Human Body

First, the Sendai High Court broadly categorized the effects of radiation on the human body into definite and stochastic effects. The former includes acute damage, leukopenia and cataracts, with no definite effects occurring below (the threshold of) 100 mSv. However, cancer occurrence is a stochastic effect; in areas with radiation above 100 mSv, an increased risk of cancer is observed in proportion to the radiation dose. However, at doses of less than 100 mSv, it is extremely difficult to epidemiologically prove a clear increase in the risk of cancer caused by radiation, because the effect is so small that it is masked by the influence of other factors.

1.2. International Commission on Radiological Protection (ICRP)

The Sendai High Court explained that the ICRP and other international organizations have applied the Linear Non-Threshold (LNT) model, which establishes standards for radiation protection based on the assumption that the risk of stochastic effects increases linearly, even in areas with radiation below 100 mSv (i.e., health effects may occur). This section introduces the ICRP recommendations for radiation protection. For example, the ICRP estimates the risk based on data from epidemiological studies, assuming that there is a dose-dependent effect (linear dose response) even in the low-dose range, and that the cancer mortality rate increases by 0.5 % per 100 mSv in a population including both, adults and children. The Court found that the ICRP's findings were not supported by the NLT assumption. On the other hand, the Court notes that ICRP, 2007 (A86) states that "there is general agreement that epidemiological methods used to estimation of cancer risk do not have the power to directly reveal cancer risk in the dose range up to around 100 mSv." [2]

1.3. Fukushima Health Management Survey

Furthermore, the Sendai High Court referred to the results of a health survey (basic survey) conducted on approximately 2.05 million people living in Fukushima Prefecture at the time of the accident in question. The results of the survey, which estimated external radiation doses for approximately four months after the accident, are shown below (see Tab. 1).

Table 1.
Sendai High Ct., Sep. 30, 2020 (Hanrei Jihou No. 2484, p. 83)

| | Northern Area of Pref. | Central Area of Pref. | Southern Area of Pref. | Aizu/Minam iaizu Area | Sousou Area | Iwaki Area |
|-----------------------|-------------------------------|------------------------------|-------------------------------|------------------------------|--------------------|-------------------|
| Less than 2mSv | 87% | 92% | — | — | — | — |
| Less than 1mSv | 20% | 51% | 88% | 99% or more | 77% | 99% or more |

Based on the said results, Fukushima Prefecture assessed that "it is unlikely that there are health effects due to radiation, although the external exposure dose estimates for four months, since no apparent health effects below 100 mSv have been confirmed" [3] as per epidemiological studies by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2008 Report [4].

1.4. UNSCEAR 2013 Fukushima Report [5]

Finally, the UNSCEAR Fukushima Report stated that it cannot be concluded whether there is a discernible increase in the incidence of thyroid cancer for those exposed to higher thyroid doses during childhood and adolescence, based on insufficient information on dose distribution (see, Tab. 2). On the other hand, the Sendai High Court concluded that the UNSCEAR report predicts no significant increase in the incidence of childhood cancer and that the verification results are consistent with the fact that exposure to radiation due to the accident is well below the threshold of definite effects. Further, no acute health effects caused by radiation exposure have been reported among the public. The Fukushima and Chornobyl Accidents can be compared in that both were classified as Level 7 "severe accidents" on the International Nuclear Event Scale. Five years after the Chornobyl Accident, the Chornobyl laws were passed in Russia, Ukraine and Belarus. After the Fukushima Accident, the laws to support the affected children and victims (Law on Support for Children and Victims of NPP Accidents) were based on the same directives. Article 7 of the Chornobyl Law [6] clearly states that the radiation dose for children born in 1986 should be maintained below 1 mSv per year (70 mSv for a lifetime of

exposure). In Japan, the same emergency standard of 20 mSv per year remains in effect 13 years after the nuclear accident.

Table 2

Sendai High Ct., Sep. 30, 2020 (Hanrei Jihou No. 2484, p. 82)

| | Effective dose for Residents | | Effective dose for Evacuees | |
|---------------------|-------------------------------------|--|------------------------------------|--------------------------|
| | Municipalities in Fukushima | 6 neighboring prefectures of Fukushima | Precautionary Evacuation Areas | Planned Evacuation Areas |
| Adult | 1.0-4.3mSv | 0.2-1.4mSv | 1.1-5.7mSv | 4.8-9.3mSv |
| 10 years old | 1.2-5.9mSv | 0.2-2.0mSv | 1.3-7.3mSv | 5.4-10mSv |
| 1 year old | 2.0-7.5mSv | 0.3-2.5mSv | 1.6-9.3mSv | 7.1-13mSv |

2. Comparison of the Chornobyl and Fukushima Accidents

Although not directly related to the health effects of low-dose radiation exposure, which is the focus of this study, certain differences were observed between the two countries in terms of restrictions on evacuation zones (see, Tab. 3) [7].

Table 3

10 Lessons from Fukushima (2015), p. 52

| Air Radiation Dose (annual) | Chornobyl Zoning | Fukushima Zoning |
|--|--|--|
| 50 mSv and above | Forced Evacuation Zone | Difficult to Return Zone |
| 20 - less than 50 mSv | Forced Evacuation Zone | Habitation Restricted Zone (temporary return possible) |
| Less than 20 mSv | Forced Evacuation Zone | Zone Being Prepared for Lifting of Evacuation Order |
| 5 mSv and above | Compulsory Resettlement Zone | No Instructions |
| (Judge for only Soil Contamination) | Compulsory Resettlement and Right to Resettlement Zone | No Instructions |
| 1 – less than 5 mSv | Right to Resettlement Zone | No Instructions |
| 0.5 – less than 1 mSv | Radiation Control Zone | No Instructions |

Despite several differences between the two countries in terms of the scale of the accident, the areas where NPP are located, and location of the country (island v/s mainland), it should be noted that, based on international knowledge of the health effects of low-dose radiation exposure, the restrictions pertaining to the Fukushima Accident were more relaxed than those related to the Chornobyl Accident.

Results and Discussion

1. International Studies on Low-Dose Radiation Exposure

We reviewed the scientific findings on the health effects of low-dose radiation exposure that were adopted by the Japanese Supreme Court. It was found that 100 mSv is the threshold radiation dose in Japanese judicial practice. However, as some opinions prove the effects of exposure to radiation lower than 100 mSv on the human body, it is necessary to review international findings that contradict the position of the Japanese Supreme Court.

This paper aims to criticize the Japanese Supreme Court from a legal perspective for its failure to comprehensively examine the threshold assumption regarding low-dose radiation exposure. Therefore, I will not discuss whether scientific evidence, supports the existence or the non-existence of a threshold, as this is outside the scope of this study.

1.1. Radiation Effects Research Foundation (RERF), Life Span Study (LSS) [8]

The evaluation and determination of the effects of radiation on the human body were based on a study of the effects of atomic bombings in Hiroshima and Nagasaki. The LSS is a research program at the RERF that examines lifetime health effects based on epidemiological (population and case-control) studies. The main objective of this study was to examine the long-term causal effects of atomic bomb radiation on death and cancer incidence. Specifically, approximately 120,000 subjects (94,000 atomic bomb survivors and 27,000 non-exposed persons), selected from those residing in Hiroshima and Nagasaki as per the 1950 census, are being followed from that point forward.

There are two studies on LSS because of differences in the data subjects. One is a study on mortality data, aggregating cancer death cases since 1950, and the other is a study on incidence data, aggregating cancer cases at the time of the onset of disease, since 1958. In a mortality study, the LSS Report 13 [9] reported that the excess risk of solid cancers was linear with doses in the 0-150

mSv dose range. The most recent LSS Report 14 [10] reported that the minimum estimated dose range wherein the excess relative risk is significant for all solid cancers is 0-0.2 Gy, that no threshold is indicated in a routine dose-threshold analysis, and that zero dose is the best threshold estimate. The optimal threshold value was reported to be zero. In an incidence study, Pierce and Preston [11] (see, Fig. 1.) analyzed solid cancer incidence rates from 1958 to 1994. They found that the low dose range of 0.05-0.1 Sv provided a useful risk estimate and was not overestimated, and that the dose range of 0-0.1Sv had a statistically significant risk, and calculated the upper confidence limit for any possible threshold to be 0.06 Sv. Grant [12] obtained similar results in a study that included smoking cessation in the Pierce and Preston survey study risk analysis; he also found that the overall solid cancer incidence rate was positively correlated with radiation dose.

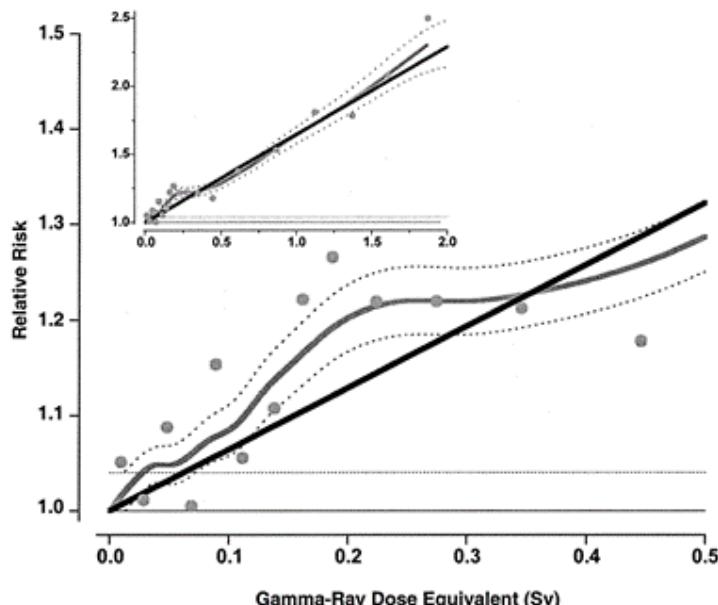


Fig. 1. Pierce and Preston (2000), p. 181; this figure shows demonstrating the carcinogenic effects of exposure to 100 mSv or less on humans.

All studies mentioned here found health effects at doses of 100 mSv or less.

1.2. ICRP

The ICRP has undergone a transition in radiation protection since its predecessor, the International X-ray and Radium Protection Committee

(IXRPC), and has not necessarily used 100 mSv as a threshold for the health effects associated with low-dose radiation exposure [13].

1.2.1. ICRP, 2005 [14]

First, an invited editorial indicated an epidemiological fact that cancer risk increases with exposure to about 10 mGy (\equiv mSv), based mainly on studies of diagnostic X-ray exposure in medicine. This increased risk is generally consistent with the predictions of the LNT model, and this fact does not support the existence of a threshold dose. ICRP, 2005 (48) also point to evidence of cancer risk on the order of tens of mGy (\equiv mSv), and 10 mGy (for fetuses ICRP, 2005 (258)).

1.2.2. ICRP, 146 [15]

The ICRP, 146 (20) assumes that the probability of cancer and hereditary effects increases in proportion to the dose and that even minimal exposure may increase the risk slightly (ICRP, 2007).

Additionally, although uncertainties remain regarding the health effects associated with low-dose exposure, epidemiological evidence of dose-risk relationships below 100 mSv has been increasing in large studies, many of which support the LNT model. Furthermore, ICRP estimated that exposure to an additional 100 mSv dose increases the lifetime risk of a typical lethal cancer by approximately 0.5 % (ICRP, 2007).

1.3. Government Reports

None of these reports rules out the health effects of low-dose radiation exposure.

1.3.1. Belarusian Government Report [16]

According to this report, there is an ongoing debate in the academic community regarding the risk assessment of low-dose radiation exposure in terms of tumor-induced radiation risks, with the academic community taking various positions regarding the assessment of the biological effects of low-dose radiation.

It should be noted that the Law on Amendments and Additions to the Law on "Social Protection for the Victims of the Chornobyl NPP Accident" (adopted on May 7, 2001) clearly states that protective measures shall not be discontinued even if the average annual executed radiation dose decreases from 1 mSv to 0.1 mSv per year and that the nature of protective measures shall be specified by the Cabinet of Ministers.

1.3.2. National Report of Ukraine [17]

This report discusses the short- and long-term effects of radiation exposure on radioactive contamination, and the health effects due to the Chornobyl Accident. Prior to the Chornobyl Accident, radiation cataracts were thought to have occurred when radiation doses exceeded 2 Sv. However, based on post-accident studies of eye diseases in radiation-exposed individuals, no threshold indicated for radiation cataracts, and it is now considered a stochastic effect of radiation exposure, occurring even at doses less than 100 mSv.

2. "Black Rain" Lawsuit (Hiroshima High Ct., Jul. 14, 2021) [18]

The "Black Rain" Lawsuit is a case, wherein 84 plaintiffs, who applied for the issuance of the Hibakusha Health Certificate associated with the atomic bombing of Hiroshima on August 6, 1945, sued Hiroshima Prefecture and the City of Hiroshima, claiming that they were exposed to rain containing radioactive fallout (black rain) that occurred after the bombing, thereby constituting Hibakusha, under the Hibakusha Relief Law. The Hiroshima High Court held that the plaintiffs were Hibakusha under the Atomic Bomb Survivors Relief Law because they were exposed to rain containing radioactive fallout (black rain) that occurred after the atomic bombing. The Hiroshima High Court recognized that, even if not exposed to black rain, residents of the black rainfall area could suffer health damage due to internal exposure to radiation by ingesting radioactive particulates. In other words, the court recognized all plaintiffs as victims of radiation exposure on the grounds that it is undeniable that even indirectly exposed persons can suffer health damage due to radiation from atomic bombs. The defendants, Hiroshima Prefecture and the City of Hiroshima, argued that the current scientific knowledge on low-dose radiation exposure is uncertain on whether health damage can occur in cases of exposure to radiation doses of 100 mSv or less, and it is quite possible that there are no health effects on the human body in the first place. Furthermore, the defendants argued that the internal radiation dose was extremely low and that the risk could not be generalized with regard to the possibility of health damage. On the other hand, the Hiroshima High Court upheld that there was no possibility of low doses of internal radiation exposure causing health damage; unlike past court decisions on the health effects of atomic bombs, the Hiroshima High Court broadly recognized the health effects of internal radiation exposure without relying on scientific dose estimation. This decision is groundbreaking because it adopts scientific findings that differ from the Supreme Court's decision on the Fukushima Accident and contributes to the relief of the victims. Immediately

after the ruling, the Prime Minister of Japan issued a statement that the ruling on the Black Rain Lawsuit was an exceptional response [19].

Conclusions

In Japan, due to ICRP, 2007 (A86), and the sudden conversion of the solid eye risk of radiation from 10 mGy (ICRP, 2005) to 100 mSv (ICRP, 2007), there is no evidence that exposure to 100 mSv or less causes health effects.

It has been highlighted that there has been no increase in cancer incidence, and many people consider the high incidence of thyroid cancer in Fukushima to be overdiagnosis [20]. However, numerous studies have shown an increased risk of cancer due to exposure to radiation less than 100 mSv, similar to the international findings discussed in this paper [21]. Why does this unusual trend prevail in Japan? This study focuses on the lack of epidemiological knowledge in the medical and legal communities in Japan as the root cause of this situation.

1. Evidence-Based Medicine (EBM) [22]

EBM is a science-based medicine, that emphasizes intuition, unscientific clinical experience, and pathophysiological evidence as sufficient basis for clinical judgment, as well as the verification of evidence through clinical research. The subjects of clinical research are humans, and the methodology for analyzing data collected by observing a large number of humans is epidemiological. Epidemiology is a basic scientific methodology used in medical research on human subjects [23]. However, the ICRP transition, regarding low-dose radiation exposure referred to in this study, was not necessarily analyzed using EBM to derive the results. The Fukushima Accident was an unpleasant occurrence not only for the Japanese government and public organizations in charge of nuclear technology, but also for international organizations. However, by applying the threshold assumption, the Japanese government was able to narrow the scope of compensation and, consequently, lower damages. Additionally, by underestimating the health effects of low-dose radiation exposure, the Japanese government succeeded in creating the impression that moving was an undesirable action, by referring to those who were originally evacuated as voluntary evacuees [24] and creating the impression that they had evacuated by choice. The Supreme Court mentioned in this paper was also complicit. As a result, the Fukushima Accident has been underestimated, unresolved, and now, forgotten. All in the name of promoting nuclear power in Japan.

2. Revision by the Japanese Court of Appeals

It is necessary to reconsider the validity of the scientific findings on low-dose radiation exposure, adopted by the Japanese Supreme Court (the new findings adopted in the Black Rain Lawsuit should also be helpful). This is because, if the rationale used by the court is false, the victims (evacuees) of NPP will be exposed to double standards: a judicial norm applicable only in Japan, and internationally accepted scientific grounds. In this case, the victims (evacuees) chose to continue fighting in court for true verification (the children's thyroid cancer lawsuit is a typical example). Consequently, the trial is expected to be a prolonged one. The situation is similar for Minamata disease, considered to originate from pollution in Japan, wherein the criteria for recognizing patients have changed with each Supreme Court decision [25]. This situation is extremely unpleasant not only for patients, but also for the government and the economics of litigation. However, there is a strong possibility that a similar situation may occur for the Fukushima Accident. Despite various theories on the scientific findings adopted by the court, regarding the health effects of low-dose radiation exposure, the views of international organizations were adopted as "scientific findings." This could be because, in the legal community, priority is accorded to qualitative, rather than quantitative, judgments of causal relationships. Even globally, nuclear energy constitutes a national policy, but victims of nuclear disasters are not responsible for it. Therefore, judicial proceedings require an impartial analysis in order to properly clarify responsibility. It is an obvious obligation of the Japanese government, which caused the accident, to adopt correct international findings on the health effects of low-dose radiation exposure in judicial proceedings, which is necessary to provide a useful judicial standard not only for Japan, but also for the world.

Acknowledgements

I thank Dr. Toshihide Tsuda (Professor, Okayama University, Japan) for useful advice and suggestions regarding this paper. I would also like to express my sincere gratitude and dedicate this paper to Dr. Yasuto Imanishi (Professor Emeritus, Kansai University, Japan) for his support and cooperation in every aspect of my research, based on his expertise.

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ARCHITECTURE AND CONSTRUCTION

INFLUENCE OF NANODISPERSE MODIFIERS ON THE PROPERTIES OF NEW GENERATION CONCRETE

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Abstract

This article presents the experimental results of the effect of highly dispersed complex modifiers on the structure and properties of cement stone and concrete. The complex modifier includes a heat-treated product of kaolin rock consisting of metakaolin and finely dispersed quartzite and a silicate gel formed as a waste during the production of aluminum from kaolin clays. Glenium SKY 303 hyperplasticizer based on polycarboxylate ether is added to the complex modifier to regulate the rheological properties of cement systems. The complex addition of organic and highly dispersed modifiers regulates the rheological properties of cement systems, controls the formation of cement stone and ensures the production of dense, high-strength concrete. Studies have shown that the complex application of 15% kaolin rock heat treatment product, 3% silicate gel and 1% Glenium SKY 303 hyperplasticizer produces high-strength polyfunctional concrete with a compressive strength of 88.67 MPa. It was found that methakolin and silicate gel, consisting of amorphous aluminosilicate, which is a part of the modifier, combine with reaction products to form additional cementitious compounds, quartzite is a mineral compound with finely dispersed particles that fills voids and pores in concrete and forms a rheological matrix in concrete mix. eliminates the segregation process, while the hyperplasticizer increases the flow of the concrete mix or gives the concrete high strength by reducing the water/cement ratio.

Key words: *modifier, cement stone, kaolin rock, silicate gel, hyperplasticizer, polyfunctional concrete*

Introduction

The development of the science of building materials requires the creation of high-performance multifunctional cement-based compositions. One of the most effective ways to improve the quality of the adhesive is the use of natural and man-made mineral additives of various origins [1-3]. Recently, many studies have been devoted to the modification of the structure of cement compositions with the use of finely dispersed materials [4-8]. These studies have shown that under the influence of modifiers, the hydration and hardening processes of cement change, the structure of cement stone improves and the mechanical properties of concrete increase. In this regard, there is a need to conduct research on the control of the formation of cement systems using multifunctional materials. Currently, effective cement compositions obtained with the use of dispersed minerals at the micro and nano levels are widely used [7-9]. In this regard, numerous studies have been conducted on the development and application of natural and artificial silicon-containing materials for the production of composite adhesives [10-12]. The hydration product of cement, the main reactive component of concrete, is a nanostructured calcium hydrosilicate (C-S-H). The strength and durability of concrete depends on the quality of the C-S-H gel. Microsilica is one of the main components in improving the quality of concrete because it reacts with portlandite to form additional cementitious compounds [13,14]. Metacaolin reacts with $\text{Ca}(\text{OH})_2$, a hydration product of cement, to form hydrosilicates, which have an additional cementing effect and improve the various properties of concrete [15,16]. The mechanical properties and longevity of concrete depend mainly on the improvement of the structure of the hardened cement stone and the increase of the adhesion forces at the boundary between the cement matrix and the aggregate. Silicate gel, which has a high degree of dissolution, contains a high amount of amorphous SiO_2 , modifies the hydration products of cement at the nano level and plays an indispensable role in the formation of a new dense structure [16-18]. The aim of the research is to study the effect of kaolin rock on the properties of polyfunctional concrete in the form of a complex at the

micro- and nanoscale of silicate gel formed as a waste during the production of heat-treated products and kaolin clays.

Experimental part

The following components were used in the experiments:

- CEM I 52.5N Portlandcement with a density of 3.15 g/cm^3 in accordance with the requirements of AZS EN 197-1 standard produced by NORM cement plant was applied in the research work. The normal density of cement is 28%, the beginning of the retention period is 135 minutes, and the end is 350 minutes, a compressive strength of $21 \pm 3 \text{ N/mm}^2$ after 2 days and $52 \pm 4 \text{ N/mm}^2$ after 28 days.
- 5-10 fr. of Guba stone quarry as a coarse aggregate during preparation of concrete mix. crushed stone was used. The water absorption of the gravel is 0.7%, and the density is 2.7 g/cm^3 .
- Tea sand from the Bahramtepe field with a modulus of size $\text{Mir} = 2.1$, density 2.6 g/cm^3 and a crushed sand with a modulus of size $\text{Mir} = 3.4$, density 2.65 g/cm^3 of the Guba stone quarry were used as fine aggregate. The absorption of sand is 1.8%, and the absorption of stone is 1.4%.
- The product of thermal processing (TEM), consisting of metakaolin and quartzite in a ratio of 1:1.2, is obtained by burning kaolin rock at 700°C . Metakaoline consists of amorphous aluminosilicate and reacts with cement. Quartzite is a mineral additive consisting of finely dispersed particles. It fills the gaps and pores in the concrete and creates a dense structure.
- During the extraction of amino oxide from kaolin clays, a silicate-containing mixture (SG) is formed as a waste. SiO_2 gel makes up 75-80% of the mixture. The particle size of SiO_2 gel is 500-1200 nm. Its ability to react with cement hydration products is higher. The silicate mixture is mixed with water and made into a 50% moisture suspension before being fed to cement systems. This method prevents the agglomeration of silicate particles and ensures the formation of a homogeneous mixture.
- Glenium SKY 303 hyperplasticizer, used to prevent aggregation of SiO_2 gel particles and its homogeneous distribution in the concrete mix, as

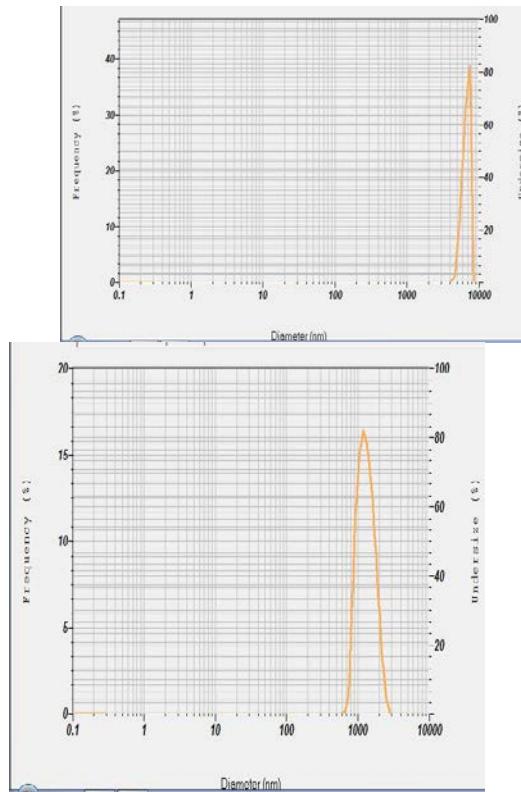
well as to ensure high flowability of the concrete mix, consists of polycarboxylate ether and was imported from BASF. The color of the hyperplasticizer is brown, pH 5-7, density 1.14 g/cm³, chlorine content 0.1%, alkali content 1%.

The following properties of cement systems were determined in experiments:

- To determine the size of nanoparticles, the device HORIBA nano partisa (nanoparticle analyzer SZ-100) in the laboratory of spectral analysis of the National Academy of Sciences was used.
- The effect of the modifier on the strength of cement stone was evaluated according to the results obtained during the determination of the strength limit in compression after 1, 3, 28 days of samples of 2x2x2 cm hardened under normal conditions. The strength limit was determined on AUTO 105/250 CEMENT COMPRESSION and FLEXURAL MACHINE.
- The effect of the modifier on the properties of fine-grained concrete was carried out on samples of 10x10x10 cm hardened under normal conditions.
- The fluidity of concrete is determined in accordance with EN 206, the strength of concrete in accordance with GOST 10180, frost resistance in accordance with GOST 10060, and water resistance in accordance with GOST 12730.5. Strength tests were performed on 1- and 28-day samples measuring 150x150x150 cm stored under normal conditions. Frost resistance and water resistance were determined in 28-day samples.

Results and discussion

The addition of high-dispersion mineral additives to cement systems ensures the filling of micro-pores and the creation of a dense structure of products, improves the mechanical properties of concrete. The combined application of kaolin rock TEM and silicate gel (SG) allows to achieve economic benefits by improving the properties of cement systems while reducing cement consumption. The size of TEM and SG particles was determined in the HORIBA nanoparticle (nanoparticle analyzer SZ-100) device (Fig.1, 2).

**Fig. 1.** Dimensions of TEM particles**Fig. 2.** Dimensions of SG particles

As can be seen, the size of TEM particles is in microns and the size of SG particles is in nano.

The effect of finely dispersed mineral additives on cement strength is given in Table 1. During the tests, the cement consumption was reduced to the amount of TEM. As can be seen from Table 1, the strength of cement stone increases by 1.9-3.8% when the amount of TEM is 10-15%. However, when the amount of TEM is increased to 20%, the strength decreases to 15.4%. When 2-4% SG is added, the strength of the cement stone gives a higher result than the ingredients used only in TEM.

Table 1.**Effect of TEM and SG on cement strength**

| № | Adhesive composition, % | | | Compressive strength, Mpa | |
|----|-------------------------|-----|----|------------------------------|---------|
| | Cement | TEM | SG | 2 days | 28 days |
| 1 | 100 | 0 | 0 | 20.1 | 52 |
| 2 | 90 | 10 | 0 | 22.6 | 54 |
| 3 | 80 | 15 | 0 | 22.0 | 53 |
| 4 | 70 | 20 | 0 | 17.1 | 44 |
| 5 | 88 | 10 | 2 | 23.2 | 56 |
| 6 | 87 | 10 | 3 | 26.1 | 61 |
| 7 | 86 | 10 | 4 | 24.2 | 58 |
| 8 | 78 | 20 | 2 | 22.1 | 56 |
| 9 | 77 | 20 | 3 | 25.6 | 60 |
| 10 | 76 | 20 | 4 | 18.5 | 54 |

This is due to the participation of SG nanoparticles in the formation of the dense structure of cement stone and the modification of the structure of newly formed hydrate compounds. As the amount of TEM and SG increases, the strength of the cement stone decreases, their particles have a high specific surface area due to their micro and nano levels, and the normal density of the cement paste increases, while the cement stone contains a large number of non-reactive particles.

When high-dispersion mineral additives are added to cement systems, the water consumption of the mixture increases to some extent and it is difficult

to achieve the full effect. The practice of using hyperplasticizers to overcome this problem is widespread [19, 20].

Therefore, hyperplasticizers in the amount of 1% by weight of cement were used to increase the efficiency of TEM and SG given in the complex in cement systems (Fig.3).

As can be seen from Fig. 3, the strength increases as the amount of SG increases, regardless of the amount of TEM. However, the strength decreases when the SG content is 4%. Due to the presence of hyperplasticizer, the strength of cement stone increases to 81-88 MPa. The highest result is obtained when TEM is 15%, SG 3% and hyperplasticizer 1%. As can be seen, organic additives are used to increase the efficiency of mineral modifiers and to regulate the properties of cement systems.

To study the effect of polycarboxylate ether-based hyperplasticizer Glenium SKY 303 on the properties of fine-grained concrete as an organic additive, a 1:3 cement filler solution (50% sand and 50% stone mortar) was prepared. Up to 15% of the cement mass is optimally TEM in the mortar.

The dependence of the strength of fine-grained concrete on the amount of hyperplasticizer and SG was studied (Fig. 4).

As can be seen, the results are higher when the SG content is 3%. When the amount of SG is increased to 4%, the strength begins to decrease. However, higher strength is obtained compared to 2%. This is due to the modifying effect of gel particles on the hydration process. As the amount of SG increases, the amount of particles in the cement stone that do not interact with the reaction products is greater, resulting in a decrease in the strength of cement systems due to the heterogeneous nature of the formation. As a result of the addition of 15% TEM, 3% SG and 1% Glenium SKY 303, the compressive strength of fine-grained concrete has the highest value and is 70.49 MPa. Research shows that the effect of Glenium SKY 303 starts at 0.6%, but the highest result is obtained with its use of 1%. The results show that the strength of the nanomodifier is due to the interaction of SiO_2 gel with portlandite formed during the hydration of clinker and the modification of the structure of the cement stone at the nanoscale. In non-additive samples magnified 3000 times under an electron microscope, micro-pores are observed between the newly formed compounds, and the structure is heterogeneous (Fig. 5 a, b).

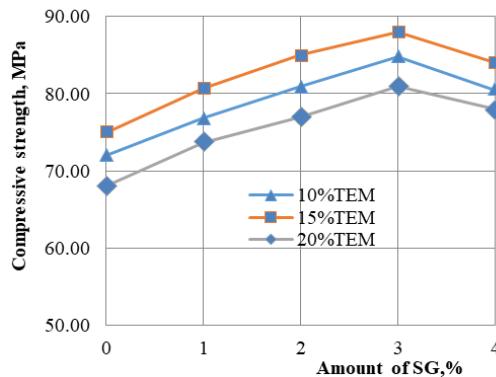


Figure 3. The effect of mineral modifiers on the compressive strength of fine-grained concrete

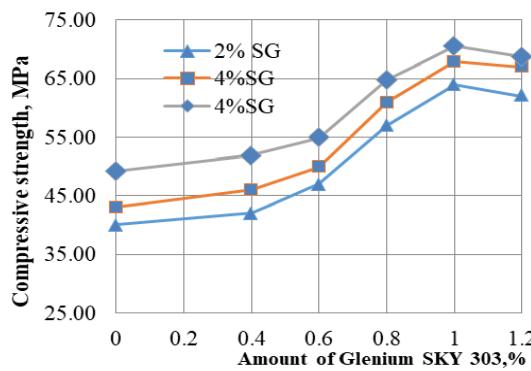


Figure 4. Effect of Glenium SKY 303 and SG on compressive strength of fine-grained concrete

Analysis of cement stone by electron microscopy showed that the addition of silicate gel increases the amount of calcium hydrosilicate in the early stages of hydration, and after 28 days the microstructure becomes denser and homogeneous (Fig. 5 c, d). When TEM and SG are given as a complex, TEM fills the inner space of the matrix and capillary pores as a finely dispersed filler to increase the compaction and strength of the cement stone, while SG provides a denser structure of the cement stone made of low-base hydrosilicates (10-15 μm in size) (Fig. 5 e, f). To determine the effect of the modifier

consisting of organic and mineral components on the properties of polyfunctional concretes, comparative tests of the concrete mix compositions given in table 2 were conducted.

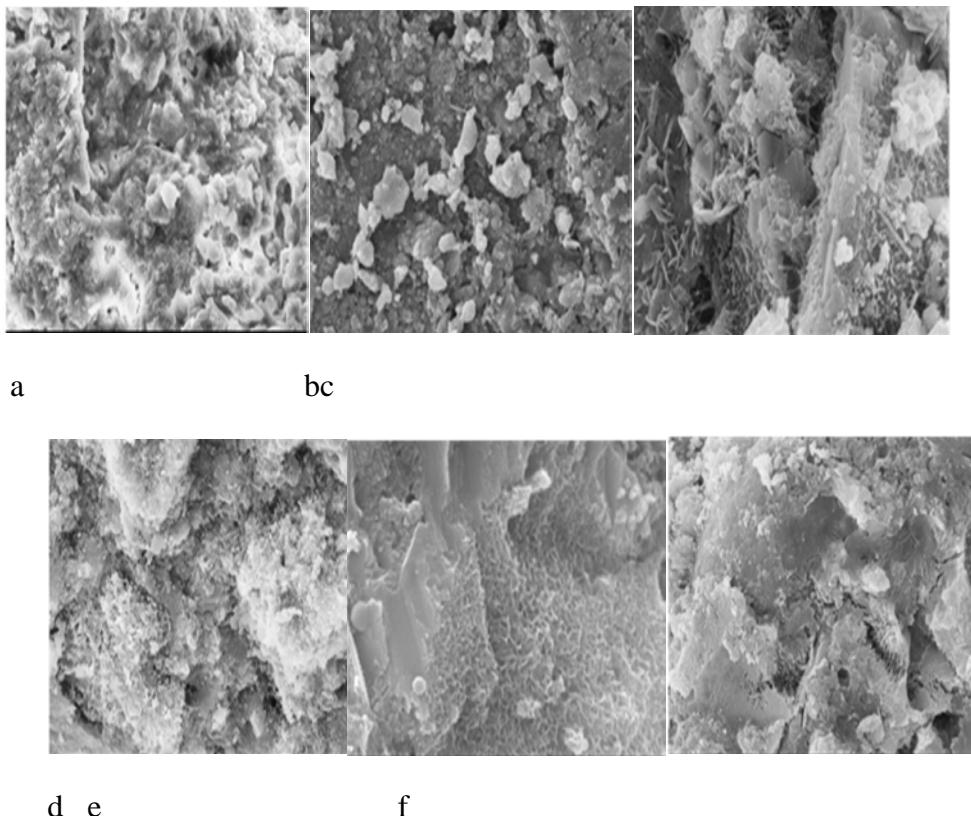


Fig. 5. Microstructure of cement stone

a, b- cement without additives; c, d- 3% SG; e, f- 15% TEM + 3% SG.

a, c, e - 1-day samples; b, d, f - 28-days samples.

To ensure even distribution in the composition of the SG concrete mix, it was first thoroughly mixed in an aqueous medium in the presence of Glenium SKY 303. TEM is supplied with the cement when the concrete components are fed to the mixer. The mixture of SG with Glenium SKY 303 is given together with water. The results of the experiment are given in Table 3. Due to the spread of the cone, all components meet the requirements of self-compacting

concrete according to ASTM and BS standards. According to the spreading class of the concrete mix, the first component corresponds to YS 1, 2-3 components to YS2, and the 4th component to YS3. According to the flow time of the V funnel, components 2-3 correspond to the viscosity class VS2/VF2. When the amount of organic and mineral modifiers is raised above the optimal level (composition 4), segregation occurs in the concrete mix, homogeneity is violated and the strength of concrete decreases by 22-25% during compaction.

Table 2.
Composition of concrete mix

| № | Composition of concrete mix, kg/m ³ | | | | | Amount of modifiers by weight of cement, % | | |
|---|--|------|--------------|---------------|-----|--|----|-----------------|
| | Cement | Sand | Crushed sand | Crushed stone | su | TEM | SG | Glenium SKY 303 |
| 1 | 450 | 400 | 550 | 900 | 180 | 0 | 0 | 0 |
| 2 | 450 | 400 | 550 | 900 | 135 | 15 | 2 | 1 |
| 3 | 450 | 440 | 550 | 900 | 125 | 15 | 3 | 1 |
| 4 | 450 | 400 | 550 | 900 | 120 | 15 | 4 | 1 |

When the modifiers are used in the complex in optimal amounts, the plasticizing effect of the modifier decreases due to the lack of organic matter, the easy molding of products deteriorates, at the same time the water-adhesive ratio in the concrete mixture increases and the compressive strength decreases to 33%. When 15% TEM, 2-3% SG and 1% Glenium SKY 303 are added in a complex, the compressive strength self-compacting concrete increases to 85.32-88.67 MPa, while the water resistance of concrete increases to W20 and frost resistance to F400.

Table 3.**The effect of organic and mineral modifiers on the properties of concrete**

| Concrete mix numbers | Slump, cm | Compressive strength of concrete, MPa | | Waterproofing | Brand for frost resistance |
|----------------------|-----------|---------------------------------------|---------|---------------|----------------------------|
| | | 1 day | 28 days | | |
| 1 | P-4 | 25.50 | 59.10 | W12 | F300 |
| 2 | P-5 | 40.62 | 85.32 | W20 | F400 |
| 3 | P-5 | 42.58 | 88.67 | W20 | F400 |
| 4 | P-5 | 38.33 | 66.53 | W16 | F400 |

Conclusion

The results of the study showed that the strength of cement increases as the amount of heat treatment product (TEM) of kaolin rock increases by 15%, but the strength decreases with subsequent increase of TEM. At a given value of TEM, the strength of the cement increases when the amount of silicate gel is increased to 3%, but the strength decreases with subsequent growth of the gel. The high specific surface area of dispersed admixtures interacts instantly with portlandite, the hydration product of cement, creating an additional cementitious compound. The formation of additional adhesive in concrete improves the adhesion of cement paste to the filler, and as a result, the strength properties of concrete are improved by the combined effect of TEM and SG. With the optimal addition of organic and mineral modifiers (15% TEM, 2-3% SG and 1% Glenium SKY 303), self-compacting high-strength polyfunctional and long-lasting concrete with a compressive strength of 88.67MPa is obtained. These concretes can be used successfully in monolithic constructions.

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DEVELOPMENT OF PILE EARTHQUAKE-RESISTANT FOUNDATIONS USING RECYCLED METAL-CORD ELASTIC WASTE

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Abstract

The article states that one of the urgent directions of ensuring the seismic resistance of structures with pile foundations is the development of pile structures with structural elements of seismic protection and seismic isolation. From the point of view of reducing the seismic load on the structure, two effects of the "pile in the pipe" type support proposed by Professor J.M. Eisenberg can be pointed out. One of them is related to the fact that the foundation is supported not near the surface, but at a certain depth, approximately equal to the length of the pile. Another effect is due to the flexibility of the piles, which determines the relatively long periods of oscillation of the "construction on flexible piles" system. Engineer F.G.Gabibov developed the first foundation structures using recycled metal-cord tires 35 years ago. Two new pile foundation designs have been developed using recycled metal-cord tires, which are characterized by optimal flexibility and damping perception of forces and deformations caused by dangerous earthquakes. In both designs, after installing a stack of recycled metal-cord tires into the well, they form a tubular pile element. Adjacent sidewalls of adjacent recycled tires form annular elastic elements arranged in equal increments on the inner surface of the elastic tubular element. The reinforcing frame of the pile is lowered into the cavity of the elastic tubular element along its central axis and fixed. The reinforcing frame of the pile is designed so that between its outer, i.e. the side part (surface) and the edges of the sidewalls of the disposed tires formed a protective layer of concrete established by building regulations. After that, an ordinary square or rectangular grillage is made. The second version of the new seismically isolated pile foundation differs from the

first version in that its grillage is made round in plan in a non-removable formwork made of recycled metal-cord tires with a diameter exceeding the diameter of the recycled tires forming the pile. The effectiveness of the proposed pile foundations lies in the fact that a simple and cheap construction of a pile seismically isolated foundation is achieved. All this is achieved due to the original geometric and mechanical characteristics of recycled metal-cord tires used in grillage and pile structures.

Key words: seismic isolation, pile, structure, foundation, recycled tire, grillage, deformation.

Introduction

Seismic isolation systems for structures should be provided using one or more types of seismic isolating and (or) damping devices, depending on the design solution and purpose of the structure, the type of construction – new construction, reconstruction, reinforcement, as well as on the seismological and ground conditions of the site. Currently, two strategies of "passive regulation" of earthquake resistance of buildings and structures are most often used: energy dissipation and seismic isolation. These strategies differ in the design solution of the structure for which they are intended, the desired modification of dynamic characteristics and the seismic isolation device used [1].

Seismic isolation, installed, as a rule, between the foundation and the aboveground part of the structure, introducing a discontinuous gap in the longitudinal and transverse stiffness along the height of the structure. The works of V.S. Polyakov, L.S. Kilimnik and A.V. Cherkashin [2], A.M. Uzdin and A.A. Dolgov [3], Ya.M. Aizenberg [4], F.D. Zelenkov [5] and others are devoted to theoretical and practical issues of seismic isolation of buildings and structures. Currently, rubber-metal seismic isolators are widely used, the research of which is devoted to the works of A.K. Chopra [6], T.K. Datta [7], O.V. Mkrtychev and A.A. Bunova [8], E.N. Kurbatsky, E.A. Pestryakova and I.I. Zernova [9], F.G. Gabibova and E.M. Shokbarova [10] and others. The use of recycled metal-cord tires in the design of elements of seismic protection and seismic isolation of buildings and structures is very promising. The works of F.G. Gabibov, E.M. Shokbarov and L.F. Habibova are devoted to this direction [11, 12].

Earthquake-resistant pile foundations

One of the urgent directions of ensuring the seismic resistance of structures with pile foundations is the development of pile structures with

structural elements of seismic protection and seismic isolation. The pioneering work in this field was developed by J.M. Eisenberg [13], the seismic isolation system "pile in a pipe" with switching connections.

The peculiarity of the considered design solution is the use of a seismic protection system for the foundation underground part of the structure, which can significantly reduce seismic loads on the building.

The seismic protection system includes reinforced concrete piles that fully perceive vertical loads from the weight of the building, reinforced concrete pressure-free pipes that perceive horizontal loads from seismic impact. Pipes of relatively large diameter have inelastic shut-off connections, which connect the pipes and the overlying part of the structure before switching off. The gap between the pile and the pipe can be 10-15 cm, depending on the geometric dimensions of the piles and foundations.

From the point of view of reducing the seismic load on the structure, two effects of the "pile in the pipe" type of support can be pointed out. One of them is related to the fact that the foundation is supported not near the surface, but at a certain depth, approximately equal to the length of the pile. It is known that the amplitudes of seismic accelerations sometimes decrease significantly with depth.

The seismicity of sites composed of loose soils resting on a rocky base increases in some cases by 1 point, that is, according to the current seismic scale, seismic accelerations on the surface are twice as large as accelerations on the underlying rock.

Thus, because of the "separation" of the pile from the surrounding soil and resting at depth, the seismic load can significantly decrease. Another effect is due to the flexibility of the piles, which determines the relatively long periods of oscillation of the "construction on flexible piles" system. For medium soils, seismic loads can be reduced by three or more times.

Both of these effects jointly reduce seismic loads. However, due to the considerable flexibility of the system, large horizontal movements of the upper points of the piles may occur. To reduce seismic movements, the design solution of the system under consideration includes a cascade of inelastic shut-off elements, which also prevent possible movement of the structure under wind loads and weak frequent earthquakes [14].

The use of recycled metal-cord tires in the construction of seismic isolating pile foundations

Engineer F.G. Gabibov developed the first foundation structures using recycled metal-cord tires 35 years ago at the Azerbaijan Scientific Research Institute of Construction and Architecture. The structure of the earthquake-

resistant foundation (Fig.1) for buildings 1 of a rigid structural scheme, consisting of main piles 2, connected on top by a high grillage 3 with the help of hinges 4 and additional piles 5, acting as elastic vibration limiters 15. The pile heads are located in cavities rigidly attached 7 on one of the end sides to the lower part of the grillage of recycled metal-cord tires 6.

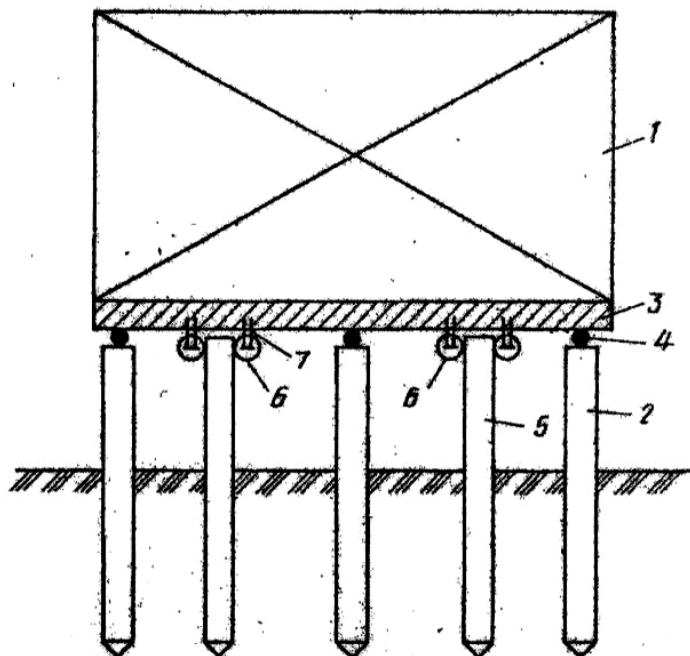


Fig. 1. Earthquake-resistant foundation: 1 – building; 2 – main piles; 3 – high grillage; 4 – hinges; 5 – additional piles; 6 – recycled tires; 7 - fasteners

When the building structure enters the zone of resonant vibrations, the amplitude increases and additional piles 5 are included in the work. In a short period, due to the presence of rubber-reinforced cups 6 and the absence of a gap between the elements of the limiters, the damping changes its stiffness and automatically exits the resonant mode. The shock-absorbing output from the resonant mode, as well as additional elastic resistance to horizontal movement of the structure, not only prevents the development of unacceptable deformations in the main connections, but also prevents the possibility of shock effects in the structures of the limiters. The sidewalls of recycled tires act as shock-absorbing elastic on-off connections. New designs of pile foundations have been developed using recycled metal-cord tires, which are characterized by optimal flexibility and damping perception of forces and deformations

caused by dangerous earthquakes. The first version of the new seismically isolated pile foundation (Fig.2) is constructed as follows.

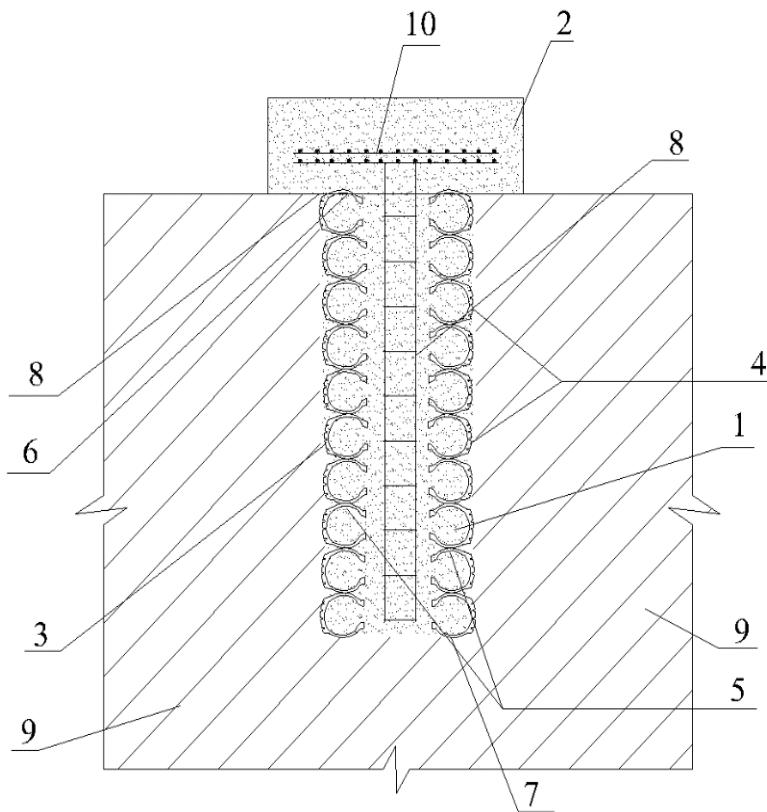


Fig.2. The first variant of a pile seismically isolated foundation with a conventional grillage.

1 – reinforced concrete pile; 2 – reinforced concrete grillage; 3 – tubular element; 4 – recycled metal-cord tires; 5 – annular elastic elements; 6 – upper sidewall of the upper tire; 7 - lower sidewall of the lower tire; 8 – reinforcing frame of the pile; 9 – the soil of the base; 10 – the frame of the grillage reinforcement

By drilling with a special screw tool, a well is formed for the pile trunk. The diameter of this well should slightly exceed the diameter of the pile trunk in order for a stack of recycled tires to be freely installed in the well in stable soils, and in the case of unstable soils, use an inventory pipe to freely lay a stack of tires and further remove this pipe. For compact installation of a stack of recycled tires in a well, special designs of stack-forming metal frames can be used, which, after installing recycled tires into the well, are removed from the latter. After installing a stack of recycled metal-cord tires 4 into the well, they

form a tubular element 3 of the pile 1. Adjacent sidewalls of neighboring recycled tires 4 form annular elastic elements 5, arranged in equal increments on the inner surface of the elastic tubular element 3. The reinforcing frame 8 of the pile 1 is lowered into the cavity of the elastic tubular element 3 along its central axis and fixed. The reinforcing frame 8 of the pile is designed so that a protective layer of concrete established by building regulations is formed between its outer, i.e., the side part (surface) and the edges of the sidewalls of recycled tires. After that, liquid concrete is poured into the cavity of the tubular element 3, after which a reinforced concrete pile 1 is formed. After that, a formwork for an ordinary square or rectangular grillage is installed. The reinforcement frame of the grillage 10 is connected by the releases of the reinforcement frame 8 of pile 1 and liquid concrete is poured into the formwork of the grillage. After setting and gaining strength with concrete, the formwork is removed and the reinforced concrete grillage 2 and, in general, the pile foundation is ready to load it with the upper part of the structure and perceive the corresponding operational loads. The proposed pile foundation, which is being built in seismic areas, works as follows. During intense seismic vibrations, the elastic metal-reinforced rubber shell of the tubular element 3 of the pile dampens the pile foundation bends in different directions, while in the pile body 1 part of the seismic forces. Then, during bending deformations without cracking in the body of the reinforced concrete pile 1, on the one hand, the grooves formed by the annular elastic elements 5 begin to open elastically, and on the opposite side, these grooves begin to contract, loading and deforming the parts of the annular elastic elements 5 made of metal-reinforced rubber located there, which dampen the compression forces arising in the specified zone the bodies of reinforced concrete piles. The same thing happens mirrorily when the pile bends in the opposite direction. The upper sidewall of the upper tire 6, located in the outer annular contact zone between the reinforced concrete pile 1 and the reinforced concrete grillage 2, forms an annular gasket made of reinforced rubber, which perceives and dampens alternating seismic and wind loads and deformations in the specified contact zone between the reinforced concrete piles 1 and the grillage 2. The lower sidewall of the lower tire 7 forms an annular strip gasket in the outer contact zone between the fifth reinforced concrete pile 1 and the soil of the base 9, contributing to the elimination of excessive unevenness of the contact load under static loads and damping of seismic and dynamic stresses and deformations in the specified contact zone between the fifth reinforced concrete pile 1 and the soil of the base 9. The second variant of the new seismically isolated pile foundation (Fig.3) differs from the first variant in that its grillage is made round in plan in a non-removable formwork made of recycled metal-

coded tires with a diameter exceeding the diameter of the disposed tires forming the pile.

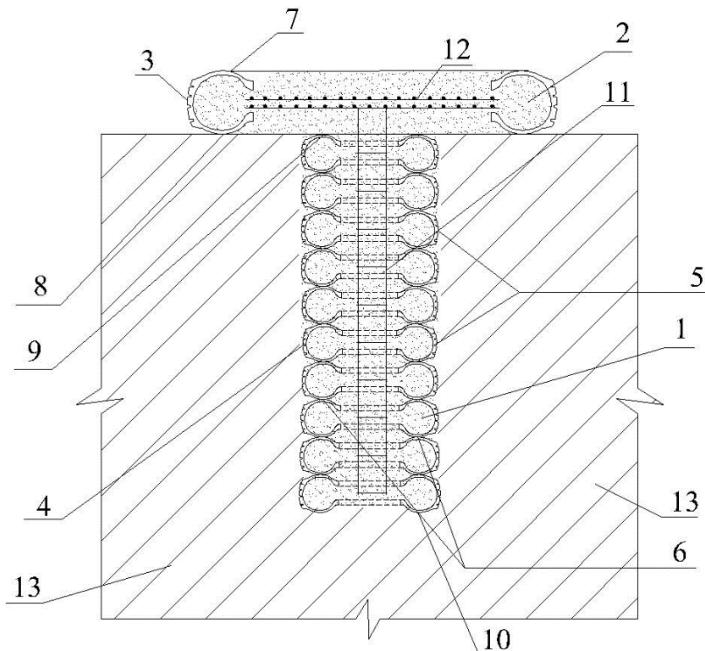


Fig.3. The second variant of a pile seismically isolated foundation with a round grillage with a non-removable formwork made of recycled metal-cord tires.

1 – reinforced concrete pile; 2 – reinforced concrete grillage; 3 – grillage shell from a recycled tire from a heavy-duty vehicle or tractor; 4 – tubular element; 5 – recycled metal-cord tires; 6 – annular elastic elements; 7 - upper sidewall of a tire from a heavy-duty vehicle or tractor; 8 - lower sidewall from a heavy-duty vehicle or tractor; 9 – upper sidewall of the upper tire of the tubular pile element; 10 – lower sidewall of the lower tire of the tubular pile element; 11 – reinforcing frame of the pile; 12 – reinforcing frame of the grillage; 13 – base soil

After the formation of the pile 1 itself, the disposed metal-cord tire 3 from a heavy-duty vehicle or tractor is installed asymmetrically on the central axis of the pile 1 on the surface of the soil base. The diameter of the inner hole of this tire 3 must exceed the outer diameter of the tubular element 4 of pile 1 (i.e., the outer diameter of metal-cord recycled tires). In the cavity of the tire 3, a reinforcement cage 12 of the grillage is formed, which connects to the outlets of the reinforcement cage 11 of the pile 1. After that, liquid concrete is poured into the cavity of the tire 3. Thus, after concrete sets the required strength, a reinforced concrete grillage 2 is created, in which the tire 3 performed the role

of a non-removable formwork, and after the formation of a reinforced concrete grillage 2, the tire 3 became a metal-reinforced rubber shell of the grillage 2. Thus, the pile earthquake-resistant foundation is ready to load its upper part of the structure and perceive the corresponding operational loads. A torus-shaped metal-reinforced rubber shell 3, made from recycled tires from a heavy-duty vehicle or tractor, in addition to the function of non-removable formwork of a reinforced concrete grillage 2, also in the finished structure of the grillage performs the role of waterproofing and seismic isolation.

The upper sidewall 7 of this tire forms an elastic metal-reinforced rubber gasket between the upper structure of the structure and the grillage 2, and the lower sidewall 8 of the tire 3 forms an elastic metal-reinforced rubber gasket between the ground of the base 13 and the grillage. Both of these elastic gaskets contribute to the damping perception and damping of seismic and dynamic stresses and deformations, as well as the alignment of contact stresses in these contact zones during static loading of the pile foundation structure. The effectiveness of the proposed pile foundations lies in the fact that a simple and cheap construction of a pile seismically isolated foundation is achieved. All this is achieved due to the original geometric and mechanical characteristics of recycled metal-cord tires used in grillage and pile structures, providing high seismic isolation and seismic resistance of pile foundations as a whole.

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DEVELOPMENT AND STUDY OF THE OPERATION OF PROTECTIVE SCREENS IN DEEP COMPACTION OF SLOWING SOILS BY HYDROEXPLOSIONS

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Abstract

The analysis of engineering methods for protecting structures from the impact of seismic waves shows that screens are one of the promising and understudied engineering methods of protection. A systemic analysis of known technical solutions for creating anti-seismic screens revealed that they are

generally formed as cylindrical cavities (vertical and horizontal), which in most cases are filled with material absorbing the destructive part of seismic energy. Engineering methods were developed for compacting arrays of loess slowing clays using rigid protective-reflective screens. Screens are created before moistening the array by the developed methods of compacting arrays of slowing clays in built-up areas. It's achieved by securing around the perimeter of the compacted area through the bottom of the contour trenches to the end of the slowing layer by injection of binding solution, thermal firing, freezing. Experimental studies of seismic effects on buildings during explosion production, aimed at hydraulic explosion compaction of loess slowing soils, confirmed the effectiveness of various developed designs and layouts of anti-seismic screens. The analysis of the results allows draw conclusion on efficiency of a screen consisting of two rows of boreholes filled with compacted clay (the near row to the platform) and sawdust (the far row). Such a screen construction, located at a distance of 8-9 m from the near row of blasting boreholes, reduced the level of seismic impact by an average of 1.5 times. Using anti-seismic screens of two types (lens-shaped and right-angled) made of two rows of boreholes in the ground allowed reduce ground vibration intensity from deep explosions by 1.2 to 1.7 times. The use of anti-seismic screen allowed the development of recommendations and the execution of deep explosions with an explosive mass of 5 kg at distances of 11 m from existing construction objects in the cities of Zaporozhye and Volgodonsk.

Key words: slowing soil, protective screen, boreholes, energy, seismic vibrations, experimental research, building, structure

Introduction

Compaction of soils at the foundation of future buildings and structures by soaking and energy of deep charge explosions (hydroexplosive method) is applied to eliminate slowing properties of soils, increase their strength, and bearing capacity. The essence of the hydroexplosive method lies in weakening the structural bonds of the soil by saturating it to the point of fluidity and initiating explosions of individual deep charges of explosive material. Subsequently, the soil is compacted under its own weight. The development, evolution, and study of the hydroexplosive compaction method for slowing soils are presented in the works of I.M. Litvinov [1], A.M. Ryzhov [2], A.A. Vovk [3], P.L. Ivanov [4], V.G. Kravets, N.S. Grishchenko and L.I. Demeshchuk [5], I.G. Takhirov and A.U. Abdullayev [6], V.S. Shokarev [7], F.G. Gabibov [8] and others.

During the compaction of soils by the hydroexplosive method in urban development conditions, seismic-safe distances to multi-story buildings are determined taking into account the dynamic characteristics of protected objects.

The seismic-safe distance from the epicenter of the explosion of a deep charge to multi-story buildings with structural anti-slowing or anti-seismic measures can be determined by experimentally derived formula:

$$r_c \geq k \times \sqrt[3]{q}, \quad (1)$$

where q is the charge mass, k - a coefficient equal to: 80 - for buildings up to 9 floors; 130 - for buildings over 9 floors.

In the built-up area, the mass of deep charges of explosive substances should not exceed 10 kg. The distance from the epicenter of explosions to surrounding buildings, which are in satisfactory technical condition, should be at least 40 m. If existing buildings and structures are located at distances less than permissible, measures are required aimed at reducing the seismic effect. One of the ways to reduce the seismic effect on construction objects is the use of seismic protective screens in the path of propagation of the explosive wave from deep charges to the protected building. One of the disadvantages of the hydroexplosive method of compacting loess slowing clays is the practical impossibility of its application in built-up areas, as seismic vibrations caused by deep explosions can lead to damage to adjacent structures. Analysis of engineering methods of protection of structures from the effects of seismic waves reveals that screens is one of the promising and little-studied engineering methods of protection.

The systemic analysis presented in [9] of known technical solutions for creating borehole seismic protective screens proved that they are generally formed in the form of cylindrical voids (vertical and inclined), which in most cases are filled with material absorbing the destructive part of seismic vibrations. These screens mainly have a static character of expecting to perceive dynamic effects.

Ya.L. Krantsfeld [10] in a review article on seismic protective screens believes that the idea of shielding seismic waves deserves serious attention. He believes that it's necessary to develop models of protective screens and practical methods for their calculation, for which the experience of the USA in the field of modeling and calculation of wave effects of different layers in a soil array [11] and the computer program SASSI in various modifications for numerical experiments and assessments of the effectiveness of the considered options for technical solutions of seismic protective screens can be used.

A.M. Uzdin and M.V. Freze [12] based on model studies came to the conclusion that shielding in earthquake-resistant construction is ambiguous. They believe that caution should be exercised in the use of shielding in earthquake-resistant construction, although the mentioned technical approach is useful in their opinion.

Development of rigid protective-reflective screens

Engineering methods were developed for compacting arrays of slowing loess clay with the use of rigid protective-reflective screens [13]. The formation of screens around the contour of the compacted area significantly reduces the intensity of seismic vibrations beyond the area. This occurs due to the wave reflection from the inner surface of the screen, as borehole as due to the wave attenuation within the screen itself. The explosive wave reflected from the screen elongates the seismic active period from explosions inside the compacted area, which allows for improving the quality of compaction of the loess clay layer.

One of the simplest problems regarding the interaction of a plane wave in a linearly elastic medium with a plane screen was considered by G.M. Lyakhov [14]. According to [15], the system of equations defining the adiabatic motion of an ideal fluid, in the case of plane, cylindrical, and spherical symmetry, can be represented as follows:

$$\begin{aligned} \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + \frac{1}{\rho} \frac{\partial p}{\partial x} &= 0; \quad \frac{\partial \rho}{\partial t} + u \frac{\partial \rho}{\partial x} + \rho \frac{\partial u}{\partial x} + \nu \frac{\partial u}{\partial x} &= 0; \\ \frac{\partial S}{\partial t} + u \frac{\partial S}{\partial x} &= 0; \quad p = p(\rho S), \end{aligned} \quad (2)$$

where u - particle velocity; ρ - density; p - pressure; S - entropy; t - time; ν - respectively equal to 0, 1, 2.

Two methods - Euler's and Lagrange's may be used for describing the motion of a continuous medium.

In the developed methods of compacting arrays of slowing loams in built-up areas, screens are created before moistening the array. It's achieved by fixing the contour of compacted area through the bottom of the contour trenches to the end of the slowing layer by injecting a binding solution, thermal annealing, or freezing. Since almost all operations of the hydroexplosive

compaction method are repeated therefore there's no need to describe the entire compaction technology, let's outline only the technologies for creating screens:

1. Creating a screen by injecting a fixing solution. Along the contour of the compacted area, contour boreholes are drilled using screw drilling rigs. Injectors are inserted into the contour borehole s through the bottom of the contour trenches. Contour boreholes are drilled at equal intervals. Fixation along the contour begins from the bottom of the contour borehole s by introducing a fixing solution (for example, sodium silicate) through the injectors. Penetration zones of the fixing solution through the contour borehole s should merge. It's resulted in the formation of a monolithic screen along the contour of the compacted area. After formation of the screen the array is locked, and hydroexplosions are performed.
2. Creating a screen by burning the soil along the contour. After the formation of contour borehole s, a device that allows igniting the borehole s during thermal treatment of the soil can be used not only from the top but also at any part of the borehole , including the bottom. The device for igniting the borehole consists of a guiding tube, at the bottom of which there is a clamp for detachable iron tips. The device is connected via flexible hoses to an oxygen cylinder. Soil burning is carried out as follows. The end of the metal tip is preheated to redness, after which oxygen is supplied through a heat-resistant tube that causes the metal to burn. Then this device is lowered into the borehole to a predetermined depth. Under high temperature ($> 1000^{\circ}\text{C}$) generated during the combustion of metal in oxygen, a heated zone is formed in the borehole bore. The burning zone is gradually moved upward towards the borehole head by raising the flame. After burning in all contour borehole s, a monolithic wall is obtained along the contour of the section 1 serving as the screen. When the screen is ready, water is supplied to the compacted array, and hydroexplosions are performed.
3. Creating a screen by freezing the soil along the contour of the compacted array. In contrast to the previous two methods, in the latter, before creating the screen, moistening of the slowing loamy array is performed. It's followed by drilling of contour borehole s from the bottom of the contour trenches to the end of the slowing layer. The system of contour borehole s is equipped with freezing columns, consisting of feed pipes and freezing pipes. Refrigerant is pumped through the freezing columns using pumps, cooled by the evaporation of the liquid refrigerant (ammonia or freon), to negative temperatures

(from -20°C to -40°C). After freezing, a monolithic wall of frozen ground is obtained along the contour of the compacted array serving as a screen. Then, the freezing columns are removed from the contour borehole s, and hydroexplosions are performed.

Creating screens along the contour of the compacted array or section provides not only more efficient use of the energy of deep explosions and prevent damage to nearby structures but also reduce water losses away from the compacted array.

Application of borehole anti-seismic screen in deep explosions in Zaporozhye

The research was conducted in the 17th microdistrict of the Khortytsky residential area in Zaporozhye. The construction site down to a depth of 32.0 meters was complex due to the thickness of slowing loess soils on Neogene deposits with a thickness of up to 10 meters. The slowing thickness of the soils was characterized by frequent interlayering and dipping of layers with different properties. The upper layers to a depth of 18 meters were characterized by relative slowing coefficients ranging from 0.04 to 0.73; the lower layers at depths from 18 to 32 meters had relative slowing coefficients ranging from 0.01 to 0.03. The total magnitude of potential deformations [16] was 2.56 meters.

Preparation of the foundation using the hydroexplosive method for residential building No. 5 (experimental site) was carried out in a partially built-up microdistrict.

The minimum distance from the explosive borehole s to the foundation of the existing residential building No. 4 was 10.5 meters. The nine-story residential building No. 4 was constructed on a hydroexplosive foundation.

The structural scheme of the buildings of the 96 series included transverse expanded clay concrete load-bearing walls with a thickness of 350 mm, supporting floor panels with a thickness of 160 mm, made of heavy concrete around the perimeter. The spacing of the transverse walls was 3.0 and 3.6 meters, the span was 5.1 and 5.7 meters, and the floor height was 2.8 meters. The foundations were designed as monolithic reinforced concrete strips with a width of 1.2 meters, continuous under all exterior and interior walls. Soil saturation at the foundation of residential building No. 5 was carried out through drainage borehole s, 20 meters in length, with a diameter of 350 mm, spaced at 3×3 meter intervals. The boreholes rows were connected by drainage trenches. The saturation of the site lasted 35 days.

For the purpose of determining the actual level of vibrations of the existing 10-story residential building No. 4 in the 17th microdistrict of

Zaporozhye and, based on this, establishing the permissible mass of explosive substance (ES) charges, studies were conducted on the building vibrations during hydroexplosive compaction of soils.

The seismic effect of deep charge explosions depends on many factors: the type of ES, the charge mass, its shape, soil conditions, depth of charge placement, etc. Due to the fact that the distance from the compacted areas (under building No. 5) to the existing 10-story residential building No. 4 was 11 meters, it was necessary to apply a anti-seismic screen in the path of propagation of explosive waves from deep charges to the protected building.

Experimental-theoretical studies of screens (artificial barriers) carried out at the State Research Institute of Building Constructions (NIISK, Ukraine) allowed to establish that their use can reduce the intensity of soil vibrations by 1.2 to 2 times. Before carrying out explosions, in the process of developing the engineering preparation project for the foundation of residential building No. 5, the effectiveness of reducing soil vibrations by anti-seismic screen (two rows of full boreholes with a diameter of 350 mm, depth of 15 m, and spacing of 1 m) was determined by calculation. On the basis of experimental data obtained at NIIKS, during the studies of soil vibrations in the 17th microdistrict of Zaporozhye, the speed of propagation of seismic blast waves (longitudinal) in loess soils was $v_p = 300 \dots 400$ m/s. The predominant periods of soil vibrations during deep explosions were: $T=0.1 \dots 0.5$ s.

Taking into account the provided data and the width of the anti-seismic screen of 1 meter, the value of the screening coefficient (the ratio of soil vibration amplitudes with and without the screen) was obtained within the range of 0.5..0.6. Experimental studies were carried out on soil vibrations and residential buildings under the influence of explosions for the purpose of verifying the calculated data and establishing the permissible mass of charges of ES. Measurements of building and soil vibrations were performed using standard seismometric equipment, consisting of an oscillograph N041.U4.2, seismic receivers of type CM-3, and a shunt box SK-2. The oscillograms were recorded on roll photographic paper. The layout scheme of an anti-seismic screen and seismic receivers during hydroexplosive soil compaction at the site near building No. 4 is shown in Fig. 1. Sensors for vertical vibrations were installed in the ground in order to determine the screening coefficient of anti-seismic screen. Measurements of horizontal vibrations of residential building No. 4 were performed on the first-floor level and on the roof. Vertical building vibrations were not recorded as horizontal vibrations of buildings were predominant during deep explosions. The maximum values of vibration parameters obtained correspond to the effects of individual deep explosions (with charge mass of ES - 5 kg) from the nearest rows to the existing residential

building No. 4. Analysis of the obtained experimental data on ground and building vibrations provides to draw the following main conclusions:

1. The amplitudes of horizontal vibrational displacements of residential building No. 4 at the levels of the first and tenth floors respectively ranged from 0.26-0.68 mm and 0.37-1.78 mm. The intensity of the building's foundation vibrations ranged from 3-3.5 points, which does not exceed the permissible value of 4 points. The amplitudes of horizontal vibrational displacements of the tenth floor of the building mostly did not exceed 1.1 mm, which is permissible.
2. Reduction in the intensity of vertical ground vibrations behind the anti-seismic screen was recorded during the charges of ES closest to building No. 4 in the range of 1.2-2.2.

The periods of forced ground vibrations (during deep explosion effects) in the horizontal and vertical directions respectively were: TH= 0.2-0.5 s and TV= 0.19-0.4 s.

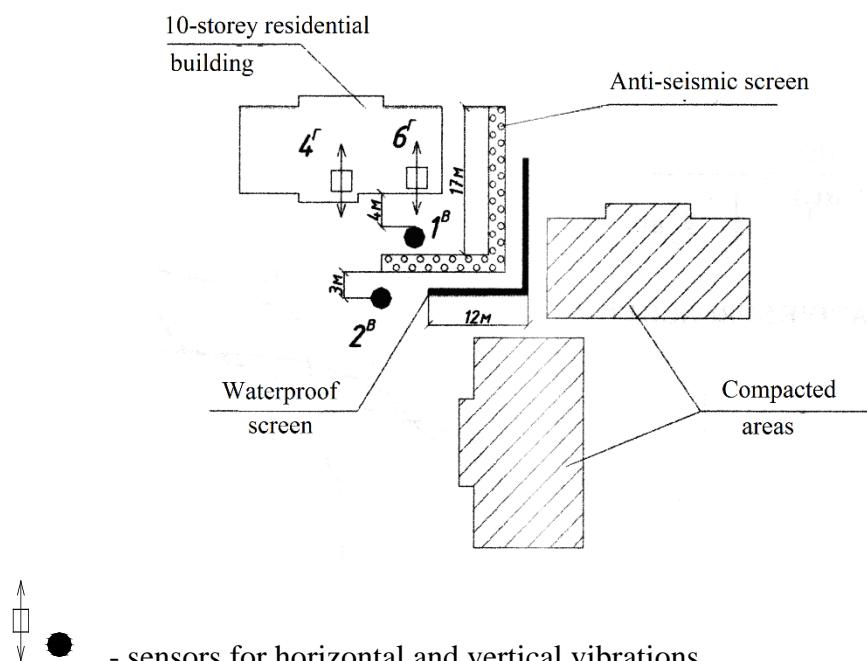


Fig. 1. Diagram of placement of seismic receivers on the ground near the anti-seismic screen and in the 10-story building

Application of a anti-seismic screen during deep explosions in the 1 May collective farm in Odessa region

The foundation of a school for 844 students was compacted using the hydroexplosive method in the 1 May collective farm in the Reni district of Odessa region. The soils comprising the site are divided into 9 engineering-geological layers. The geological structure of the area to a surveyed depth of 20.0 meters includes loess deposits underlain by deluvial loams and alluvial sands. The total settlement of the identified layers ranges from 45.2 mm to 49.9 cm, with a slowing thickness of 12-14 meters. Groundwater was not encountered to a depth of 20 meters. The saturation of the compacted array was carried out through borehole s with water distribution using trenches. The depth of the drainage-explosive borehole s was 8 meters, with a diameter of 400 mm. The mass of a single explosive charge was 6.4 and 4.9 kg.

For the purpose of reducing water seepage during saturation and seismic impacts between existing structures and the compacted area, the installation of anti-seismic screen s (Fig. 2) was provided. These screens consisted of two rows of borehole s with a diameter of 400 mm spaced at 1.0 m intervals in a staggered pattern.

The first row of screen borehole s, located closer to the compacted area, was filled with kneaded clay, while the second row was filled with sawdust. Additionally, a section of the screen measuring 10.0 m in length was filled with gravel.

The project plan of the work involved carrying out explosions in series, with a 50-millisecond delay between explosions in the series. In order to assess the seismic effect of the hydro-explosion at this site, four control single explosions were performed. The first two boreholes were detonated at the block 1 site. The charge mass of explosive substance (ES) in each borehole was 4.9 kg. Sensors OSP-2M were installed in the near-field explosion zone, which, together with galvanometers MO12-10, recorded vibration velocity. SM-3 sensors were installed in the far-field zone paired with the same galvanometers, recorded vibrodisplacements. Data on the intensity of vibrations at the studied points during these and other explosive events are set into Tab. 1. The next two control boreholes with a mass of ES of 6.4 kg were located in block 3. Sensors OSP-2M No. 5 and 2 were installed in the near-field explosion zone, and sensors SM-3 No. 4 and 1 were installed in the far-field explosion zone. Two series of explosions were also carried out at the block 3 site, with a charge mass of 6.4 kg, using a short-delay scheme.

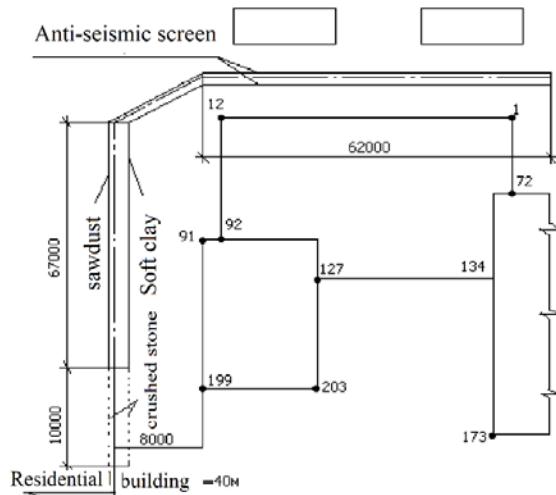


Fig. 2. Configuration of anti-seismic screens in soil

The next stage of the study involved explosions of three series of charges using a short-delay scheme at the block 2. The mass of ES in this case was 6.4 kg. One seismic profile was set up to measure the intensity of the wave field in the direction of the warehouses block, and the other in the direction of the farm office. All sensors were placed outside the screen area. All boreholes in the block were detonated in one series.

The following conclusions were made on the basis of the processing of ground vibration records:

1. The analysis of the results allows conclude that efficiency of the screen consisting of two rows of boreholes filled with clay (near row to the site) and sawdust (far row). Such a screen design, located at a distance of 8-9 m from the nearest row of explosive boreholes, allowed reducing the level of seismic impact on average by 1.5 times.
2. The coefficient of seismic wave shielding, calculated as the ratio of the vibration velocity amplitude outside the screen to the vibration velocity

amplitude behind the screen, ranged from 1.02 to 2.08 at a distance of 10 m and from 1.76 to 2.88 at a distance of 40 m. The frequencies of ground vibrations both in single explosions and in explosions with a short-delay scheme with a micro-delay of 50 milliseconds ranged from 2.2 to 5.0 Hz.

Application of anti-seismic screens during deep explosions in Volgodonsk (Russian Federation)

A typical geological site for this region was the area under the Palace of Culture, where work was carried out to compact loess slowing soils using the hydraulic explosion method. A powerful layer of yellow-brown loess-like clay lies below the soil-vegetable layer with a thickness of 0.5-0.6 m, down to a depth of 16.2-16.7 m slowing, below, to a depth of 19.6-20.8 m - non-slowness. Below the clay layer lies a layer of greenish-gray clay of solid and semi-solid consistency. At elevations of 21.1-23.6 m lies a layer of yellowish-gray, dusty, water-saturated sands of medium density composition. The groundwater level is at a depth of 16.1 m and tends to seasonally and steadily rise. According to slowing properties, the soils of the Volgodonsk region belong to soils of type II slowing. The use of anti-seismic screens of two types (lens-shaped and right-angled) consisting of two rows of boreholes in the soil allowed to reduce the intensity of ground vibrations during deep explosions by 1.2 to 1.7 times.

Table 1.

Experimental data on the level of ground vibrations in hydraulic explosion

| Channel No. | Installation location of sensor | Frequency, f , Hz | Displacement, a , mm | Speed, v , cm/s | Note |
|-------------|---------------------------------|---------------------|------------------------|-------------------|-------------------------------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 33 m behind the screen | 4.0 | 0.307 | 0.77 | $m_{es}=4.9 \text{ kg}$ Scheme 1 |
| 2 | 7 m in front of the screen | 3.0 | - | 25.0 | |
| 4 | 50 m behind the screen | 5.0 | 0.328 | 1.03 | |
| 5 | 10 m behind the screen | 5.0 | - | 11.8 | |
| 1 | 40 m behind the screen | 5.0 | 0.481 | 1.51 | $m_{es}=6.4 \text{ kg}$ Scheme 2 |

| | | | | | |
|---|------------------------|------|-------|------|--|
| 2 | 10 m without a screen | 4.0 | - | 9.0 | |
| 4 | 40 m behind the screen | 5.0 | 0.243 | 0.76 | |
| 5 | 10 m behind the screen | 5.0 | - | 8.8 | |
| 1 | 40 m behind the screen | 5.0 | 0.625 | 1.96 | |
| 2 | 10 m behind the screen | 5.0 | - | 9.6 | |
| 4 | 40 m behind the screen | 4.0 | 0.271 | 0.68 | |
| 5 | 10 m behind the screen | 5.0 | - | 4.6 | |
| 1 | 40 m without a screen | 3.33 | 1.54 | 3.22 | |
| 2 | 10 m without a screen | 3.0 | - | 8.6 | Series $m_{es}= 6.4\text{kg}$ |
| 4 | 40 m behind the screen | 4.0 | 0.729 | 1.83 | |
| 5 | 10 m behind the screen | 3.33 | - | 8.0 | |
| 1 | 40 m without a screen | 3.0 | 1.15 | 2.17 | |
| 2 | 10 m without a screen | 3.33 | - | 4.6 | Series $m_{es}= 6.4\text{kg}$ |
| 4 | 40 m behind the screen | 3.33 | 0.559 | 1.17 | |
| 5 | 10 m behind the screen | 4.0 | - | 3.6 | |
| 1 | 42 m near the store | 3.33 | 1.42 | 2.08 | |
| 2 | 22 m near the store | 5.0 | - | 5.2 | Series $m_{es}= 6.4\text{kg}$ Scheme 3 |
| 4 | 42 m at the office | 3.33 | 1.02 | 2.13 | |
| 5 | 22 m at the office | 3.0 | - | 2.4 | |
| 1 | 42 m near the store | 3.33 | 1.39 | 2.92 | $m_{es}= 6.4\text{kg}$ Scheme 3 |

| | | | | | |
|---|----------------------------|-----|-------|------|--|
| 2 | 22 m near the store | 4.0 | - | 3.2 | Series $m_{es} = 4.9\text{kg}$ $m_{es} = 6.4\text{kg}$ Scheme 4 |
| 4 | 42 m at the office | 4.0 | 0.50 | 1.26 | |
| 5 | 22 m at the office | 5.0 | - | 1.8 | |
| 1 | 50 m behind the screen | 2.5 | 0.827 | 1.30 | |
| 2 | 7 m in front of the screen | 3.3 | - | 1.56 | |
| 4 | 70 m behind the screen | 2.2 | 0.656 | 0.91 | |
| 5 | 10 m behind the screen | 4.0 | - | 1.8 | |

Conclusion

The following conclusions were drawn on the study:

1. Analysis of engineering methods for protecting structures from the effects of seismic waves reveals that one of the promising and little-studied engineering methods of protection is screens;
2. Engineering methods for compacting arrays of loess slowing clays using rigid protective-reflecting screens were developed. It was achieved by fixing around the perimeter of the compacted area through the bottom of contour trenches to the end of the slowing layer by injecting a binder solution, thermally annealing, freezing;
3. Experimental studies of seismic impacts on buildings during explosive work, aimed at hydraulic compaction of loess slowing soils, confirmed the efficiency of various developed designs and layouts of anti-seismic screens. The use of anti-seismic screen allowed the development of recommendations and the performance of deep explosions with an explosive mass of 5 kg at distances of 11 m from existing construction objects in the cities of Zaporozhye and Volgodonsk.

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HUMANITARIAN SCIENCES

DESSERTS OF WESTERN AZERBAIJAN CUISINE

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Objective of the Research

The conducted study aims to investigate and determine the etymology of traditional sweets from the western region of Azerbaijan.

Method

The article is written based on the historical-comparative method. Sources include studies by various ethnographers and travelers who have worked in the western region of Azerbaijan, as well as works of poets and writers who lived and created in that area, and literary texts. Additionally, a survey was conducted with 1,500 respondents who were refugees and internally displaced persons from the region, collecting the names, ingredients, and preparation methods of the sweets they made.

Result

The research is significant and crucial from the perspective of protecting the population displaced from the western regions of Azerbaijan from assimilation and preventing the loss of the national identity of their traditional sweets. The theses and proposals put forward in the article have been adopted by confectionery enterprises and the population. Apart from all this, as a final result, it can be said that the study has identified the etymology of western sweets and substantiated the importance of researching our national cuisine.

Key words: Western Azerbaijan, confectionary, baklava, sudjuk, behmez, Nizami Gendjevi, desserts, Turks of Iravan and Western Azerbaijan.

I'd like to start by discussing the confectionery traditions of Western Azerbaijan, beginning with the assessments provided by the famous Russian writer and diplomat, A.S. Griboyedov, on this subject.

He had been a guest at the palace in Iravan several times and wrote with admiration to S.N. Begichev:

- *"In front of him and behind him, heavy candelabrum, delicious dishes, and trays filled with sweets were brought, which, if I were to describe them, it would be difficult for your imagination to evoke their taste."*

Elsewhere, *"There were over 30 types of delicacies and desserts presented in golden, jewel-adorned dishes. I was seeing all of them for the first time in my life. Each of them appeared as an unprecedented novelty to me."* [1,2,3].

Of course, confectionery traditions of Western Azerbaijan were an integral and inseparable part of the overall Azerbaijani confectionery art.

Tabriz, Baku, Ardabil, Ganja, Kars, Iravan, Shamakhi, Derbend, etc. were like siblings of one mother, members of one family; notwithstanding some differences sourced from local climates and food bases, they were carriers of the same culinary traditions. This manifested itself in toponyms, as well as in fruit and culinary terms.

Baklava, shekerbura, halva, qatlama, qand, sheker, bal, behmez, sucuk, bulamadj, and the like are terms pronounced the same throughout the entire territory of Azerbaijan.

Of course, complex dishes and desserts are created by skilled chefs in palaces, then passed down to the general, folk cuisine.

Simpler desserts like qatlama, feseli, axitma, kömbə, and the like, however, penetrated from the folk kitchen to the palace kitchen.

Those who worked in the palace kitchen and prepared sweet products were called pastry (those who prepare sweet products), sugar confectioner (working with sugar), confectioner and halva makers (from the Arabic word for sweets, "halavat"). Sherbet makers also belonged to this group. There were also specialized internal divisions: baklava makers, noğul (a small round candy with bulges and coriander seeds inside) makers, and so on.

Sometimes a common name and technologically similar but different products were combined under one name. For example, like in baklavas from Sheki, Baku, Ganja, Quba, and so on. Or the same product was produced under different names in different regions. For example, under names like "axitma," "yelapardy," "guymag," "yayma," "makhara," "lalanga," and so on (known as

"blinchik" in Russian cuisine), the same product was prepared, which is consumed with honey, butter, jam, and sugar.

Bahmaz (from bah-bah (expression used to emphasize the exceptional taste of food such as Wow) maza (snack)), or bakmaz (berk meze which means a solid snack), doshab (petrified, thickened fruit juice or "dushab" which means the essence of water – spirit - spirit of water), narbey (flame-colored gentlemen) "grapes", "honey", "chashni" - typical product names throughout Azerbaijan - everywhere refer to condensed fruit juice. [4] Among these, the term "narbəy" is used only in the literature of the capital of Western Azerbaijan, the city of Yerevan.

In the creation of Azerbaijani sweets, honey and behmez undoubtedly played the primary initial role. Before the arrival of sugar, all our sweets were prepared with honey and bahmaz.

The simple honey and behmez sherbets originated from the sweetening of a certain amount of water and aromatic brew with honey and behmez, without the need for any complicated preparations.

The preparation of fruit in honey and in behmez has led to the creation of the first jams - richals (irchals).

Undoubtedly, the local production of sugar significantly contributed to the development of confectionery.

By the X century, refined sugar was already being produced in Azerbaijan.

Sugar obtained from sugarcane was called "*neyşəkər*", "*taxta qənd*", or "*qamış şəkəri*".

The population was preparing sugarcane syrup (behmez) from sugarcane.

Sugar obtained from fruits was called "*nabat*" (meaning plant), later they also learned to convert sugar into "*nabat*".

Sources indicate that centuries before Marco Polo, Azerbaijanis were preparing syrup (behmez) and obtaining sugar from beetroot (paz, pencer).

Adam Olearius reports that in the early 17th century, travelers would dry syrup (behmez) before setting out on their journey, they dried behmez and wrapped it in a towel and carried it in their pockets to drink tea with it: - "In Azerbaijan, they do not make wine; they take juice from grapes, boil it until 1/6 of it remains, and thicken it until it flows like oil. To use this doshab (syrup), they mix it with water and a small amount of vinegar. It becomes a very pleasant drink. Sometimes the syrup becomes so thick that it needs to be cut. Travelers usually dry it and take it with them on their journey. In Tabriz, they also make halva from this syrup." [6] Perhaps this is where another name of behmez - bekmez (solid snack) comes from.

V. Dvitski shows that: - (In Iravan, T.A), "A yellowish narbey called "chashni" is made from kishmish grapes (raisin (small sort of grape)), with the consistency and sweetness of honey". [6]

It is possible that the saying "I bought doshab, but it turned out to be honey." is related to this particular type of behmez.

We believe that calling the sommelier who serves the drinks in palaces "çashnigir" is also related to this.

Bahmez(bakmez, narbey, doshab, chashni, grape honey) was prepared by the people of Iravan in several ways.

- A liquid and dark-colored narbey is made from khərci grapes (sour grapes).
- Narbey prepared from misqal, edjeri grapes (sort of white grapes) is light in color.
- "Narbey, grape honey made from kishmish (raisin) grapes is called "*chashni*" and it has a yellowish color, with the consistency and sweetness of honey". [6]

Of course, behmez could be in liquid, thick, very thick, and dry varieties. In the region, people also made behmez from mulberries, sugarcane, watermelon, persimmon, and more.

Behmez, can be enjoyed with butter and yogurt just like honey. Bekmez is used in the preparation of jam, halva, scrambled eggs, etc., as well as in the making of drinks, govud and etc. It serves as a base for such products as bulama (bulamaj, bulamash), bastikh, sujuk. Bekhmez is also used as a remedy for colds and other illnesses. It is served with dishes and pastries such as ahytma, fasali, katlama and scrambled eggs.

In Azerbaijan, such a variety of sweets were prepared that Nizami Ganjavi mentioned it in the 12th century: "There are such halvahs with unknown names, tastes of which eliminated by almonds and pistachios"

Of course, before bekmez, honey was used as a source of sweetness in the region.

In the 19th century, the researcher N. Shirakuni wrote about Zangezur: "The local honey is distinguished by its excellent taste." [7]

The poet Musa Baghirov from Vedibasar wrote about the wild honey in Vedibasar:

"The honey would drip and flow from the rock.

Its allure would draw the bear out." [3]

This is how Muslum Gudsi describes the local honey in his essay (masnavi) " Description of Iravan":

"It brings to mind the pure honey mirror

Delighted by the sting of two hundred bees

Its taste cannot be forgotten, it's indescribable.

The meadow honey of Sahand and Nishab

It has no equals in the world." [3]

Ashiq Alesger from Goyche reports about the most delicious, esteemed, and widespread dessert of these places:

- "The butter of the cow and the honey of the bee". [8]

According to M.İ. Tkeşelov's writings, Azerbaijanis living in the Iravan governorate serve "dough cooked in honey named alva (halvah T.A)" at mourning ceremonies. [9]

Thus, there was an initial sweet base in the region for the creation and development of confectionery, which was formed by honey and various types of bekmez.

As a sweet base, various sweet fruits grown in the area were used both fresh and dried. These fruits were used to make various sweets (alana, sucuq). To add sweetness, they were also added to baked goods, kombas (sweet bread), pastries, and some dishes (pilafs).

The most used dried fruits were dried grapes, mulberries, apricots, apples, pears, and qakh (dried fruits).

Some kinds of apricots, pears, and peaches were used to make alana (dried fruit with filling from minced walnuts and honey or behmez), and figs were used to prepare miyanpur (dried fruit filled with a whole walnut).

For this, walnuts, almonds, sweet apricot seeds, and cinnamon were commonly used. After sugar was introduced to the region, it was also added to the filling of alana.

Various sweet, sweet-sour, and sour pastilles, pustille, and lavashana or rolled out fruit leathers were made from apricots, cornelian cherries, green plums, plums, and others. To make these, fruit puree was spread thin like a sheet and dried.

Jams were also made from fruits, using behmez or honey. The most commonly used dried fruit was raisins.

V. Dvitsky writes about three types of raisins used in Iravan: yellowish-red raisins, black raisins and blue raisins. According to him, bunches of white raisin grapes were soaked in ash-water and dried in the sun for 15 days to produce yellow-red raisins were. To get black raisins (dark red), the grapes were simply dried in the sun, while for blue raisins, they were dried in the shade. [6] Nasir al-Din Shah's cook Akbar Khan (1844) writes that green raisins are obtained by drying "Asgari" (sort of grape) grapes in the shade. [10]

Crushed walnuts and walnut flour were added to the bekmez and cooked. Before the mixture thickened, whole grape berries, pieces of watermelon and melon, whole kernels of walnuts, hazelnuts, almonds, and pistachios were added, boiled for a while, then cooled to make bekmez halvah

and bulamadj irchal. The bulamadj and irchal were stored in large jugs and eaten with butter.

When crushed walnuts are cooked in honey instead of behmez, they get a honey bulamadj irchal, which is also called "goznak."

Georgians call the final thick stage of making sudsuk "tatara" (meaning belonging to the Tatars). To this day, Georgians refer to Azerbaijanis as "tatareba," meaning Tatar community (habitat).

The mixture that is not yet fully thickened and still stirrable ("bulana bilen" in Azerbaijani) is called "pelamushi." This word is actually derived from the words existing in our language: bulama, bulamak (meaning to stir), bulamaash.

This shows that the Georgians and Armenians inherited this product precisely from the Azerbaijanis. When bulamadj (irchal) was cooked, children would gather around the fire to taste the hot bulamadj. We even have a saying related to this:

"The bulamadj pot was hung
Doors and windows were crowded
I stirred the bulamadj
The more I stirred, the more I licked
My hand (tongue) burned from the bulamadj
My tongue got cut from the bulamadj." [4,11]

After sugar was introduced, they started adding sugar paste, flour, and bekmez to the bulamadj. Once it thickened, they would take it off the fire and mix in spices such as saffron, anise, cardamom, cloves, cinnamon, and ginger while it was still hot.

Sudsuk is prepared based on bulamadj.

Adam Olearius describes an interesting method of making sudsuk in the 17th century: "They make special sweets and candies from doshab, which they call halva. To make halva, they mix ground almonds, wheat flour, and walnuts into the doshab and fill it into elongated bags." [5] Thus, we see that in the 17th century, sudsuk was made in elongated bags.

Adam Olearius also describes the sudsuk known today, which has a string running through the middle: "From the same dough, long candies resembling sausages are made. These are the so-called sudsuk. A string runs through the middle of the sudsuk and holds the candy." [5]

To make sucuk, walnut kernels are strung on a thread. In Iravan, this type of walnut was called "sudjuq-cövuz." [6] Thin-shelled and thick-shelled nuts with hard-to-peel kernels walnuts were.

The "sudjuq-djovuz" variety has a hard shell that is broken with a stone and hammer, and the kernels come out easily and whole. These walnuts are strung on a thread and dipped into hot bulamadj, then taken out and hung to dry

for a day. For higher quality of sjuduk, the process of dipping into bulamadj and drying is repeated several times. Because they are dipped (pressed) and taken out of the bulamadj, they are also called "basdiq" (basdiq in Azerbaijani means "to press"). The name varies by region. Known under the names Sudjuk, basdik, zilə (hung high), and köftər. In some of our villages, instead of walnuts, dried apricots and peaches are strung on the thread to make sjuduk.

For another type of sjuduk, when the syrup (bəhməz) is half-cooked and not fully thickened, the fruits with the seeds removed are strung onto thin, flexible mulberry sticks, as if one would skewer them. These sticks with the fruits are then cooked in the bəhməz and stored in jugs. [4]

It is noteworthy that in the preparation of 'lavashana' and 'pastil,' a slurry mass was utilized, and 'lavashana' containing walnuts and hazelnuts was occasionally referred to as 'sucuk.'

As the art of confectionery developed, rahat lokum was made using the same method with sugar and starch. Rahat lokum is also prepared in the same way as sjuduk. The technology of making rahat lokum and sjuduk from it spread from the Turks to Yugoslav cuisine [4].

It should be noted that when making lavashana and pestil, the bulamadj mixture was also used, and sometimes lavashana with walnuts and hazelnuts was also called sjuduk.

The term "pestil" was more commonly used in the Iravan Khanate and the Borchali region and was adopted into Russian as "pastila."

The term "levashniki," as found in the medieval Slavic manuscript "Domostroy," have originated from the word "lavashana" [12]. In the rural areas of Baku, there are mentions of a similar culinary preparation known as "ancirfaraj" (zincirfaraj), which consists of slightly thick pastes made from figs. All these examples illustrate that these products were indeed created by the ingenuity of the Turks. They also affirm that Turks of Iravan and Western Azerbaijan, their cuisine, and the occupied lands are an inseparable part of us - the Azerbaijanis.

Moreover, the ancient techniques employed in the production of "behmez" and "bulamadj" bear resemblance to the methods used in the preparation of various types of "sameni" halva, both solid and dense, during the celebration of Nowruz Bayram [13]. These similarities underscore the continuity and persistence of culinary practices across time, reflecting cultural and gastronomic traditions deeply rooted in the region's history.

The process of thickening the liquid derived from "sameni" during the Nowruz Holiday, kind of 'bulamac' ('samani bulama' or 'fluid samani', 'gubba samani' in Shaki), as well as the preparation of solid 'samani' halvah, are also characteristic in the region of the Iravan Khanate.

One of the widely spread natural sweets in the Western Azerbaijan cuisine was "alana." The word "alana" actually means "alanəm," which means not completely dry or dried.

"Alana" is made from apricots, peaches, and pears processed with walnuts, sugar, cardamom, and cinnamon.

According to information provided by Dvitski, in Iravan, "alana" was made from the "yarma" variety of peach, the "malaqa" variety of pear, and apricots [6].

As a result, walnuts are ground together with sugar and used to fill the cavities of the fruits instead of their pips before being dried. Due to the hygroscopic nature of sugar, the product does not completely dry out; slight moisture remains. Occasionally, walnuts are also placed inside dried or fresh white figs.

This culinary creation is also known as "miyanpur."

In Baku, at the "Khanadan" ethno-restaurant, a variety of alanas (miyanpurs) made from assorted fruits are served.

Undoubtedly, the world's oldest, delightful, and simple confection known as "Govud" was crafted not only in Western Azerbaijan but also across the entirety of Azerbaijan. To prepare "govud," wheat is soaked in water for 2-3 hours and subsequently roasted on a sheet pan to produce "govurga." The resulting "govurga" is then ground using a traditional "kir-kira" hand mill to obtain flour, thus yielding "Govud" flour. Since qovud flour is somewhat sweet, it is eaten in its flour form as well. However, by mixing this flour with various syrups (bəhməz), honey, or sugar syrup, small balls called "kuredjik" were made.

"Govud" was traditionally prepared on the 10th of February during the Khidir Nabi holiday (also known as Khidir Ilyas or Khidir Allaz) [13,16].

Currently, "Govud" is available for consumption at the "Khanadan" ethno-restaurant in Baku.

During research on Baku's cuisine, a manuscript from Eldar Mansurov's grandfather revealed that while preparing pilaf, women would gather and clean raisins and "zersheker" (golden sugar) beforehand. After extensive investigation, in 1995, it was discovered that "akhja nabat" was utilized for culinary purposes in Tbilisi. "Akhcha" refers to money, specifically gold, while "nabat" denotes a particularly crystalline form of sugar, akin to "tabarzad" gold, which has a reddish hue. In Baku, "money" could colloquially refer to "zar" (gold), and "nabat" could denote sugar. However, the simultaneous mention of "zarshakar" and raisins within the same context, along with the purification process of "nabat," raised doubts. Ultimately, it was confirmed that the reference was to "Aghjanabat" kind of apricots cultivated in Iravan. Both "Aghjanabat" and "Goyche nabat" apricots from Iravan were exclusively dried

while still attached to the stem [6], as drying them separately would lead to rapid decay. "Goychanabat" apricots were primarily consumed fresh, with minimal drying. In contrast, "Aghjanabat" apricots underwent more extensive drying. These dried apricots were traded in Tabriz, Baku, Tbilisi, Derbent, Ganja, and other regions, and were exported and distributed accordingly.

To prepare "plov," "gaisava," "alani," or "myanpur," the stem of the apricot is removed along with the pip. It is noteworthy that although the current state of Armenia has adopted the apricot as its national symbol, similar to the grapes cultivated in Iravan, the names of no apricot varieties are in Armenian; all names are in the language of their historical cultivators, the Azerbaijanis, reflecting the original varieties from Western Azerbaijan [3; 6].

An additional point of interest is the account of the 16th-century Turkish traveler, Evliya Çelebi, who noted being served "date palm milk" in "Uchkilsa" in Iravan [14]. There is no corroborative information in other sources, and respondents were also unaware of its nature. Given that preparation of almond milk is known, it is conceivable that the author might have mistakenly referred to "almond milk" as "date milk."

The inclusion of "shiri dates," or "date palm milk," in the Azerbaijani book "Dastani Ahmad Harami," written in the thirteenth century, implies its distinction as a separate dessert: "sugar, almonds, gulabu shiri dates" (i.e., date milk with rosewater) [15].

Thus, we were able to revive our dessert and its two forms.

Ingredients: 25 large dates, 1 liter of milk, 1 gramm of salt.

The dates should be washed and their pits removed, then placed in a saucepan and covered with milk. A pinch of salt should be added (optionally, vanilla can also be added). When the milk starts to boil, reduce the heat and simmer the dates for 5-7 minutes. Allow it to cool in a covered container at room temperature for at least 2 hours (preferably overnight). The milk can be strained and consumed. In the other variant, the dates should be mashed and thoroughly mixed with the milk. In modern times, it is easier to do this with a blender. It should then be eaten with a spoon. It can be served warm in winter and chilled in summer. Just before drinking date milk, adding a little rosewater (gulab) before blending will enhance its flavor.

In the other variant, cornstarch dissolved in milk is added to the prepared mixture. It is stirred and then placed in the refrigerator. Date milk is delicious, flavorful, and possesses both energizing and therapeutic significance.

According to English scholar and researcher of Turkish cuisine Mary Priscilla, sugar became prevalent in the daily life of Turks by the 7th century [17]. By the X century, refined pure sugar, was already being produced in Azerbaijan [4].

Nizami provides information about refined sugar in the 12th century in his work "Seven Beauties". Nizami indicates that sugar is obtained not only from sugar cane but also from beetroot (panjar, chard). [4]

The advent of sugar further advanced the art of confectionery. Sugar gradually replaced both "bahmaz" and honey in the preparation of many sweet products. Moreover, various confectionery items, such as lump sugar, nogul, brittle almonds, and sugar cheese, emerged with the utilization of sugar. The emergence of sugar significantly influenced the creation of confectionery, including its aesthetic aspects. Transparent caramel, derived from sugar, was used to craft figures of animals and birds on wooden sticks. Simple white candies, such as mint candies, were produced from sugar wax, while colored caramel products were created by incorporating dyes.

Various sources indicate the preparation of a wide array of sweet dishes, bakery products, and candies in Western Azerbaijan, including sherbets, fruit and vegetable jams, halva, phirni, terek, akhitma, gaysava, honey gayganag (scrumbled eggs), gayganag with bahmaz, candies, vegetable sugar, guymak, nogul, govut, baklava, shakerbura, gogal, badambura, samani halva, fluid samani slurry, qatlama (folding-layered pastry), bishi, ayirdak, paluda, rahatlukum, kata, milk bread, fish bread, nazik (thin), qalin (thick), mafis, butter-honey, butter-bahmaz, yogurt-bahmaz, honey-cream, and others.

The Novruz Holiday was enthusiastically celebrated across the villages, districts, and cities of our Western Azerbaijan region. In the locations where the capitals of the Khanates were situated, the principal sweets prepared in the palace kitchens included baklava, shakerbura, and gogal. Naturally, elaborate confections such as baklava and shakerbura were crafted by palace confectioners and represented the culmination of professional confectionery craftsmanship.

Subsequently, these confections gradually integrated into the national cuisine, with various sweets being featured on the Novruz table in remote regions.

Pastries made from layered dough were simpler. For instance, in the Goycha district, during Nowruz, "qatlama" (folding), "fasali," and "eyirdek," cut into half or finger-length portions, were commonly served. Similar cultural environments, as observed in Tovuz, Gazakh, Borchali, among others, also reflected these traditions. Likewise, in Zangezur, bordering Nakhchivan, in addition to the aforementioned sweets, offerings such as sudjuk, basdikh, and alana, akin to those in Ordubad, were served.

In Vedi, a dish called bishi, prepared in a similar manner to qatlama (folded pastries), was predominantly served during mourning ceremonies. According to insights from our esteemed scholar Tariyel Azertürk, a native of Nuvedi, during his childhood, "it was customary for women visiting the home

of the deceased after a funeral to bring "bishi". They would sprinkle powdered sugar on it. In such instances, my father would humorously remark, "Bish is the substitute for the bishil, but what is left for the dead?" This phrase alludes to the notion that the living consumed the bish, leaving nothing for the deceased. Additionally, halva with "yukha" (thin bread) would be provided in these ceremonies.

"On holidays, sweet balls made from "govud" and "behmez" were prepared and served. During Nowruz celebrations, offerings included "gourga," "movuz," and "nogul" of Ordubad (considered the most delicious one), possibly accompanied by "sucuk," and sweet pomegranate if it remained available until the spring months."

In all regions of Azerbaijan, halva is served alongside yukha (thin spread bread) at places of mourning. This practice dates back to the 12th century, as evidenced by historical sources [4]. While "Bishi" is typically served at places of mourning in Nuvedi, it is prepared during holidays in Iravan and Lankaran. In rural areas, baklava and shekerbura were prepared on random occasions. While in certain regions ardk and ayirdak were cut to the length of a finger, in others they were cut to the length of one or half phalangs offinger. Furthermore, ardk and ayirdak represent types of confections known as baurak and barsak among Central Asian Turks, and they are prevalent across the Turkic world.

"Katlama"-folding is a confectionery item that belongs to the broader Turkic world. The folding technique also transitioned from the Turks to the Slavs and the French. In 14th-century Slavic sources, such as "Domostroy", the folding pastry is referred to as "kotlami". [12]

In the years 1610-1613, the "List of Tsar's Foods" prepared for the newly elected Tsar of Moscow, Vladislav, included the recipe for "kotlami". Its ingredients are almost the same as they are today. [4]

The layered cake in French cuisine, known as "de gato", bears resemblance to "gateana" and retains the root "qat" (layer) within itself.

It is noteworthy that the term "gat", also referred to as "kats" in Karabakh and Iravan, shares phonetic similarity with "kat" in the Turkish dialect and has been incorporated into Armenian as "kata".

The earliest documented references to the preparation of baklava can be found in the works of Nizami Ganjavi in the 12th century. Our available sources indicate that baklava was prepared in the palaces of Turkish rulers during the 15th century (Suheyli Unver), 15th-17th centuries (Arif Bilgin), 18th century (Artun Unsal), and 19th century (Mrianna Yerassimos). [4]

In 1944, the poem of Careful Abdal mentions:

"Among two hundred trays of baklava's delight,

Some filled with almonds and some with lentils inside." [4]

The most intriguing and peculiar aspect is the inclusion of lentils within the baklava.

In 1521, the technology of preparing baklava is documented in the records of Bavarchi, the palace chef during the reign of Shah Ismail.

"They place ten layers of bread, rolled out and buttered, on top of each other". If a handful of powdered sugar, chopped almonds, and rose water are sprinkled between each layer, it will be even better. They cover the top of the dish. [18] The palace chef also assigns pouring coals onto the top of this baklava dish cooked over embers. This cooking technology still preserved in Ganja.

In a source dating back to the early 16th century, detailing the palace kitchen during the Shah Ismail era, baklava is described as being prepared with two varieties of lentils, alongside a variation featuring an almond-sugar filling under a single name.

In 1590, Master Nurullah, the cook of Shah Abbas I, noted, "You should be aware that baklava comes in many variations, with the most popular being prepared with lentils. It is also becomes delicious with almond and pistachio filling." He further added, "This humble cook (Nurullah) prepared it with fresh walnut and hazelnut fillings, which were appreciated by the master and guests alike." Thus, Master Nurullah's distinct walnut-filled baklava is attributed to him by name.

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LINGUISTIC ANALYSIS OF GEOGRAPHIC NAMES WITH THE "GÖY" (SKY) COMPONENT IN THE SYSTEM OF TOPOONYMS OF TURKIC ORIGIN OF WESTERN AZERBAIJAN AT THE POLYDIALECTAL LEVEL

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Summary

In the system of Turkish-Azerbaijani toponyms of modern Armenia, geographic names with "göy" (sky) component form a series. No attention has been paid to the comprehensive and systematic study of the phonetic composition of geographic names of this type in a polydialect context in Azerbaijani onomatology. When we look closely at the phonetic composition of place-country names with the "göy" (sky) component, we see that the substitution of consonants k-g-y in this type of paleotponyms, or the sound correspondences, belong to the ancient period, to different periods of the division of Turkic languages - dialects. It is clear from the ancient history that after the collapse of the Hun Empire, one of the largest empires in the world (and the strongest) was the Goyturk Empire. There were also inscriptions of the Goyturk empire, which are known to the world as the Orkhon inscriptions. In

Goyturk ethnotoponyms with a complex structure, the word "göy" (sky) is used to mean "God". Otuken means "God's Turks", "Great Turks", "High Turk". Since the 6th century, this ancient city has been the capital of the Goyturks. In the dialect area of the Azerbaijani language, the word "göy" (sky) is used in the sense of "fire", "stingy", and "son-in-law". In the mythological sense, "fire" means "sun, star, lightning". The meaning of "stingy" also has the figurative meaning of "burning", because when a stingy person gives something to someone else, it seems to catch fire and burn. In other words, the semantic shades of both words "göy" (sky) are not far from each other. The name of one of the water bodies of paleohydronymic Turkic origin in modern Armenia is the Kokja hydronymic unit, which was formed on the basis of the "sky" component in our modern times. During the Albanian period, the hydronym of Goycha Lake was used in the phonetic composition "Kogcha göl" and in the "Gorgud" epic in the form "Gokce Tengiz".

Key words: dialect and slangs, toponyms of Turkic origin, phonetic change, paleohydronyms, sound change

The modern word "göy" (sky) is given in Mahmud Kashgari's "Divan" in the phonetic composition of "kök" (root) 5 meanings are indicated: 1) root = sky, air, sky; 2) root = blue color, blue color, navy blue; 3) root = the green area surrounding the four sides of the city; 4) root = saddle; 5) root = root, origin. In the sense of color, the word "root" in the plural form of the adjective in Oghuz is "kömgoy"; came up with the phonetic variants of "koppogoy" in Kypchak" (1, 323). About 500 years before the Kashgari period, the word "sky" was used with the phonetic "gök" (g-k consonant harmony) in the meaning of "air, sky, rainbow". There are a large number of words with the "göy" (sky) component in the modern Azerbaijani language. Goycha (a type of cherry), goychak (as a general word, "beautiful", an onim given to girls' names), goydemir (a name given to boys in the sense of hardened, strong iron), goyem (in dialects and dialects, appearing in the phonetic composition of plum, goyalı, "blue fruit" meaning), green (blue, or green edible plants in shiva areas), goynemek (meaning to burn as a verb), goyalı (as a masculine personal name, "strong Ali, steadfast Ali//Ali"), etc. In the paleo-dialectal aspect, it is possible to detect certain forms of such common words by comparing the processes taking place in the oldest phonetic composition conceptually or in Turkish. In the dialects of the western group of the Azerbaijani language, the word "goy" (in the sense of son-in-law) is called "güvey" in the sense of engaged girl, and "güveyi" in the sense of engaged boy. The lexical unit Goyerti appeared in the phonetic composition of "choyerti" (g-ç sound harmony) in the dialect areas of Turkish. Goycek lexical unit is used in the Tuva language in the form of "kurek" and

means "beautiful". The word "gök" belonging to the literary language of Azerbaijan in the meaning of "sky, air" is used in Turkish, Bashkir, Kazakh, Kyrgyz, Uzbek, Tatar, Uyghur, Gagauz languages in the form of root // "gök" (k-g consonant harmony) and has the same meaning in all Turkish languages (2, 278). In the Azerbaijani language, the word "göy" in the meaning of color is still based on the template we mentioned above in modern Turkish, i.e. "göy" (Azerbaijan), "gök" (Turkish, Bashkir, Uzbek, Kazakh, Turkmen, Gagauz, etc.). Such phonetic forms show that, unlike other Turkic languages, the phenomenon of "g" has occurred strongly in the Azerbaijani language. The word "göy" used in the Azerbaijani language or dialects in the sense of "bald, immature" distinguishes our language from other related Turkish languages due to the consonant harmony "k-y". Almost most of the toponyms that have existed in the territory of Western Azerbaijan with the "göy" component are geographical names with a complex structure, and a small number of them with a simple and correct structure. In the word "göy" in the first component of the Goyabbas oikonym, which existed in the territory of Darelæz, which has a complex structure, k-g consonant matching occurred. This type of consonant replacement is manifested only in Native Turkish in the appellative "köy", which appears in modern Azerbaijani. Since the residents of Goyalbaş village migrated to this area from Turkiye and settled there, they brought with them the toponyms of the Turkish language component "köy". An interesting point is that the geographical term "köy" is currently used only in Native Turkish. In Azerbaijani the geographical term "kend" is used instead of this geographical term. Place names formed by the geographical name "köy" in Turkish and "kend" in Azerbaijani are avil // avıl // oyyl in Bashkir, Kyrgyz and Kazakh Turkish, and "keshtuk // kışlak" in Uzbek, Turkmen, Uyghur, and Tatar languages (winter home) is expressed in geographical terms (2, 510). Among the toponyms of Turkic origin of Western Azerbaijan, there is a majority of place names with geographical names "aul" and "village". In explanatory toponymic dictionaries, the oikonym Goyabbas is etymologically defined as "Village Abbas, Abbas's village, the village founded by Abbas's descendants" (3, 319). Until 1950, there was a settlement of Turkmen Kuyarchi // Guyerchi // Quyerchi (k-y-q consonant harmony) Goyerchinli in the territory of Ijevan region of Western Azerbaijan. As a result of the influence of dialects the name of Goyerçinli settlement was transformed and integrated into the phonetic variants of Kuyarçi // Guyerçi in connection with the historical development of Turkic languages. It is noted in the sources that at the beginning of the era, the Kuyarchi tribe was among the Pechenegs who came to the South Caucasus as part of the Huns, but later this ethnonym was mixed with the name of the familiar pigeon bird in the dialects and was reflected in toponyms (3, 320). There are many toponyms reflected in the word "pigeon" in the toponym

system of modern Armenia, Azerbaijan, and the Caucasus. In some research works, there is a majority of people who connect the names of places formed by the word "pigeon" with the ethnonym "kureychi". In our opinion, the lexical unit "Goyerçin" in the names of ancient settlements, at the same time appearing in paleodialectal forms (Kureyçi, Gureyçi) in the names of large mountains, reflects the modern ethnonym "pigeon". In small geographical names, for example, in the names of small mountains, valleys, hills, ridges, it means the name of the pigeon box. Thus, it is more logical to connect the paleotponymy of the Kuyarchi castle recorded in the sources in Western Azerbaijan only with the name of the tribe of the same name of Turkic origin, because no one can doubt that the castle was built by the Kurechi tribes during the Pecheneg period. According to our conceptual point of view, the lexical unit "pigeon" belonging to the Turkic people was in the phonetic composition of kurey, gurey, kurey in the oldest historical period, more precisely, during the Hun Empire, because the "ku, gu, "qu" sound imitation is at word level. If we take into account that the names of most animals and birds were formed as a result of sound imitation in Turkish, then we can conclude that the words processed with the phonetics kureychi, qureychi, gureychi are the oldest forms of the modern bird name "pigeon". There are a large number of onomastic units used in the meaning of color in the oronymic, oikonymic, hydronymic system of Western Azerbaijan. Hasan Mirzayev recorded the toponyms with "göy" (blue) component in the sense of color - Goytepe, Goygal, Goybulag, Goytala oronyms, and dedicated etymological comments about the geographical relief and natural features of the landscape to them as appropriate. The age of these oronym-type place-names does not go much beyond the centuries after the Middle Ages, because they were formed in the last centuries. The name of one of the water bodies of paleohydronymic Turkic origin in modern Armenia is the Kokja hydronymic unit, which was formed on the basis of the "göy" (sky) component in our modern times. During the Albanian period, the hydronym of Goycha lake was used in the phonetic composition "Kogcha göl" and in the "Gorgud" epic in the form "Gokce tengiz". "In connection with Amir Teymur's military visit to the South Caucasus in 1386, it is in the form of "Gokcha Tengiz", in the work of Hamidullah Ghazvi (XIV century) it is called Gekcha Tengiz, and in the source of 1548 it is in the form of "Gokcha Deniz" (3, 321). In the history of the development of Azerbaijani toponyms, a number of layers are revealed, and the phonetic phenomena and sound correspondences that have historically occurred in the modern Goycha lake hydronymic unit can be grouped as follows: 1) the oldest period: Kogcha lake; 2) Albanian period: Kogcha gol; 3) Medieval period; Gökçe sea, Geksin sea; 4) New period: Goycha lake. From the most ancient times to the modern times, this hydronymic unit has been used in the meaning of "blue, blue lake". In our opinion, the vowel and consonant sound

correspondences in the Paleohydronym are a reflection of the dialect characteristics of the Ghuz // Oghuz who lived in the west of the Caspian Sea during the first millennium AD, reflect the phonetic rules of the Oghuz language, because Western Azerbaijan has been the home of the Oghuz since ancient times. In this hydronymic unit, it is also possible to determine the Kipchak elements. Although Oghuz and Kipchaks belong to separate branches of Turkic languages, they were united with each other at different periods of history and had to separate again and again. Sound correspondences in the phonetic composition of the considered paleohydronymic unit once again confirm that the formation of the dialects of the Azerbaijani folk language began earlier than the arrival of the Oghuz and Kipchaks to this area (West Azerbaijan). As we mentioned above, the Goycha Lake hydronym was used together with the appellatives "gol // göl (lake) // kol (bush) // göl (lake) // tengiz (sea)" at different periods of history. In modern Turkiye and Azerbaijani Turkish, this appellative is used in the phonetic composition of "lake", and in the Bashkir and Tatar languages, it is used in the phonetic composition of "bush" (2, 278-279). Therefore, the "k" of the consonant "g" is observed more often in the Kipchaks than in the Oghuz (in this geographical term). In Turkish and Azerbaijani Turkish, the appellative "deniz//dəniz" (e-ə) is used phonetically as "dengiz" (deaf nun) in Bashkir language, "dengiz" (deaf nun) in Turkmen, and "dengiz" (deaf nun) in Uyghur, and in this geographical term the historical events of "deaf nun, ng" distinguish Turkish and Azerbaijani Oghuz from some Kipchaks. It should also be noted that the modern Kazakh language has preserved the oldest phonetic composition in the appellative "dəniz" (sea). In general, the t-d consonant sound correspondences that occurred in the word front position are considered to be specific phonetic phenomena for both Turkic languages and their dialects and dialects in both ancient and modern times. The ancient form of the sound of deaf in the middle of the word was in the forms nq//nğ//ng, which are currently more typical for the Baku dialect. The occurrence of these images in the language of classical Azerbaijani poets and in written monuments shows that certain sound elements of that image (q, ğ, g, y) are observed in certain words or toponyms in Shamakhi and dialects. This type of joint sounds occurred as a result of the splitting of Turkic languages and their dialects.

Conclusion

The phonetic sound correspondences that make up a series of geographical names with the "sky" component in the toponymic system of Western Azerbaijan reflect the events that took place on the basis of the ancient forms of the dialects and dialects of Azerbaijani Turkish during the period and

subsequent stages. Such phonetic event types are specific not only in the toponyms of Western Azerbaijan, but also in the onomastic system of related Turkic-speaking peoples, and indicate the great antiquity of the living spoken language and dialects of related Turkic languages.

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A COMPARATIVE STUDY OF MAN'S PLACE IN THOUGHTS OF MANSUR EBN HALLAJ, EMADEDDIN NASIMI AND FRIEDRICH NIETZSCHE WITH AN EMPHASIS ON EMADEDDIN NASIMI'S THOUGHT DEVELOPMENT

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Abstract

The present study aims to investigate man's place in thoughts of Mansur ebne Hallahj, Emadeddin Nasimi and Friedrich Nietzsche along with a glance at opinions of Feuerbach and Carl Marx by comparison, explaining the governed differences and commons. Hallaj, one of the prominent characters in gnosis and mysticism in second Hijri century and early third Hijri century, put on cloak of mysticism when he was 20 years old and became Pir of Sufism. As in mysticism he acted in his own private manner, finally he took off cloak of mysticism and called himself free. This action was not disassociation with mysticism but it was a kind of tendency to manner of Malamatiyyans which led to his well-known slogan "An-al-hagh" (I am the right (I am God)).

Nasimi, Hurufi poet and thinker, in his poems could explain thoughts of Hurufism well and this caused some people such as followers of Bektash order and Kakayiyya know his poetical works as their sacred books. By exceeding from reflecting thoughts of Hurufism, his thought path appears. What appears from his couplets is that he knows himself transcendent and the path he has started does not end there and gets higher and more transcendent.

Nietzsche (1844) is known as a great philosopher by some people and as a mad poet by others. His superman theory, extraction of his philosophical thought, he knows God-awareness as something born by fear and a painkiller for pains of men as Feuerbach knows religion as something made by human visions and imaginations and Marx knows religion as opium of masses.

Results indicate that the governed difference between thought development of Nasimi and Nietzsche with Hallaj is that Nasimi and Nietzsche could reach from the transcendental step which Hallaj has ascended there to a more transcendental step. But commons resulted from thought development of the three characters can be explained that thoughts of the three thought schools somehow has caused to freedom.

Key words: Hallaj, Nasimi, Nietzsche

Introduction

Literature never has been separated from philosophy and philosophical thoughts due to being specialized to man and because of being linked with thought so that one can know philosophy as intellectual leader of literature. In general, philosophy means movement of mind toward to discover and open up universal mysteries and querying that complex. Due to this definition, one can observe and discover some close interrelations and linkages between most of literal works remained with philosophy (Khojaste and Fasai, 2015: 180).

One of the research methods in humanities is the comparative study method. Principally, comparison has a central place in man's thought and also is the methodological core of the scientific method. Comparative study is a kind of investigation method which places phenomena with each other and analyzes them to find differences and similarities.

The present study, with the comparative method, aims to investigate man's place in thoughts of Mansur Hallaj, Emadeddin Nasimi and Friedrich Nietzsche with an emphasize on thought development of Emadeddin Nasimi and a glance at opinions of Feuerbach and Karl Marx.

The present study aims to declare the three mentioned thought schools and to compare them. Since investigation of opinions and thoughts of the three schools, which has gained a mysterious expression among different

interpretations and implications, wants a complete caution and a null analysis, it is hoped we could meet such a responsibility.

Importance of dealing with the present subject, on one hand, has been at comparison of thoughts of West and East and on the other hand, at presence of vacuum in the previous studies in relation to introducing and investigating philosophical place of Nasimi so that in the researches done in Iran mostly this character had only literary place; therefore, it seems that the present study is innovative.

Personality

In this section, we briefly introduce the key characters. Since these characters belong to human society, so it is not good to limit them to a specific city or country and consequently it is avoided to note place.

Mansue ebne Hallaj

Hosein ebne Mansur Hallaj, the popular theosophist of third Hijri century, is of followers of Sokr School who promoted his thoughts through travel and migration (Yahaghi, 2010:314). Hallaj is one of prominent characters of gnosis and mysticism in second and early third centuries whose explanation of the most sensational Shaths still has remained the puzzle of his statements and states unsolved for numerous people both at his time and after him (Ebrahimi Dinani and Jalali Pendari, 2011:6). Hallaj is the factual representative of the perfect lover in the history of Islam in works of Arab, Iranian, Turk, Hindi and Malaysian poets who was executed because of his slogan “An-al-Hagh (I am the God)” which he has gained in Sokr State (Massinon, 2004:17). The reason why Hallaj has been taken into account in the contemporary period in literature, narrative characteristics and freedom concept is selflessness pattern of this character (Hassanzade Niri and Jamshidi, 2015: 80).

In Hijri 297, Ebne Davud, antecedent ruler of Baghdad, sentenced Hallaj's excommunication and in Hijri 301, Ali enbe Isa, Abbasi antecedent minister who was a bigoted person, arrested and imprisoned Hallaj. He remained in prison for eight years and finally in Hijri 309 in ministry time of Hamed ben Abbas he was sentenced and executed (Jafari, 2010:16). Death of Hallaj is a phenomenon which theosophist-like Muslim poets, from Abu Saeed Abikheir to Hafez, have reported it over and over. Attar (poet) has left two live narratives with exciting beauty from his death and its tragic exhibition. These works have historical base. Martyrdom of Hallaj has occurred in real and there is some evidence (Massinon, 1909:127).

Emadeddin Nasimi

Emadeddin Nasimi (772-821 Hijri) is Hurufi thinker and poet in ninth Hijri century. He has poems in Turkish, Persian and Arabic (Nasimi, 2008). Poetry of Emadeddin Nasimi is the only successful poem of Hurufism sectarian so that in his poems he could explain thoughts of Hurufism well in frame of poetry and this has caused some sectarians such as Bektash Order and Kakaiyya have some opinions like Hurufism and know Nasimi Poetical works as their sacred books (Ramezani, Mohammadzade, and Ebadi, 2013:120).

Hurufism is one of interpretation-centered sectarians after Mongol's attack whose followers have learned the manner of interpretation from Esmailiyya. Hurufis know themselves interpretations and subjectivist. They were humanistic who interpreted everything beneficial to men. Gnosis of Hurufism and Nasimi is based on a substantial principle and it is human and cognition of his creative forces. According to the perspective of hurufism, human is a complete sample of God and his caliph (vicar) on the ground and more than other creatures expresses God (Tadayyon Najafabadi and Ramazani: 106).

Friedrich Nietzsche was born in 1844. His father died when he was young. Nietzsche, after studying linguistics and theology, received PhD in linguistics and when he was 24 years old, he became professor in University in Basel, Switzerland. Nietzsche participated in Germany-France War voluntarily. He became sick in front and after that he remained sick more or less and was forced to finish his job in university in 1879 (in 34-year-old). Then, he dealt with philosophical disquisition fully for ten years so that in 1889 (44-year-old) he stopped working completely and in 1900 (in 55-year-old) died. There are many differences among critics about Nietzsche's works. Some know him a great philosopher and others know him a mad poet (Jefrudi, 2012:69).

According to Levastarus, Nietzsche has developed the third and last wave in political philosophy (First wave was developed by Machiavel and second wave by Rousseau). He is considered as one of originators and popular characters of Existentialism School and however, he is called blasphemer, he cannot be known as fully blasphemer. His popular statement is: 'God is dead.' It means God is absent in the area of spirit of men and the era does not require people worship God (Mansurnezhad, 2004:139).

Man in thought of Mansur ebne Hallaj

Mansur Hallaj gradually became sufi (theosophist) during his permanent travels and when he was twenty he put on cloak of mysticism by the help of Amr ben Abbas and became Pir of Sufism (Massinon, 2002:22). He selected the heaviest way of worship and in legal cases, based on comparison manner, always chose the hardest way. Since Hallaj acted in his private manner in his

mysticism and revealed his internalities by mystery and Shath language, soon great theosophists became dissatisfied. Then, Hallaj emphasized on his own practice and tired of mysticism and its practices and traditions due to which his opponents have reproached and blamed him. He took off cloak of mysticism and thus called himself free from being constrained to practices and traditions of Sufism. This action was not disassociation with mysticism but it was a kind of tendency to practice of those who reproached him (Zarrinkub, 2010:268) which led to his famous slogan and according to Mirfetres, this was a step of transcendence of Hallaj who opened up a new path after ascending from gnosis and religion step and he promoted to the point that overflowed against the Transcendent and reached to self-planking after desecrating divine categories (Mirfetres, 2015:155) and finally through a trial he was sentenced to death and was killed in the most calamitous way (Diri and Ashuri, 2014:36).

Human in thought of Emadeddin Nasimi

As it was noted previously, Nasimi could cite thoughts of Hurufism well in the frame of poetry and therefore, he introduced beliefs of Hurufism as man's expression expresses Quranic signifiers and this is the most important purpose of Hurufism that by giving a kind of sacredness and divinity to man's expression it has tried to introduce man's inherent rights as sacred and guard it from aggression. To notice a sample of these beliefs, Hurufis believe that because human is the minor universe, then the divine book is the man himself and therefore human is counterbalance with Quran (Tadayyon Najafabadi and Ramazani, 2011:107). But what stated knows Nasimi more than a successful missionary and after this his thought development starts and heightens his place and this thought path is revealed beautifully and explicitly in an Azeri Turkish poem that we analyze some couplets of this poem as following:

Məndə sıgar iki cəhan, mən bu cəhanə sığmazam,
Gövhəri-laməkan mənəm, gövnü məkanə sığmazam!
(I am a placeless jewel.)

Surətə baxü mə'niyi surət içində tanı kim,
Cism ilə can mənəm vəli, cism ilə canə sığmazam!
(I am not contained in body.)

Can ilə həm cahan mənəm, dəhr ilə həm zaman mənəm,
Gör bu lətifəyi ki, mən dəhrü zəmanə sığmazam!
(What a jest! I am not contained in time (I am timeless).)

Kimsə gümanı zənn ilə olmadı həqq ilə biliş,
Həqqi bilən bilür ki, mən zənnü gümanə sığmazam!
(Those who are knowledgeable know that I am not contained in guess and doubt.)

Zərrə mənəm, günəş mənəm, şəms ilə həm qəmər mənəm,
Ruhi-rəvan bağışlaram, ruhi-rəvanə sığmazam!

(I offer spirit and I am not contained in spirit.)

The main context of the poem is obtained from Nasimi, 1987L 148-151.

The above couplets indicate Nasimi's thought which differentiate him from other Hurufis. In couplets one, two, and three, it is explicitly noted that I possess the adjectives of placeless and timeless. Now, we consider these adjectives.

Shiite thought is based on the fact that existence of God is so vast and comprehensive that he is present and observer in every place, and at the same time, there is no place for him and this comment that 'Everywhere you go, God is there.' is a live, explicit and interesting interpret for placeless-being of God. All places and times are the same for him. And from couplet 24 of Enfal Sura (وَاعْمُوا إِلَّا هُوَ أَنْتَ الْمَرْءُ عَوْنَقْبَهُ), it is interpreted that God is so close to man that intervene between man and his heart and this is an allusion of God's closeness to all of his servants because if we consider heart as center of man's being, there is nothing as close as jugular vein of heart to heart, and God says we are closer to man than that artery. Therefore, this verse has revealed closeness of God to man in the best way because it says God is closer to man than man's heart artery. So, God is present in every place, even in our heart. Certainly, such a person is above time and place because a unit thing cannot be at different places in a time (Makarem Shirazi et al. 1993:272-280).

Now, Nasimi reaches to the step that sees himself corresponding with God or knows himself that God because knows himself in common with God's adjectives.

And in third couplet, he indicates others' vision that this claim can be in jest and wit limit and this explicitness and knowledge of Nasimi to others' vision is about self because reactions of others toward himself reveals his correct cognition from others perfectly because in a short time he was executed due to their intolerance and lack of thinking.

It looks that the path which Nasimi has started does not end there and gets more transcendental because he states in couplet four that: I offer spirit and I am not contained in spirit.

At here, we should think about the words 'offering' and 'spirit.'

Offering or granting: offering means giving gift (Ghudarzinezhad, 2010: 126). It is of the adjectives attributed to God in the Holy Quran and suggests God's kindness and gifts and include Al-rahman (Asra:110), Al-Rahim (Nahl: 119), Vadud (Hud: 90), Ghaffar (Nuh: 10), Karim (Enfetar: 6), Rauf (Hadid: 9), Halim (Asra: 44), Vahhab (Al-Emran),

Imam Ali praises God with this adjective: "Praise is for God who has offered his abundant gifts to his creatures and always is ready to forgive them." (sermon 100 of Imam Ali, passage 1, translated by Dashti) or has said: "He offers all kinds of gifts." (sermon 91 of Imam Ali, passage 2).

Spirit: Allame Tabatabai believes that spirit in Quran has used in all cases in its real meaning and in general, it attaches two senses for spirit: absolute spirit and constrained spirit. Constrained spirit has some meanings such as human spirit, angel spirit, etc.

Allame Tabatabayi knows the attribution between constrained spirit and absolute spirit as the attribution of shadow to owner of shadow. He declares that the spirit in plants, the spirit flowed into human, the spirit affirming believers, the spirit affirming prophets, and the spirit belonging to angles all are of diffusions of absolute spirit.

Divine spirit can express in human such that he can resurrect a dead body with his breath and converts a muddy body of a bird into a real bird. Among divine prophets, Jesus Christ (PBUH) has a specific relationship with absolute spirit. Therefore, Allame Tabatabayi has expressed the most coherent interpretation from 'spirit in Quran.'

This great interpreter believes that spirit in Quran has attributed to a heaven creature whose role is creation of life; everywhere there is a sign of life and its indications, this indication shows the presence of a rank of spirit.

The spirit present in angles, men, animals and plants all are of diffusions of absolute spirit (Shaker, 1999: 6-17).

Based on what stated, Nasimi ascended to the point that he not only knows himself above the spirit (transcendent) but also above creator of the spirit (more transcendent) or the same creator of human reality (term 'spirit' in Kalam science) that this thought can be counterbalance with thought of Karl Marx (about religion) because religion, in his point of view), exclusively is one of manifestations of social life, not its root.

He always said religion is realization of vision of man.

He, relying on Feuerbach's point of view, knew religion as made by human's vision to getting closer to what human knows God. Of this important point, he reached to the concept of man's alienation.

Marx believed that alienation is man's serving for his own products which have taken faces of independent things for themselves. With this look, one can understand well place of religion in Marx's beliefs.

Firstly, he knew religion as something born by man's visions and secondly he emphasized that religion abducts man from his own human self and so called it causes man's alienation (Montazeri and Nezahdan, 2014:133; cited by Rahimi, 2004:76).

Human in thought of Friedrich Nietzsche

Nietzsche's superman theory is his extraction of philosophical thoughts. He tried to provide the required bed for making his intended human by criticizing the philosophies before him, i.e. he tries to provide "superman." Superman, apart from every internal issue, is an external fact which is created every moment and in contact with level. Superman is "the explicit emblem of the fact that nothing is written before and nothing has ended." (Debneva, 2005": 167). In Nietzsche's perspective, superman is obtained as a result of merging in animality and then In Nietzsche's perspective, superman is obtained as a result of merging in animality and then In Nietzsche's perspective, superman is obtained as a result of merging in animality and then receding from humanity. But formation of superman is a result of the special perspective of human to God, world and himself. Nietzsche believes that it is more than 2000 years that the Western men are enchanted by what he calls "Christian moral culture." He believes that it is a culture which is relied on blemishing presence of earth and physicality of human (Pearson, 1994: 44). He emphasizes that Zoroaster wants to educate superman in this ground and to make a joyful life on it (Pearson, 1994:154). Such a person searches his dreams on the earth and eliminates God in his belief. So, Nietzsche firmly wars with Christianity and its divine and ulterior thoughts and knows the teachings beyond limitation of earth as barrios for human growth and progress and believes they are human visions and imaginations (Nietzsche, 1973:99). Nietzsche has two oppositions to Christianity: firstly, Christianity despites life of human in this world. Nietzsche believes that Christianity summarizes humanity in spirit and devests will from him and do not allow human to concentrate his senses in the earth (Nietzsche, 1973:41). Nietzsche, according to Zoroaster, announces those who seek happiness in the world to failure while in his mind, tiredness, agony and disability of human and his hopelessness from earth caused he finally make vision of gods. Therefore, Zoroaster invites men to think only to ability of human: "For me, this valuator and advocator of 'me,' is measure and origin of everything." Then, all things are summarized in body and body does not speak about meaning of the earth (Nietzsche, 1983:42-47). Secondly, he knows man follower, obedient and subordinate of God (Stern, 1999, 141-150). In his opinion, this issue hinders formation of superman. In his perspective, what hinders superman must be eliminated, whether it is God (Nietzsche, 1983:99) or priests who have foisted themselves as supermen (Nietzsche, 1983:33). In other words, of Nietzsche's main thoughts is atheism and enmity with the concept of God. He believes that superman is born if God is denied (Pearson, 1993:151). Generally, Nietzsche knows God as a vision and something born by fear

(Nietzsche, 1999:39). In his mind, facilities will be opened up by death of God and says if human consumes his force for his visions after death, he cannot use all of his talents in this world (Mirsepasi, 2005:239). Nietzsche believes God-awareness is born by human's fear and is a temporary painkiller for his pains (Nietzsche, 2010:184) as Marx knows religion as opium of masses.

Conclusion

In the present study, development of three thought of three influential philosophical characters were investigated separately and then differences and similarities between beliefs of the three characters were considered.

When Hallaj gravitated to Sufism suddenly he became Pir of Sufism and finally he himself became originator of a way that was completely separated from that way. His slogan was: 'An-al-hagh (I am God.)" and has reached from God to man himself. Nasimi, like Mansur Hallaj, separated from the school which he was relied on and he became a generator of the school. Nasimi, counterbalance with Hallaj, with placeless and timeless slogans, elevated himself to transcendence rank. But this flight continued until it separated from Hallaj so that he elevated himself from transcendence (spirit) to higher transcendence (creator of spirit or the creator of human reality). This is the point that Feuerbach accepts it and believes religion is made by human visions and Marx accepts that religion is born from human visions.

As Nasimi elevated human (self) from transcendence, also Nietzsche promised birth of superman by denying transcendence and believed God is made by human fear and it was counterbalance with Marx's slogan that religion is opium of masses. Of what explained, the difference governed between thought development of Nasimi nad Nietzsche with Hallaj is this that Nasimi and Nietzsche could reach from transcendence step which Hallaj had ascended there to higher transcendence and the common obtained from thought development of these three characters can be explained that thoughts of the three thought schools have led to freedom in a way.

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THE CREATIVITY OF MASHADI AZER BUZOVNALI

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Abstract

Mashadi Haji Majid oghlu Azer (1870-1951) was born in the village Buzovna, in Baku, in the family of merchant. As all poets of Baku, he had got his primary education in Mollakhana. Those periods was very difficult, and Azer was obliged to help his family. His father was a merchant, after finishing from mollakhana, he had got in trade in his father's shops, sometimes had joined to his father and did the trades trips, mainly to the East. Journey with camel caravans to the Arab countries, Hindu Muslims, Iran, Anatolia and the East, led to the formation and developing of his worldview at the young age. But all this

hadn't satisfied the young Azerbaijani, when he was fifteen, he had gone with his father to Petrovskport (now it is called Makhachkala), had got lessons on theology from the greatest theologian, besides knowledge of all theological sciences, he had owned Arabic-Persian and the archaic Turkish language. Azer, who already owned deep knowledge and rich information, along with great love for the wiseacre Fuzuli, also read the works of all the Eastern classics, regardless of nationality, as well as, in their native language. For example, he had read Arabic classics in Arabic, Persian artists in Persian, and poets, who grew up in Anatolia, on treatises written in Ottoman Turkish. Besides this, he had read elegies and grief verses from Gyumri Derbendi, Dakhil Derbendi, Mirza Abdurrahim Talibzade and others, whose creativities were very popular in Quzey and Guney (the North and the South of Azerbaijan) during his lifetime. He had got the rich information about Irfan poets and had read manuscripts of the Eastern classics. When he was seventeen, he had met Mirza Abdurrahim Talibzadeh, from Tabriz. Although, he was very young, Mirza liked Azer's excellent knowledge and high intelligence, and he had become friends with him from the first meeting. Later, their friendship was so strong that Mirza, who arrived in Baku, in 1906, visited Azer's mansions, both in Baku and Buzovna during the year, and had taken part in all meetings of the Madjmaush-Shuar (meeting of poets), which he had headed.

Key words: ghazal, verse, literary critic, philologist, poet, theologian

Introduction

One of the leading representatives of the Baku literary environment of the second half of the XIX century and the beginning of the XX century is Mashadi Haji Majid oghlu Azer (1870-1951). He was born in the village Buzovna, in Baku, in the family of merchant. As all poets of Baku, he had got his primary education in Mollakhana. His father was a merchant, after finishing from mollakhana, he had got in trade in his father's shops, sometimes had joined to his father and did the trades trips, mainly to the East. Of course, the journey with camel caravans to the Arab countries, Hindu Muslims, Iran, Anatolia and the East, led to the formation and developing of his worldview at the young age. But all this hadn't satisfied the young Azerbaijani, when he was fifteen, he had gone with his father to Petrovskport (now it is called Makhachkala), had got lessons on theology from the greatest theologian, besides knowledge of all theological sciences, he had owned Arabic-Persian and the archaic Turkish language.

The object of the research is a complex study of the poetic creativity of Mashadi Azer.

Actuality of article. From the end of the XIX-beginning of the XX century, the exploring of the creativity of Mashadi Azer during his activity, who touched to the actual problems of that period, is important from the point of view to follow the line of print and literature, which determines the tradition of classical poetry and their novelty.

Scientific novelty of the article. The presented research paper is distinguished by scientific innovation. Mashadi Azer Buzovnali, Azerbaijani poet's personality and literary activities haven't yet been exploring quality according of party literary criticism, but his many-branched creativity had been discussed and analyzed on his manuscripts.

Methods

The method and methodology of the research is a systematic and historical approach to the study. The historical-comparative method was also involved in the research. Monographs, essays, articles, other sources, as well as quotes from the works by authors, presented with scientific conclusions.

Results

Azer, who already owned deep knowledge and rich information, along with great love for the wiseacre Fuzuli, also read the works of all the Eastern classics, regardless of nationality, as well as, in their native language. As all the members of "Majmaush-Shuara", he wrote poems about Fuzuli, and at the same time showed his mastery and greatness in a number of his works:

*What if Azer also said as Fuzuli,
"Everyone who comes to us happy leaves us sadly". [3, p.61]*

For example, he had read Arabic classics in Arabic, Persian artists in Persian, and poets, who grew up in Anatolia, on treatises written in Ottoman Turkish. Besides this, he had read elegies and grief verses from Gyumri Derbendi, Dakhil Derbendi, Mirza Abdurrahim Talibzade and others, whose creativities were very popular in Quzey and Guney (the North and the South of Azerbaijan) during his lifetime. He had got the rich information about Irfan poets and had read manuscripts of the Eastern classics. When he was seventeen, he had met Mirza Abdurrahim Talibzadeh, from Tabriz. Although, he was very young, Mirza liked Azer's excellent knowledge and high intelligence, and he had become friends with him from the first meeting. Later, their friendship was

so strong that Mirza, who arrived in Baku, in 1906, visited Azer's mansions, both in Baku and Buzovna during the year, and had taken part in all meetings of the Madjmaush-Shuar (meeting of poets), which he had headed.

Repeatedly exploring the creative heritage of great creators played a big role on Azer's formation as a poet. For this reason, whichever genre of poetry he tried, he hadn't stumble and had created graceful examples of poetry.

He had grown up in a religious family as a child, and his dedication to Ahl al-Bayt, led him to visit the shrine of our eighth imam, Imam Reza (as) in Mashhad, when he was about twenty years old. When he returned to his homeland, everybody had named him "Mashadi", as everyone who visited the holy place, and therefore everyone called him "Mashadi Azer".

Writing poems from his childhood, Azer's farsighted had improved after visiting Mashhad, and he had begun to improvise spontaneously poems. Famous creator of ghazals, a repeatedly witness, who considered Azer as a master for himself-Aliaga Vahid, couldn't hide his tears, when Azer spontaneously improvised poetry.

It is necessary to note, that Mashadi Azer was a propagandist on Turkism and Turanism ideas, and he had opened up great opportunities for increasing of Turkism in the thoughts of members of "Majmaush-Shuar" from the end of the 20th century.

Mashadi Azer's grandson, journalist, bibliographer, publisher, encyclopedist Rahimaghla Azersoylu Imamaliev writes in his book [4], which was published about Mashadi Azer: Memories of Mashadi Azer who had been the child and riper- writer of 1945-1951, must be praised today. Mashadi Azer-the master of Aliagha Vahid, who resound with his ghazals in the East, leading the ideas of J.Jabbarly, M.Mushfig, S.Mansur, A.Muznib and others, in addition, a master of Arabic, Persian, Turkish, Uzbek, Turkmen, Tajik, Old Latin, Avar languages and literature, he was friends with Hashim bey Sahib, who said: "Be proud of Azer in Azerbaijan", with Novruz Neyir, who said: "He diversified every word-this is Azer", with Abdulhalig Yusif: "having shine in the garden of faith" with Abdulhalig Rahim; with Abdulhalig Ragii, "Ragii, too, destroyed whole as Azer"; and with Asi, Muniri, Jannati, Uryan, Shargi, Vusagi, A.Muznib, Dilhun, S.Mansur and others, and it is both pleasure and a pride for me to say heart-full words about a classic.

Meshadi Azer Buzovnali was one of the leading creators of his time in attitude to the cultural heritage of other peoples. At the same time, the poet tried to assure his readers and contemporaries, but it is impossible to rise to the level of developing world literature without assimilating national traditions, studying the cultural and literary heritage of other peoples. Mashadi Azer was inspired by the famous Persian poets Sheikh Sadi Shirazi, Abulgasim Firdovsi, one of

the pearls of Ottoman literature Farouk Hafiz and others; and had made translations.

Translation the story of “Rustam and Isfandiar” which was translated by Mashadi Azer, from “Shahname” written by Abulgasim Firdovsi, about brave and heroism the Iranian warlord Isfandiar, is a suitable source of creativity. Mashadi Azer translated this story decorating with new patterns and new loops, so perfectly, that, those, whose Persian and Turkish languages are perfect, can assume, that this work, was translated from Azeri into Persian.

Fact is that, during the period of socialism, Abulgasim Firdovsi insulted and humiliated Turkish people in work “Shahnameh” [1], and at the same time he presented himself as a Muslim, but his creativity power is not so high, although he covered his works with fire-worshiping elements, it was exaggerated and was rose to a point that it doesn't deserve. But translation, which Mashadi Azer translated with great poetic logic proves his superiority, from Abulgasim Firdovsi, as a Turkish-Azerbaijani poet, and for this, it is enough to look to the part of the story:

*Father is sacred place, son, you are young,
You are shadow of the country, son.
May be wishness is richness on this work, son
Honestman, later or sooner, this will be yours,
Hear, an elderly mother's sermon,
Changing the new square to the precious
Mix poison to the feast of sorrow's goblet
You are going, to the monster of wish, you son.
You are going, to the dragon wish, oh son. [2, p.28]*

Mashadi Azer Buzovnali also translated into our language the epos “Rustam and Burzu” from “Shahnameh”. However, the poet dedicated this literary part to his son Amir Imamaliev, the commander of a light artillery regiment.

Having amazing thinking and understanding, Mashadi Azer was perfect in Arabic, Persian and Russian languages, and easily read and wrote in the Ottoman dialect. It is no coincidence, that translations of poems from Nizami Ganjavi “Makhzanul-asrar”, “Seven beauties” from Persian, several parts from the poems of Sheikh Sadi Shirazi “Gulistan”, “Bustan”, works of Khagani, Hafiz, Khayyam, gained fame on literary translation sphere.

Mashadi Azer Buzovnali's creativity is many-branched, and he has a very rich heritage. Being a great poet, he also was one of the specialist on expressive reading of the “Quran”, as well as an expert on the “morphology and syntax” of Arabic language. Mashadi Azer Buzovnali's creativity is many-

branched, and he has a very rich heritage. Being a great poet, he also was one of the specialist on expressive reading of the “Quran”, as well as an expert on “morphology and syntax” of Arabic language. Thus, for learning of youngs’ people the alphabet of the “Koran”, he compiled an “Practice Book”, which is also kept at the Institute of Manuscripts named after Mohammad Fuzuli, under the format 11x17.9 sm. Besides that, the manuscript on the grammar of the Arabic and Persian languages is also kept under the format 17, 7x11 sm [2].

Philologist, poet, literary critic, theologian and the historian-theologian Ramiz Fasheh writes in his article about Mashadi Azer: Mashadi Azer using metaphors in his creativity and said in his literary-work – “Mutawwal” about the Turkmen scientist Taftazazani, about the Arabic “morphology-syntaxis” (grammar): “Al-majaz qentereqete al- heqiqet “the metaphor is completely based on the idea that “metaphors are the bridge of truth.”

It should be noted, that the science of “morphology and syntax” had known deeply not only by Mashadi Azer or Baku poets, but also to members of poetry meeting, in all regions of Azerbaijan. If we looked through the creativity of poets, we can clearly see this. “Serf” – morphology-mainly consists of nouns, a verb-consisting of nouns, “infinitive” – consisting of adjective, “Plural from singular”, “muqassar” (diminution), “mansub” (belonging), “muzakkar” – figurative and literal masculine, “munnas” means feminine, “marifa” means – definition, “nakara” – means indefiniteness, “zamir” substituting the noun, the noun verbs-in the means of the sign of noun: “ishare” (sign), “mazi”, “muzari”, “emr” (order), “mukhabat” means a man, “mughaib” means a woman, lyrics in my expression “mutakallim” and etc. from verbs, “Nahv” part is consist of the verb “naqis” (irregular verbs), which connected predicate with subject and etc.

For exploring the meaning of deepness these sciences, our classics had spent time and instead of they had created gracefull literary works. Unfortunately, poets, which that reflected these metaphors, symbols and poetic laws, or rather, poets-whose works were contained on these, had been called epigonists during former Soviet, with rhythms, even a child can write poetry with the words, such as “mountain”, “garden”, “oil”, “age”, “white”, “right”, “face”, “eye”, “step”, “flat”, “ice”, “salt”, “goose”, “small”, “spring”, “sleep”, “horse”, “bat”, “sell”, and etc. or “Marxism”, “Leninism”, “Bolshevism”, “socialism”, “communism” and so on. those, who wrote poetry with slogans were considered incomparable poets, the pride of Azerbaijani people. Exactly, during former Soviets Azerbaijan poetry degenerated, real Azerbaijani poetry had stayd in shady, and had been appeared a deep chasm between our predecessors and successors.

Real name of Mashadi Azera is Khosrov, surname is Imamaliev. His father, Haji Majid Buzovna, was one the elders of village. Azer began writing poetry under the pseudonym “Azer”. He began to write poems, when he was 15

years. Of course, young Khosrov didn't mature for creating such perfect poetry pearls on this age, and after reading the literary works of the Eastern classics day by night, he had achieved to this.

Literary critics know that poetry has its own laws. Mastering the science of the poetic module and literary expression, as well as "eloquence" originating from the Koran, which is very important for the poetry of an Eastern Muslim, as well as acquaintance with the style of Eastern classics, can create not only an Eastern poet, but can create a real poet too. Some poets sweeten themselves to Russians and considered it a sacred duty of the poet, who benefited from Russian literature, those, which explored on the Eastern poetry, were considered rotten of scholastic poetry during the former Soviet times.

But, over time, when they freed from the shackles of Russia, they realized that Russian poetry, which didn't express any creative means other than rhyme, excepting Pushkin and Lermontov, could never be considered the origin of the greatest Azerbaijani poetry. Although, Mashadi Azer's creativity belonged to the times of former Russia, but he had never had betrayed to the poetic laws, which inherited from his predecessors, he created great ideas, expressing great meanings in small poems, and at the same time expressed a special fluency of tonality, rhythm and harmony of the poetry and as a result, he was able to turn the reader, into a participant, in the poetry notes of each created poetry:

*If my beloved is at the carousal with me this night,
Then, bliss star is at the highest peak on the sky, this night.*

My fate did me the comer for lucky later

Everything is on like the dream, this night.

All my wishing is more enough, this night,

Because, the favor of beloved, is very lighting, this night. [5, p.195]

Mammadaga Sultanov, a late orientalist on the collection of the classical Azerbaijani literary heritage, in sphere of publications and propaganda, had called the first period of Mashadi Azer's creativity, the pre-revolutionary period-pessimistic, and the post-revolutionary period-optimistic. Mammadaga Sultanov had come to such a "conclusion", because, he knew, that it was dangerous to be out of black limit, which the socialist ideology built against our literary heritage. Looking through the creativity of our poets and writers, who created during the former Soviet times, we wouldn't meet with the pessimism in any of them, in accordance with the requirements of the time.

Because every creator, pessimistically tuned to the "bright" of "light" brought by Lenin, had to answer not only with his life, blood and execution of his generation. Fact is that, the creator was never tuned to pessimist on the first

period of his creativity and his critical thoughts in some pre-revolutionary works or the whipping of time, of course, was mainly due to the uprising of tsarist tyranny and colonial politics.

Enamored line appeared on Mashadi Azer's creativity after gainening independence of Azerbaijani, in 1918. Everybody knows, that there was a very strong pressure on Turkism and Turanism, and even before the revolution, those, who glorified Turkism had been accused for this during the Former Soviets period, however, being an optimist, Mashadi Azer, who created the literary works of divine, as one of the supporters of Turkic ideas, in the period, when the sosialist ideology cuts both in front and behind like sword, works such as "Oghuzname" in 1925, "Chingizname" in 1935, and "Darya Khan's story with Pike Khanum".

That's why, from the Former Soviet times some unexploring literary works hadn't took place on textbook. A number of his works, written at an elderly age, were on the contend of grievance. If we look through ghazal, which he wrote in last years of his life, we can clearly see the injustice of the socializm ideology:

*What I would say, nobody reacts me,
Nobody gets me as person, nobody cares of me,
Whom I would greet, no greetings back,
Interesting is that, nobody replies greeting. [4, p.5]*

Personality and creativity of Mashadi Azer, who became to the prominent person of Azerbaijani literature, is important for researching of his original style of expression and modernity.

Conclusion

Mashadi Azer used about a number of problematic characters from poetics, meanes of literary description and expression, from metaphors and their various types, epithets (metaphors), teshbehs (metaphors). Of course, we can talk by hours about the life and creativity of Mashadi Azer, as well as about his meaningful life. And we hope, that our prominent scientists, philologist, those, who research, publish and popularize Mashadi Azer's classical heritage will lighted our literary history with their activities. Because, thousands of poetry lovers need it, and this need must be satisfied.

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THE GEOECONOMIC IMPLICATIONS ON THE SOUTH CAUCASUS REGIONAL SECURITY PROVISION: “MIDDLE TRANSIT CORRIDOR” AND ITS GEOPOLITICAL DEVELOPMENT

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Abstract

The South Caucasus region is increasingly becoming a priority on the international agenda. In fact, a regional approach is emerging as actors understand that common problems need to be addressed jointly. Nevertheless, cooperation efforts are hampered by a number of factors, such as uneven economic and political development within and among countries, nationalist forces, and longstanding animosities between regional players. In this context, it is imperative to foster sound policies aimed at strengthening dialogue and cooperation so as to contain and ultimately resolve conflicts with peaceful means. However, there is little policy-oriented research on the challenges and opportunities for cooperation in the South Caucasus region based on development of the “Middle Transit Corridor”.

The purpose of this paper is to offer insights that contribute to addressing a current literature gap on geoeconomics and geopolitics of deterrence exploited in aegis of the South Caucasus regional security. The work

also describes the significance of international terrorism and its general definitions. Besides, the result and findings are based on theoretical studies and assumptions and the result of the analysis of the "Case Study" of the South Caucasus regional security format as well as SWOT-analyses of the "Middle Transit Corridor".

The Case study examines how the South Caucasus region influences the spread of terrorism and what threats it poses for this region. Furthermore, the aspects of what makes the region important on international arena are analyzed and the existent and potential security issues are examined, as well as strategic importance of the region for the EU and NATO is analyzed even from academic framework – "Securitization" theory.

The theory is based on security studies conceptual background and the background spectrum includes: the Copenhagen School and Regional Security Complex theory as the type (1). The last theory implies - a set of states whose major security perceptions and concerns are so interlinked that their national security problems cannot reasonably be analyzed or resolved apart from one another reflected at the regional security level. Moreover, the South Caucasus regional security and geopolitics are to be reviewed and scrutinized in several modalities in aegis of the Securitization theory, like political, military and economic sectors.

The hypothesis provides provision that the South Caucasus regional security has already became indispensable part of the contemporary international security system and determines tendency for promotion of geoeconomic implications and new type of geopolitical balance at global level due to the re-globalization process. In addition to that the South Caucasus regional security format determined with "3+2" one and the format does not include any global power involvement into the regional affairs (for instance, the USA and the EU).

However, due to the geoeconomic implications, the South Caucasus could be transformed into the central pillar area for launching geoeconomic wars between the global powers, i.e. the USA, Russia and China with involvement the EU and its member-states on France example. That is why the region is very vital for contemporary international security system perspectives, dealing with geoeconomic security ("Middle Transit Corridor" case) and local actors in case of Georgia's national security.

Key words: the South Caucasus region, Copenhagen School, Regional Security Complex theory, geoeconomic implications, SWOT-analysis, Case-study method, geoeconomic war.

Introduction

The Caucasus region was one of the most important region in a lot of ways in the world history. Some features of region such as history, geographical location, ethnicities, and natural resources caused to be arisen powers' interest to the region. On the other hand, Caucasus should have an identification within its name, location, geostrategic position, history, and ethnicities in international relations. In the early post-Cold War era, it was widely believed that — as a result of the rise of globalization — traditional geopolitical rivalries would be replaced with peaceful collaboration and harmonious economic competition under the umbrella of a “rules-based order”. Such assumption, anchored to the world view of classical liberalism and its intellectual iterations, held that the end of the 20th century would give birth to an era of unparalleled prosperity, everlasting peace and institutionalized collaborative governance (2).

Globalization indeed affects development of regionalism and multilateralism in its origin in different ways and evade all barriers for further their development. The multi-vector nature of the Caucasian political space, Russia's involvement, partially in the form of direct participation and partially as an external factor, in its reform processes, the region's rich hydrocarbon resources and its significance as a transportation corridor for exporting Central Asian oil and gas to the world market, and the arduous nation-building period the region's countries have been going through are all drawing the attention of both the academic community and politicians to the Caucasus, and particularly to the Central Caucasus. Hence, the Caucasian regionalization is being held back by disintegrating factors, for example, by the military conflicts in the region and the impact of the contradictory trends of the world market. The globalization also affects the regional security provisions and have multifaceted consequences with varied forms of cooperation and even rivalry. Therefore global governance is another phenomenon that makes all geopolitical events taken place in aegis of the concrete region case, for instance, the Caucasus region even devoted to new identity in aegis of the “Central Caucasus” identity (3).

In this case, the regional security provision is being determined by new identification labeled as geoeconomics and geoeconomic war zones.

Globalization promotes trend of intercontinental cooperation without developing regional and national interdependence. With the onset of the COVID-19 pandemic, some experts have suggested that not only the process of de-globalization, but also isolationism has begun (4). In fact, the process of pseudo-globalization has begun, because, if only because of the global nature of the illegal economy, the process of globalization will never end. The COVID-19 pandemic contributed to the transition from hyper-globalization to turbulent

globalization, while the Russian war in Ukraine and Western economic sanctions against Russia marked the beginning of confrontational globalization. Against this background, the beginning of the “Food War” and, especially, the “Oil War” can be qualified as the beginning of a global geo-economic war.

Classical geopolitics was rather rigid, however, in its assumptions about the limiting factor posed by geography. A core assumption of many classical geopolitical studies was that geography is immutable and cannot be overcome. Hence, if a country occupies certain strategic territories or has access to crucial chokepoints in international waters, it will always be able to dictate its will to other nations and have a permanent political advantage. Halford Mackinder in 1919 claimed, “Who rules East Europe commands the [Eurasian] Heartland; who rules the Heartland commands the World-Island; who rules the World-Island commands the world”(5). If that were true, the Soviet Union—as the country that ruled Eastern Europe and the Eurasian heartland—should have won the Cold War (6).

Eurasia attracts attention not only because of its wealth of natural resources, in particular energy, but above all because of its ability to influence global geopolitics. The persistence of numerous unresolved conflicts in the region directly or indirectly affects relations between great powers and states of the greatest importance at the regional level. The dissolution of the Soviet Union revealed pre-existing regional tensions: ethnic or territorial conflicts that had been suppressed by the Soviet authorities. The outburst of some of these claims has created significant international tensions (7).

Geo-economics is an interdisciplinary field that examines economic and geopolitical concerns in an international context. It combines elements of political science, economics, and international relations to study the relationship between economic policy, security (including economic security) matters, and geography. The field draws on a variety of theories and concepts, including realist international relations theory, neoliberalism, and market-oriented economic theories. It emphasizes the importance of power, resources, and strategies in international politics, as well as the role of government policies in influencing economic conditions. Geo-economics has become increasingly relevant in recent years, as the world has become more interconnected and the stakes in international politics and economics have grown higher.

The field is increasingly relevant to businesses interested in international markets and political actors who must navigate the complexities of global economic policy. The concept of geo-economics has emerged in the post-Cold War era as a way to understand and analyze the interplay of economic and geopolitical factors in the international system. It looks at the ways economic transactions, investments, and trade interact with political and economic security considerations, and how economic flows and activities can shape

international relations and power dynamics. By analyzing the economic and geopolitical elements of a particular region or country, geo-economics can provide strategic insights that allow policymakers to better understand the underlying dynamics of global economic and political systems. The term entered the lexicon in 1990 with an article by Edward Luttwak, which argued that following the Cold War, the importance of military power was giving way to geo-economic power (8). In that context, certainly economic power remains key element in providing geo-economic basis and promotes its tendency in sphere of current international security. Samuel Huntington identified raise of economic considerations in international relations. Notable he mentioned: “Economic activity is, indeed, probably the most important source of power, and in a world in which military conflict between major states is unlikely, economic power will be increasingly important in determining the primacy or subordination of states” (9).

New Regionalism as the Caucasus Geoeconomic Reality and New Modality – From “Trans-Caspian International Transit Route - Middle Corridor” (TITR-Middle Corridor) till “the Caucasus Transport Union

As it is known definition “regionalism” associated with a policy designed to reduce trade barriers between a subset of countries regardless of whether those countries are actually contiguous or even close to each other. On other side, Regional Trading Arrangements are based on the principle of discrimination as it goes for liberalization of trade within a group of country – a discriminating policy towards the rest of the world.

Above-mentioned notes clearly underpin importance of new jargon “New Regionalism” that directly fits to the Caucasus regional security realities. By general definition: **“New Regionalism”**- *is a selection of newly identified national trade and economic sectors (for instance, railway highways “North-South” and “East-West” development of Baku-Akhalkalaki-Kars Railway geoconomic project and for Russia-Armenia interests “Krasnodar-Sukhumi-Tbilisi-Yerevan” railway highway/).* The configuration of “new regionalism” is becoming increasingly reinforced in world politics and economics. During the past 50 years, several successful geo-economic areas, regional integration coalitions, and groups have formed in the world. They include NAFTA, the EU, APEC, ASEAN, MERCOSUR, and others. They are becoming increasingly firmly established as unified socioeconomic complexes and are characterized by the great similarity of the goals and interests of the states belonging to them. And this process is continuing (10). “New regionalism” is based on the ties between the region and international (including European, Asian, and so on) order, whereby the regions are striving to find their place in the state, on the

continent, and on the international markets. In this sense, it is entirely in keeping with globalization (since it creates stimuli for the participation of countries and regions in the integration processes), and more precisely, with its local version, which is an alternative to the world mechanism of trade liberalization (like the WTO). Each regional organization forms its own consensus regarding its recipe for economic success and focuses its activity within the framework of the organization. In so doing, “new regionalism” is intensifying the competitive struggle between regions, and is not providing new roles in the national division of labor (10). Having considered high stakes in geopolitical disposition of the region is possible to take into account geoeconomic perspectives to the world economy and world trade. Transportation connectivity of the Caucasus region can be concerned in two primary axes: north-south and east-west. North-south communication is of course very difficult which makes it more difficult for Russia to influence the region and create more physical military presence. As far as the connections of the South Caucasus (that is, de facto, the region located on the southern side of the Greater Caucasus mountains) with Anatolia and the Middle East or Iran are concerned, the contemporary situation of connectivity is somewhat better. After all, the Caucasus has a significant position in point of history, geography, ethnicity and geostrategic in international community. The important powers of the 21st century keep their eyes on the region thanks to their past, relations, and projects with the states in the region. Its geographical position made it geostrategic location for the world power except for its natural sources. In shortly, it is connected;

- ✓ To Central Asia via Caspian Sea,
- ✓ To Middle East with border of Iran,
- ✓ To Europe via Black Sea, Azov Sea, Aegean Sea, and Marmara Sea,
- ✓ To Africa via water corridor reaching to Mediterranean.

The Caucasus region is wealthy region in context of geopolitical position, strategic importance and history on the world map. Notable the impact and geo-economic relevance of the region has been reviving since post-conflict situation development in Nagorno-Karabakh. Namely, the fragile peaceful situation in the ex-conflict zone provide new stimulus of development of trans-communicational corridor systems. These systems include the following:

- 1) **“West-East”** – *the EU-the South Caucasus-the Central Asia-China transit corridor*
- 2) **“North-South”** - *Eurasia (Russia)-the South Caucasus-the MENA transit corridor*
- 3) **“West-South”** – *the EU-Black Sea Basin-the South Caucasus-the MENA transit corridor*

- 4) “*East-East*“ - Azerbaijan-Georgia-Turkey (*Baku-Tbilisi-Kars*) railway transit corridor
- 5) “*South-West*“ – India-Iran-the South Caucasus-the Black Sea Basin-the EU transit corridor
- 6) “*South-South*“ – Azerbaijan-Armenia-Turkey transit corridor (“*Zangezur*” corridor)

These above-mentioned geoeconomic trans-communication transit zonal corridors are to be promoted further on and geopolitical stability is a key promoter of the mega-projects. Therefore in order to really perform the projects are needed to set up an institutional instrumental provision, like creation of so-called “*The Caucasus Transport Union*” where the regional actors are to be engaged and involved in. With consideration the opportunity, local regional society could be promoted in aegis of the so-called “European four principle” pattern and could be based on so-called “Four Society” development modality: *Media-Community, Business-Community, Public Diplomacy Community* and *Expert Regional Community*. The confrontation dilemma is not easy to defuse and navigate into peaceful resilience and remains a sole option to transform the Caucasus region from confrontation modality into peaceful island as it is perceived into by the geopolitical concept “*Caucasus Geostrata*” - as a *geostrata, the Caucasus is the region where geopolitical projects are either synchronized or clash* (this is one of the leading theory of modern Georgian geopolitical school) (11). In aegis of the concept is perceived for realization of peaceful co-existence not only local actors but also international actors representatives – setting up Caucasus Public Chamber institution for coordination of the regional NGOs, academicians and media as a regional community representatives activities and fostering among themselves direct dialogue in for sake for confronting conflict modality and via re-appraisal and trustworthy communications reach and attain peaceful society modality installation at the regional level and this is not a myth but reality. It is interesting that the “New Regionalism” with center-pillar area of the Caspian Basin is linked with realization of the Trans-Caspian International Transport Route (“Middle Corridor”) that has origin of geoeconomic basics.

The Trans-Caspian International Transport Route (TITR-Middle Corridor) starts from Southeast Asia and China, runs through Kazakhstan, the Caspian Sea, Azerbaijan, Georgia and further on to European countries.

Kazakhstan, Azerbaijan, and Georgia announced in late June of this year that they are seeking to unify rail tariffs and set up a joint logistics company. This marks a major milestone in the process of expanding the Trans-Caspian

International Transport Route (TITR) into the long-anticipated Middle Corridor between Europe and China. The Middle Corridor is a shorter and sanctions-free alternative to the Eurasian Northern Corridor, which runs through the Trans-Siberian Railway, Trans-Manchurian Railway, Trans-Mongolian Railway, and the Baikal Amur Mainline. The Russian route used to carry more than 90% of the rail traffic between Europe and the Far East prior to the war—yet now, with sanctions reducing shipments over the Eurasian Northern Corridor by as much as 40% last year, support for the Middle Corridor is growing. The wider region is already busy building railways and other infrastructure. Kazakhstan alone has built 2,500 km of railway in the past six years, to the cost of at least \$35bn. Uzbekistan and Kyrgyzstan are rapidly expanding their rail links, as well as their links with China. Azerbaijan and Kazakhstan, meanwhile, are working on their port capacities and ferries, seen as a potential bottleneck in the TITR. In May of 2023, a joint venture was agreed between Kazakhstan Railways and Singapore-based PSA International to further speed up the process that will see Central Asian and Kazakhstani railroads take a leading role in the logistics of Eurasian trade. Similarly to the ancient “Silk Road”, it is often compared to, the “Middle Corridor” is more of a network of interconnected routes than a single, neatly delineated corridor.

TITR is consolidating organization, which represents today an interests of number of countries and companies on the new Silk Way which now starting its functioning like in the days of the ancient Silk Road. **TITR is aimed** to coordinate interaction of all the participants of transportation of goods and containers along the route from Asia to Europe and in the reversed direction, including needed informational support. **TITR is recognized** as an authoritative partner, which contributes simplification an administrative procedures, helps to create competitive environment and assist making best efficiency for the companions from business societies of different countries not only along the Trans-Caspian route.

On September 28-29, 2023, regular sessions of the Working Group and the General Meeting of the ALE "International Association "Trans-Caspian International Transport Route" (hereinafter - the Association) were held in the city of Aktau (Kazakhstan), dedicated to the 60th anniversary of the port of Aktau. During the meeting, the participants of the General Meeting noted the growth in transportation volumes along the TITR route, and signed the Agreement on interaction and liability measures when organizing the transportation of goods as part of container trains along the TITR route using feeder vessels and the Agreement on the organization of container transportation in direct international railway-sea communication with the participation of feeder vessels between the ports of the Caspian Sea (Aktau - Baku (Alyat)).

The following companies were accepted into the Association as members: Alport (Azerbaijan), BMF Port Burgas (Bulgaria), Semurg Invest (Kazakhstan), LTG Cargo (Lithuania), Global DTC Pte.Ltd (Singapore) and Eastcomtrans LLP (Kazakhstan). Thus, the composition of the Association has increased to 25 companies and is represented by 11 countries.

At initial stage, promotion of the TITR was delivered to seven logistic companies from Kazakhstan, Azerbaijan and Georgia in 2014. Among the companies could be considered as follow: “Kazakhstan Railway Road Company”, “Aktau Sea Port”, “Azerbaijan Maritime Corporation”, “Baku Sea Port Company”, “The Georgian Railway Road” and “Batumi Sea Port Company”. After corporate consolidation in 2023 was set up special “Geoeconomic Alliance: with involvement of the Caucasus-Caspian Region – Kazakhstan, Azerbaijan, Georgia and Turkey. It seems so that later the Alliance could be joined by Uzbekistan and Turkmenistan whose political leadership express readiness to join the TITR. The geoeconomic project directly linked to the “One Belt, One Road” Chinese megaproject and really felt in contradiction to the Russia’s new geoeconomic project “North-South” from Sankt-Petersburg till Mumbai (India) where the South Caucasus is becoming the linchpin or cornerstone of its promotion. Hence, it seems so new type warfare strategy is underway – Geoeconomic war. According to new definition (from the author of the paper), it is a special type of warfare which aims of promotion of geoeconomic missions and goals and accelerates hybrid warfare elements of political, economic and even military ones.

That is why below to be is considered three possible scenario of the development toward the TITR. However, here is SWOT-Analysis of the TITR that could be presented in the following below Chart (see **SWOT-Analysis Chart №1**).

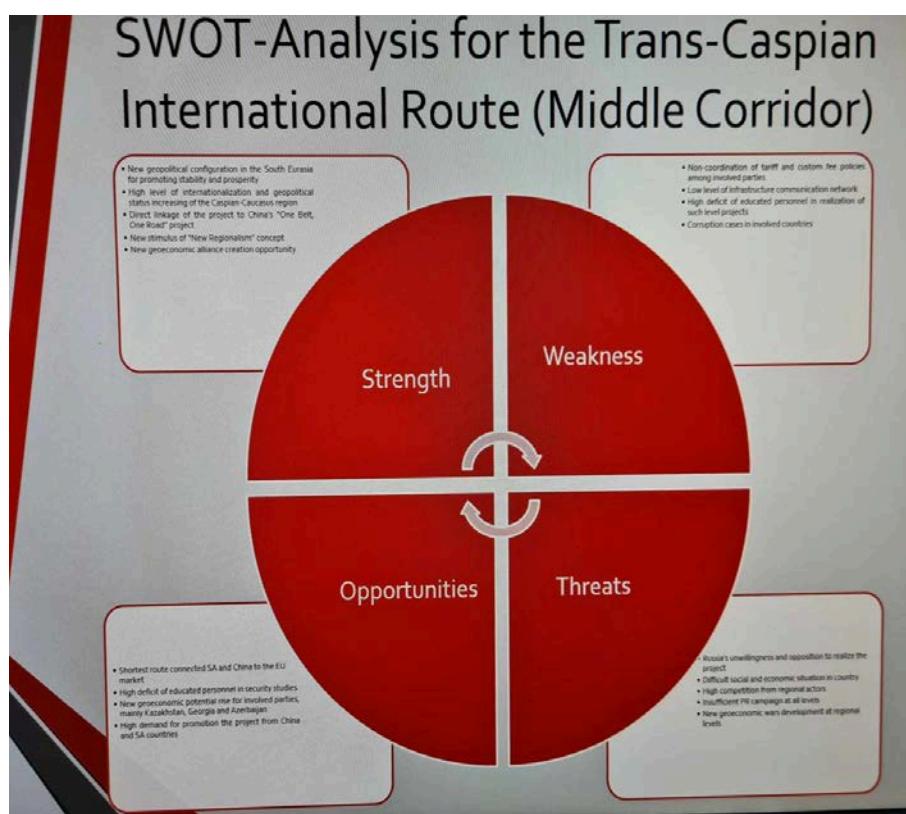
The possibility of geoeconomic wars development is real cases that are running in aegis of “North-South” and “West-South” geopolitical directions and could be subvert the realms of the regional security format: “3+2” which is really endorsed at time being. The tendency is possible for re-frozen conflict spots in the region. The processes taken place in the area prone toward instability and vulnerability are causing to stimulate also so-called “Asymmetric Challenges and Threats” at the special geopolitical format at all three levels: local, regional and global.

Historically, the South Caucasus has been playing a significant role for establishing and developing the economic relations between Europe and Asia. After the trilateral agreement amongst Azerbaijan, Armenia and Russia, which led to a complete ceasefire and a cessation of all hostilities on November 10th of 2020, new geo-economic opportunities have been established in the South Caucasus region.

Thanks to the trilateral agreement, the normalization of the relations between Turkey, Azerbaijan and Armenia and the potential for economic cooperation has emerged in the region. Hence, developments throughout the past two years show that there is a mutual interest in all South Caucasus countries for further establishing and expanding the trade and economic cooperation across border lines through establishing new opportunities.

Therefore, it is suggested to promote the regional socioeconomic reconciliation and cooperation programs for the sustainable peace in the region. Additionally, Armenian borders with Turkey have been closed since 1993 due to the conflict between Armenia and Azerbaijan. However, in the post-conflict period there is also a new solid opportunity for the recovery of Turkey-Armenia economic relations, too.

Chart №1: SWOT-Analysis of the Trans-Caspian International Transport Route (Middle Corridor)



The South Caucasus Regional Security Scenarios Development from Geoeconomic War Cases

Having considered above mentioned geopolitical confrontation between the actors of the Caucasus region and even confrontation lines among three regional hegemons: Iran, Russia and Turkey and with attempt of outside regional actors, like the USA and EU (mainly with France engagement and with weak involvement of Germany – German Foreign Affairs Minister Annalena Baerbock just lately paid official visit in Georgia and criticized the current Georgian government for pursuing anti-Western foreign policy and that was only the mission) attempts to have their influence in the region, the situation in the South Caucasus more strain and would be deteriorated further on. In this case, several scenarios could be perceived in nearest future, probably even in long term but even in short term the geopolitical landscape in the region would be detrimental to international security perspectives. Let's consider the period of for 2 years period and review the scenarios development cases:

The First Scenario – Military Confrontation Development: recent processes taken places in the South Caucasus mainly in conjunction with so-called “Zangezur Corridor” (see in more detail below Case-study) and Nagorno Karabakh problem where two peacekeeper missions are available – the Russian Federation military contingent and the EU Military Monitoring Mission operate. Regarding the “Zangezur Corridor” where Iran and Azerbaijan and with together Armenia interests are being intertwined. However, Azerbaijan and Iran are at the edge of war wagging and in nearest future low intensity military conflict could be developed. Iran allied with Armenia and even can provide military assistance and even provoke a small scale military intervention in order to provide its military interests in order to defender “Zangezur Corridor” bordering between Azerbaijan and Iran. By the way, on April 9 of 2023 two high level officials of Iran and Armenia met in Tehran – Secretary to National Security Council of Armenia, “grey cardinal” of the Armenian politics Armen Grigorian and Secretary to Supreme Council of National Security of Iran Islamic Republic Ali Shamkhani. By the way, namely Ali Shamkhani noted that if geographical changes occurs in the region, it will be linked with military conflict and he certainly deems Azerbaijan Armed Forces attempts to seize “Zangezur Corridor” and even in Nagorno Karabakh so-called “Lachin Corridor” connected the Nagorno Karabakh region with Armenia and now being under controlled by the Russian peacekeepers. Iranian Special Revolutionary Islamic Guard Corp military formations have been converted on military readiness level №1 across the border with Azerbaijan. The situation deterioration between Iran and Azerbaijan formally started when

the Azerbaijan opened its diplomatic mission – Embassy in Israel and launched strategic partnership cooperation with the country. In conjunction with more deterioration situation in the Middle East region between Israel and Iran either in Syria, Lebanon or in Gaza sector and if Israel starts realize its plan on Air Strategic Offense on Iran in order to suspend its nuclear project, the situation would be strained in the South Caucasus. Hence, alliance conflict could be inflamed with proper ones: Turkey-Azerbaijan-Pakistan vs. Russia-Iran-Armenia. At time being, Turkey is refraining with engaging in conflict scenario with Iran unless the Presidential elections are held on May 14, 2023. However, the regional security current modality: 3+3 (Armenia, Georgia, Azerbaijan as local actors and regional hegemons – Russia, Iran and Turkey) is the only one fragile stability fora but anyway the military confrontation stage is very real to develop;

The Second Scenario – Geoeconomic War between Russia and USA in the region: the scenario and confrontation between two global powers the USA and Russia is very real one and linked with realization of proper geoeconomic projects – Russia promoted “North-South Transit Corridor” from Sankt-Petersburg till Mumbai (India) and the USA promoted also “North-South” Transit Road in case of “Three Sea Concept” with domination in the Black Sea Region. Hence, the Russia-USA geoeconomic war is very real one and could strain the geopolitical landscape in the region. Both powers are confronting to get direct access to China mega-geoeconomic project “One Belt, One Road” with around \$1 trillion. The confrontation line is being dwelled in realization so-called “Anaklia Sea Port” project and the USA also launched its geopolitical game. On March 15, 2023 the Senate adopted new “Black Sea Security Act” where the official Washington declared as its privileged geopolitical zone the Black Sea Basin and submitted the proper strategy how to realize the Act. Hence, the geoeconomic war between Russia and the USA is actually de-facto underway already. The scenario is being developed in real case and who wins the game situation determined.

The Third Scenario – Geoeconomic War between Russia and China in the region: China’s interests toward the region in aegis of the Trans-Caspian Transit Corridor (Middle Transit Corridor) increased since sanction policy imposition on Russia by the Western community that forged blocking the shortest Trans-Baikal Transit Eurasian Corridor via Russian territories connected China to the EU zone as well as blocking also Arctic Maritime Transit Network. Moreover, stiff geopolitical and geostrategic instability in the Persian Gulf and Red Sea basin and blocking the “One Belt, One Road” Maritime project transit capabilities, forced the Chinese political leadership to exploit only remained de-facto real sole Trans-Caspian Transit Corridor opportunities with construction in Anaklia deep-seated port in Georgia and ship

put by land network the cargos and goods via the “Middle Transit Corridor”. The project clashes with the Russia’s own geo-economic project realization “North-South Transit Route” launching from Sankt-Petersburg to Mumbai (India) where the South Caucasus is a lynchpin in realization of the Russia’s project. That is why Russia seeks to set up very near to the Georgian Anaklia sea port, in Ochamchire occupied territory of Abkhazia in Georgia a special naval base. It means that China and Russia will start their own geo-economic war for the domination at the South Caucasus region that could be converted into geopolitical confrontation between the actors.

Conclusion

Moreover, in conjunction with traditional military threats, mentioned above, are coming out on the scene so-called „non-traditional” military threats – international terrorism, drug smuggling and drug cartels activation, aggressive separatism, violent non-state actors, etc. Hence, degradation of the essence of collective security provisions in the Black Sea Region and Basin due to the „New Cold War” confrontation increases tendency multiplying those non-traditional military threats and challenges undermining basis of the regional security and national security of the regional actors and creating „anarchic disorder” modality in the 21st Century. As a result, the Caucasus is a significant location by connecting Middle East to Asia, Central Asia to Europe. Moreover, it has borders with Black Sea and Caspian Sea which are important for energy resources. By the way, it has ethnic and separatist conflicts that effected the development of the region and the Caucasus states’ internal and external policies. The west tried to provide energy without Russia, and Georgia is playing important role for transportation of Caspian oil and gas reserves to the West. Turkey has good relations with Georgia and NATO. On the other meaning, Turkey has bases on its territory against Russia and it provides security of these energy corridor by using NATO’s influence in the region. Thus, the west is directly or indirectly in on the region with a NATO’s member country, Turkey. To provide security, stability, economic stability, democracy, securing energy corridor and existence of Georgia and the Caucasus is important mission for Turkey and the west. So that, Turkey and Georgia have to enough power and policy with regard to security and foreign policy to support stability in the region. The geo-economic and geopolitical importance of a particular region is characterized by long-term economic, management, territorial-spatial, and other factors, as well as their impact on foreign relations and international processes. The Caucasus has always been a zone of interest of many states of Europe and Asia, as well as a cluster of sociopolitical and economic contradictions. The current state of the world is such that more and

more countries are inclined to view the Caucasus as a zone of their interests, which is largely due to the rising need of highly developed states for energy and raw material resources and their interest in international projects aimed at producing and transporting Caspian oil and gas, laying communication lines, building infrastructure, and so on.

The regional security implications are neatly imposed by geoeconomic indications, with its components as are to be:

- *Geoeconomic warfare*
- *Sanctions and embargos*
- *Currency warfare*
- *Asset seizures*
- *Pipeline warfare*

The geoecnomic wars in aegis of the region remain one of the key geopolitical threats sparked with fierce competition of the global power geoecnomic projects with involvement of the regional actors. Russia endorsed and develops its own mega-geoecnomic project „North-South” Transit Corridor (Sankt-Petersburg and Mumbai). The USA exploits and proposes its own version of the „North-South” mega-geoecnomic project also transcended the South Caspian and Caspian Basin but started from Alexanropolis (Greece) and ended up in Mumbai (India). The Chinese mega-geoecnomic project „One Belt, One Road” (OBOR) with \$1 trillion in worth promotes further on „Middle Transit Corridor” route also transcended the Caucasus-Caspian Region. That is why the geoecnombic wars are to be wagging into the following format:

- ❖ *Russia „North-South” vs. USA „North-South”*
- ❖ *USA „North-South” vs. China „OBOR”*

All these above-mentioned factors clearly illustrated how and in which way the “New Cold War” dominates and abrogate fully implementation of the national interests of the regional nations. Namely connotation of “New Cold War” dilemma primarily lead to non-harmonization of the national interests per se nations. As it is known, foreign policy issues typically engage a multiplicity of values and interests that are often difficult to harmonize (12). However, the confrontation modality even in aegis of New Cold War context and being labelled as “Central Eurasian Rimland” land between Eurasian Union and Euro-Atlantic Community could make possible to easy the stalemate via transforming the Caucasus region as “peaceful island” and appease two confronted global powers and alliances – a future forecast how is the scenario is possible to be fulfilled and promoted.

Hence, the Caucasus region as an indispensable part of the Black Sea Area is one of the main factors in the make-up of security and stability in Europe and Asia. In addition to the numerous other issues in the region, ethnic conflicts, ongoing state-building processes, the presence of vast natural resources, and strategic transport and energy corridors mean that the region is an extremely important and sensitive area.

Appendix:

Case-Study of the Regional Instability Scenario: Zangezur Corridor: A Way for the Economic Integration and Impacts on Regional Peace

It is highly believed that through economic cooperation and integration, Azerbaijan and Armenia can open a new page in bilateral relations and end hostility between two states. Foremost, the implementation of the Zangezur corridor will increase the regional economic integration with the collaboration of the region countries including Azerbaijan, Turkey and Armenia. Hence, along with the economic integration amongst the region countries, the new corridor will form the mutual economic interdependence and trigger to shape a stronger foundation for the future peace. One of the significant contributions of the Zangezur Corridor is that it will create new geo-economic conditions in the region. Thus, the Zangezur Corridor envisages not only the opening of the railway routes between Azerbaijan and Armenia, but also the operation of roads, airlines and energy and electricity lines along this transport artery.

The new corridor will boost the development opportunities of the economic markets in the region. Thus, the growth of the trade and economic ties, along with the production, will promote import and export operations between the region countries. The impact of the new corridor on the development of not only transit trade, but also regional trade and production will be of vital significant. Hence, there are products in which all three countries of the South Caucasus specialize, and there is a demand for these products in the countries of the region. As a result of it, the revival of the domestic trade will directly expand the integration of inter countries trade and production in the region. For example, Armenia, which may import oil and gas products, electricity, various agricultural products, etc. from Azerbaijan, will have the opportunity to export metals and a large number of agricultural products and etc. to the opposite direction. Consequently, as a result of the opening of communications, it is more likely to increase the trade volume amongst the region countries, and thousands of new jobs will be created. In the short term, electricity transmission from Azerbaijan to Nakhichevan via the

Corridor, and in the long term and perhaps in the medium term, the transportation of Caspian energy resources to Europe via this corridor may be actualized. Such projects will strengthen regional integration. In the short term, new Corridor will support the economic development of cities and regions along the corridor, which will make a significant contribution to the development of trade and job creation, poverty reduction, youth employment, and the development of small and medium enterprises in the region. In this respect, the project will make a significant contribution to the development of Zangezur region of Armenia and the central city of Kapan, its remote rural areas and the Nakhichevan region of Azerbaijan. In general, the areas where the Zangezur Corridor passes, is considered a dispersed settlement and higher emigration regions compared to the other parts of the region. In particular, it should be noted that one of the main directions and destination of emigration from the region is Eastern Europe and Russia, which is expected decreasing remittances to the region in the future.



Thus, this the corridor becomes important in terms of poverty reduction, too. The “Zangezour transit” route could stipulate more global project. The same rest for the other geopolitical project: “Lazurit Project” (namely with realization of the project was linked realization of Anaklia sea port building in nature) that also geoeconomically pinches Pakistan and India to the region. As for both countries, Pakistan and India despite of their rivalry, separately, they are looking forward to realizing fully the other newly endorsed geoeconomic project: Pakistan-Iran-Azerbaijan-Georgia-EU thus boosting most interesting

geopolitical axes: “South-North”. Quite recently as it is known has been arranged a deal between Iran and Azerbaijan on building of 4 ride bridge with 100 length on river Astarachai as it fastens cargo delivery sevelar times and reaches of turnover in both directions up to 80 million tons annually that more increased EU-Iran trade turnover that is now at rate of \$5 billion (the same rate for EU-Pakistan is \$11 billion and for EU-India is about \$62 billion).

The project is to be a continuation of so-called “Zanzegour Corridor” and promote dialogue among the regional actors. It is clear also that the “3+3” exactly reoriented toward Nagorno-Karabakh conflict resolution and attained common geostrategic provisions sponsored by Turkey and Russia.

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THE SOUTH CAUCASUS GEOPOLITICAL TRANSITION: NEW REGIONAL SECURITY “3+3” FORMAT AND CONTRADICTION WITH NATIONAL INTERESTS

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Abstract

The paper deals with perspective of the regional security development in aegis of the South Caucasus after bipolar era was ended. New realities that entering in frame of the regional security became very sensitive and truly corresponds those ones taking place at global geopolitical level. The South Caucasus region is increasingly becoming a priority on the international agenda. In fact, a regional approach is emerging as actors understand that common problems need to be addressed jointly. Nevertheless, cooperation efforts are hampered by a number of factors, such as uneven economic and political development within and among countries, nationalist forces, and longstanding animosities between regional players. In this context, it is imperative to foster sound policies aimed at strengthening dialogue and cooperation so as to contain and ultimately resolve conflicts with peaceful means.

The purpose of the paper is to be relevantly analysed and evaluated realms of the South Caucasus Regional Security provision and identify who are key promoter of the trend. The Caucasus region was one of the most important region in a lot of ways in the world history. Some features of region such as history, geographical location, ethnicities, and natural resources caused to be arisen powers' interest to the region. On the other hand, Caucasus geopolitical reality should have an identification within its name, location, geostrategic position, history, and ethnicities in international relations. In the early post-Cold War era, it was widely believed that — as a result of the rise of globalization — traditional geopolitical rivalries would be replaced with peaceful collaboration and harmonious economic competition under the umbrella of a “rules-based order”. Such assumption, anchored to the world view of classical liberalism and its intellectual iterations, held that the end of the 20th century would give birth to an era of unparalleled prosperity, everlasting peace and institutionalized collaborative governance (1). The tendency of the trend also promoted

reflection of the concentration of any state's national interests toward regional security direction. Having exploited the research methods of Case-Study and Content-Analysis are possible to completely identify what type of the regional security model is getting relevant to modern system of the South Caucasus regional security.

Key Words: South Caucasus, Cold War, Regional Security, geopolitical realities, Case-Study

Introduction

The Caucasus region as it is known by general geopolitical acronym remains still blatant and noise from exactly the geopolitical standpoint. Generally known that the Caucasus is the name of a mountain range and geographical region that includes the southwest of European Russia, as well as the territories of Armenia, Azerbaijan and Georgia. This region encompasses a two absolutely different part of the areas: South and North Caucasus that make unique opportunity and geopolitical climate of the whole region, labeled as the Caucasus Region. As a result, the Caucasus faces its own distinct geopolitical realities that could become even more important given talks of a new Cold War. Due to the transformations taken place in the region, including submission several regional security modalities, like: 3+3+3, 3+2+2, 3+1, etc., the double approach foreign policy paternity obliterated the region. As it is known, according to Russian geopolitics school approach, well-received by the Foreign Affair Ministry of Russia, the region geopolitical identification prescribed as “Transcaucasus” (or “Zakavkazie”) and the term was exploited and underpinned in the “National Security Concept of the Russian Federation” adopted in 2015. As for the Western approach (the USA and the EU) the region geopolitical identification means “The Caucasus-Caspain Region” (the term was composed and delivered to political lexicon by the Caucasus Committee in 2006) or even “Central Caucasus” meaning that the “East-West” geopolitical axes is prevail with inclusion of the Caspian Basin abundant energy reserves where the Caucasus region is an indispensable “energy corridor” and geopolitically attached to the Caspian Basin. Hence, due to ongoing “New Cold War” run between the USA and Russia where the EU is a strategic partner to the USA (for the special case with exclusion of Turkey which is gambling that different game pursuing only its own national interests), the geopolitical battle and incacuration of term provision has become very important. Therefore, the regional initiatives provided recently by the regional hegemons – Russia and Turkey and even promoted its further development that was hold in Ankara working official meeting between Turkish and Russian diplomats with its prolongation in Moscow on 9-10 December 2021, ideally demonstrated that the

pro-Russian “Transcaucasus” regional identification is being modelled by the two capitals. As it was mentioned, the first session of the “3+3” regional consulting platform was held in Moscow today, the Russian Ministry of Foreign Affairs reports. Participating in the meeting were the Deputy Foreign Ministers of Russia, Armenia, Turkey, Azerbaijan, as well as the Director General of the Ministry of Foreign Affairs of Iran. The so-called “Moscow Summit” meeting was aimed to discuss prospects for the development of multilateral regional cooperation and creation of favorable to the parties’ atmosphere of geopolitical and geoeconomic matters. It seems possible that some concrete project outlines also were discussed, for instance, promotion of so-called “Zangezour Trade Corridor” attained geoeconomic goals and missions of Turkey and Azerbaijan and neatly supported by Russia and Armenia. Moreover, at the “Moscow” meeting an agreement was reached to focus on the practical issues that are of interest to all participants. These include confidence-building measures, cooperation in the trade, economic, transport, cultural and humanitarian spheres, and response to common challenges and threats. In addition, the parties also reconsidered of installation of special institutional provision to further promote the “3+3” platform and create an organization for the regional security fora.

The Caucasus Region Geopolitical Identification: Ideology vs. Reality

As it is known, the Caucasus is the name of mountain system and the geographical region that including southwest of Europe Russia with territories of Georgia, Azerbaijan and Armenian. This region includes 440.000 km² area between Caspian Sea and Black Sea and the population in 2000 was approximately 30.6 million persons (2). It means that the Caucasus has its own geographical configuration and contains for sure its own geopolitical identification that becomes more vital in aegis of New Cold War game. According to some scholars and researchers, the Caucasus geopolitical landscape could be outlined as regional structuring modality in the following manner:

- 1) ***The Central Caucasus, including three independent states – Azerbaijan, Georgia and Armenia;***
- 2) ***The Northern Caucasus, consisting of the border autonomous state formations of the Russian Federation;***
- 3) ***The Southern Caucasus, including its of Turkey bordering on Azerbaijan, Georgia and Armenia (Southwestern Caucasus) and the northwestern ostan of Iran (Southeastern Caucasus)(3).***

In addition the Caucasus geopolitical identification has coined with contemporary integration incentives and modalities despite of having being

indicated deep political and military conflicts sheltered the region and obstructing the regional security at large (for instance, Russia and Georgia de-jure warfare and Armenia and Azerbaijan de-facto wargame scenarios) that promote a trend toward reaching stability and resilience in the region. The incentives are to be grouped into the following manner:

- ❖ *The Caucasian Home* models, incorporating the autonomous the republics of the Northern Caucasus (there is also the viewpoint that these autonomous republics should participate in this integration model as independent actors) and independent Caucasus states;
- ❖ Models uniting the independent Caucasus states – Azerbaijan, Armenia and Georgia;
- ❖ The “3+1”model, uniting the independent Caucasus states and Russia;
- ❖ Sub-global models, incorporating the three independent Caucasus states, three regional hegemons and global powers and international organizations (3+3+2);
- ❖ Modern regional security modality implies “3+3” with involvement local actors and local three regional hegemons (4).

Despite of the integration provision that has its own historic root, considering “Natural Independence” period of 1917-1922 before “Sovietization” of the region, it is important to reckon bipolar division of New Cold War applications shaping up the regional security. Certainly, Russia-American confrontation at the regional level is being configured not only in aegis of military, political, economic, information and psychological features but what is surprisingly even linguistically and is possible to introduce a jargon “geopolitical neo-linguistic” affiliation. Namely, the bipolarity context of “geopolitical neo-linguistic” competition between the Russian Federation and the USA is seen in nomination of the Caucasus from foreign policy implications and approaches that is also differentiate national interests of the national policymakers. The terms "Transcaucasus" and "Transcaucasia" in Western languages are translations of the Russian "Zakavkazje" meaning "The area beyond the Caucasus Mountain Range". It should, however, be pointed out that the term "Transcaucasia" is so widely spread in international usage that, obviously, a certain period of time is needed for the latter term to be replaced by the correct "South Caucasus", Russ. "Juzhnyi Kavkaz" (5). It means that both jargons “Transcaucasus” and “South Caucasus” belongs to Russia’s foreign policy lexicon terms and coincided with Eurasianism doctrine application that is still in usage in official documents of the Russian Federation, like “Foreign Policy concept of the Russian Federation” adopted in 2016 (6) (see in detail Attachment №2).

On the other side, there is the other approach from the American or Atlanticism point of view regarding identification of the geopolitical modality of the Caucasus region. A special institution was created in order to adopt new geopolitical identity “Caucasus-Caspian Region” in order to promote the USA national interests in the area. The institution name has been also reflected the original name of the proposed regional merits – The Caucasus-Caspian Commission. The commission has outlined the following: “The Caucasus Caspian space is not a precisely defined region either geographically or politically. In preparing this report the Caucasus-Caspian Commission has decided to look at three concentric circles: inner core, outer ring and global circle” (7) that is defined the geopolitical applicability of the region to World Politics. Moreover, another term was introduced “Central Caucasus” - consequently, linguistically too, the concept “the Central Caucasus” is more in tune with Central Eurasia and Central Asia than the concept “the Southern Caucasus”(8). Hence, it is true that contemporarily the geopolitical dilemma in the Caucasus region could be regarded as:*Eurasianism vs. Atlanticism*.

The dichotomy remains important case where new type of ideological trend – foreign policy ideology is considering as vital factor in promoting national interests any actor at regional level. Georgia has skipped the meeting despite of being invited to the meeting. As for Georgia, the representatives of the five countries expressed interest for Georgia to join the platform, noting that the door remains open. However, it is less probable that Georgia would take part in the format as its foreign policy orientation prescribed in the article 78 of the Constitution of country adopted in 2020 is making impossible of such participation (the Article implies irreversible foreign policy goals achievement in membership in NATO and EU structures). Moreover, Georgia earlier proposed its own regional security format “3” (with participation of all three local actors: Azerbaijan, Armenia and Georgia) and that is precisely fitted in aegis of the Western identification of the region as “Central Caucasus”. It is very clear that the Georgian approach to the regional security format absolutely unfitted to the other actors and evermore contradicts their interests. It seems so that key regional hegemons: Russia, Turkey and Iran are eager to block any entrance to the region of other global and regional hegemones, like USA, the EU and maybe in some extent even China. The modality of the regional security is indeed oriented toward East and by its geostreategic provision has so-called “orientalist” provision and with aiming of create new kind of geopolitcal axes: “MENA-Transcaucasia-Central Asia” with partially incursion as well as South Asia as India and Pakistan are also seeking to pursue their interests to the “geopolitical triangle”. Namely, Pakistan has joined the tripartite military alliance: Azerbaijan-Turkey which was formed in November 2020 due to the Karabakh war consequences and Pakistan has also been participating in

the project: “One Belt, One Road” launched by China and promoted the “oriental Silk Road” perspectives toward the Caucasus region. The same rest for the other geopolitical project: “Lazurit Project” (namely with realization of the project was linked realization of Anaklia sea port building in nature) that also geo-economically pinches Pakistan and India to the region. As for both countries, Pakistan and India despite of their rivalry, separately, they are looking forward to realizing fully the other newly endorsed geo-economic project: Pakistan-Iran-Azerbaijan-Georgia-EU thus boosting most interesting geopolitical axes: “South-North”. Quite recently as it is known has been arranged a deal between Iran and Azerbaijan on building of 4 ride bridge with 100 length on river Astarachai as it fastens cargo delivery several times and reaches of turnover in both directions up to 80 million tons annually that more increased EU-Iran trade turnover that is now at rate of \$5 billion (the same rate for EU-Pakistan is \$11 billion and for EU-India is about \$62 billion) (9). The project is to be a continuation of so-called “Zanzegour Corridor” and promote dialogue among the regional actors. It is clear also that the “3+3” exactly reoriented toward Nagorno-Karabakh conflict resolution and attained common geostrategic provisions sponsored by Turkey and Russia. Hence, the regional security format “3+3” is joint Turkish-Russo project and has also correlations with adjustment of the common geopolitical interests in the Middle East in aegis of Syrian crisis. Therefore, linkage between Nagorno-Karabakh conflict with the Syrian one is predominantly evident due to the Turkish-Russian cooperation perspectives. Therefore it is interesting too that despite of neglecting the initiative from Georgia, the format meeting organizers intentionally remained title as “3+3” and is meant that Georgia is being geopolitically blackmailed and the regional hegemons would be promoting the idea and lobbying with the Georgian government that is on its way has slight clashes with the Western strategic partners on case of internal politics (for example, USA and the EU sharply criticized Georgia on performing unilaterally the court system reform that is unacceptable for those actors from their geopolitical approaches). Nevertheless, Georgia could consider how to join format in future, however at time being there are several reasons to take into consideration why it is not possible to do it:

- 1) The format is unbalanced from the Georgian foreign policy perspectives thus ignoring completely the Georgian allies interests, namely as of the USA and NATO (10);
- 2) Georgia is lost its status-quo in meddling as mediator to conclude a deal in Nagorno-Karabakh conflict;
- 3) Georgia’s geo-economic privileges due to its current geopolitical status-quo could be diminished and Georgia could be traced into the “periphery” at the regional level;

4) Georgia cannot present at highest diplomatic scene with Russia unless the national territories are under occupation and Georgia has broken off political and diplomatic relations with Russia.

It seems that these are main factors not mentioned others why Georgia avoided and canceled the invitation to join the format. Due to the real political conditions the format is executing de-facto in that format where Georgia reinforces its ties with Russia with economic and trade interactions and seeks to exploit more balanced foreign policy provisions. In nearest future is very possible that the contemporary the South Caucasus Regional Security shifted drastically and new format emerged.

Conclusion

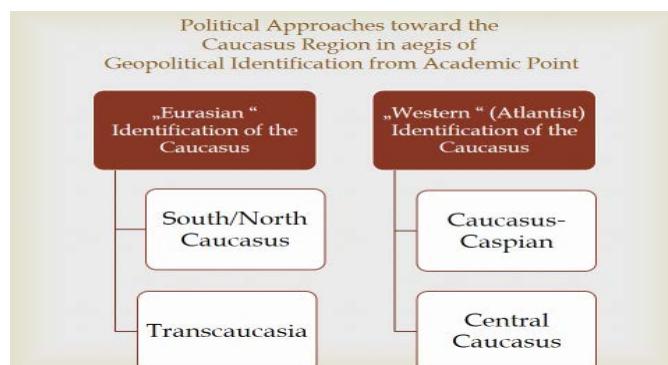
It is clear indication that due to the shifts in contemporary international relations, several challenges and difficulties created at the regional level and the South Caucasus is not an omission. The regional security complexities that been developed in stable manner in time of the Cold War period, after the one transformed into more dynamic and transcended systems of the regional security systems. The geo-economic and geopolitical importance of a particular region is characterized by longterm economic, management, territorial-spatial, and other factors, as well as their impact on foreign relations and international processes. The Caucasus has always been a zone of interest of many states of Europe and Asia, as well as a cluster of sociopolitical and economic contradictions. The current state of the world is such that more and more countries are inclined to view the Caucasus as a zone of their interests, which is largely due to the rising need of highly developed states for energy and raw material resources and their interest in international projects aimed at producing and transporting Caspian oil and gas, laying communication lines, building infrastructure, and so on. It made difficult to make any changes in contemporary regional security system “3+3” that already created as the clandestine provision to settle conflict spots in aegis of the region and getting adjusted national interests of the involved actors.

Appendices:

Attachment №1: Picture-map: “South-North” Geoeconomic corridor and its provision



Attachment №2: The Modern Geopolitical Map of the Caucasus Regional Security



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KING SOLOMON'S MINES. (ON THE QUESTION OF METAL DEPOSITS IN ANTIQUITY)

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Annotation

The article is devoted to the analysis of the route along the continuous waterway from the Hyrcanian Sea to the Red Sea – Israel. The geomorphology of the Caspian region up to the end of the period of antiquity, consisting of three separate basins, is considered: the Northern Caspian – Ocean, the Middle Caspian – the Caspian Sea and the Southern Caspian – Hyrcanian Sea. The possibility of a sea route for Solomon's ships to the mountains of the Greater Caucasus – to the country of Ophir for gold – is substantiated. The author offers his own interpretation of ancient history, based on ancient written, paleogeographic and archaeological sources.

Key words: Caspian Sea, Atlantic Sea, Sargasso Sea, Ethiopians and Indians in the Caucasus, the country of Ophir.

Metal mining in antiquity.

Acquaintance with metals came from the East. The concept of the word "metal" has its roots in ancient Greek and Latin. The origin of the word "metal" is derived from the Skrit word "मेध्य" (médhya), which has several meanings: "suit", "clay" or "fat", "valuable metal", "submission" [19]. The origins of the name of metals from India in the Caucasus [35, p.151] indicate a wide extraction of metals in ancient times in this region.

The presence of gold on the mountains of Ripa, Meru and Khara Berezaiti, corresponding to the Greater Caucasus [35, p.69], is noted in the sacred texts of the Indians and Persians, in ancient sources. The Zoroastrian "Book of Creation" ("Bundahishn") speaks, for example, of one hundred thousand golden channels through which water flows into the lake on the highest peak of Khara" [7, p.35]. Similar testimonies are also found about Meru and the Ripes. Ancient authors wrote about the Caucasian tribes (Svans) extracting gold from the river with sheep skins. Strabo, describing the Massogaetes near the Araxes and the Hyrcanian Sea, noted the abundance of gold among them: "in battles they wear gold belts and the same bandages. Their horses are golden-bridled and in golden shoulder pads. They have no silver at all, little iron, and copper and gold are in abundance" [21, 390].

It was believed that in the time of Homer and before him, tin was brought from India (in the Caucasus - author's note) or Persia. It was assumed that Greece borrowed its knowledge of tin from India. Tin is called kastira in Sanskrit and κασσίτερος in Greek, but the syllable "kass" is typically Celtic. "The word "cassiterides" in Celtic originally meant nothing more than "very distant islands" [36, p.124]. The path to the Casterid Islands beyond the Pillars of Heracles in the Atlantic, to Tartes, leads to the west. However, in ancient times, seafarers and merchants carefully hid the routes of their voyage. This, in fact, was the route of the navigators in search of metal.

L.A. Elnitsius noted that both Hyginus (Fab., 274) and Cassiodorus (Cassiod, III, 31) attribute the discovery of tin to the semi-mythical Phrygian (a

descendant of Bhrigu – Inda) king Midas. «... Pliny's account can be interpreted in the sense that the voyages of the Greeks of Asia Minor to the west for tin date back to the era of Phrygian power. However, this legend could also refer not to the western, but to some north-eastern sources of this metal, which the Phrygians traded in the VIII-VII centuries BC" [16, pp.43-50].

The route of the navigators for metals includes descriptions of the Atlantic Sea, the Sargasso Sea. The appearance of gold in Israel under King Solomon is explained by its extraction in Ethiopia. However, ancient authors speak of the location of Ethiopia in the East. Where was Ethiopia, from which the Queen of Sheba came? What did it mean to sail for tin in the Atlantic Ocean to the Casterid Islands?

Atlantic Ocean.

In the 1st millennium B.C., the waters of the Caspian Sea flooded two-thirds of the Caspian lowland in the north, north-west and north-east, the valley of the Volga and Akhtuba (up to Volgograd)" [23, 143]. N.S. Muravyov's calculations of the level of the Caspian Sea fit into the Scheme of the "Earth Circle" of Honorius [27, p.290], about the location of the Caspian Sea at the junction of the Northern and Eastern Oceans. Nikolaeva N.A. in her work "On the Concept of the Four Ancestors of the Indo-Europeans" (25, p.58) noted that the Northern Caspian Sea merged in the north, north-west and north-east with the water space formed by the melting of glaciers (the ice sheet descended below the Baltic Sea) which began about 10,000 years ago. The Greeks called it Oceanus. Stephen of Byzantium in his work "Description of the Tribes" gives another name for the Ocean from which the Caspian Sea is formed – the Atlantic Sea. "The Caspian Sea; from it come the names: the Caspian, the Caspian Mountain, the Caspian Men, the Caspian Country and the Caspian. The Caspian Sea is also called the Hyrcanian Sea: some, however, distinguish between these seas: the outer sea is called the ocean by the majority of barbarians, the inhabitants of Asia – the great sea, and the Hellenes – the Atlantic Sea" [21, p.830]. To the many names of the Northern Caspian: the Northern, Eastern, Serian Oceans, the Great Sea, etc., is added the name given by the Hellenes – the Atlantic Sea. This is how the inhabitants of Asia, the "barbarians" and the Hellenes called the same basin differently – the Northern Caspian, connected with the northern rivers. The Hellenes called the water in

the north of Europe the Northern Ocean. The Hellenes called the water area northeast of the Mangyshlak rapids the Atlantic Sea.

Strabo (VII, 2, 4) spoke about the unknown geographical boundaries of the northern part of the Eurasian Ecumene and about the proximity of Pontus and the Atlantic Sea. «.... the countries beyond the Albis by the ocean are completely unknown to us. We do not know of anyone who has previously sailed along these shores to the eastern countries stretching as far as the mouth of the Caspian Sea. ... Exactly the same uncertainty prevails with regard to the other northern countries that lie farther away: for we know neither the Bastarnae, nor the Sauromates, nor in general anyone living above Pontus; we do not know how far they are from the Atlantic Sea, nor whether they are in contact with it" [21, p.364]. Only the basin of the Northern Caspian Sea (the Atlantic Sea) could come into contact with "those living above the Pontus", and not with the modern Atlantic Ocean.

The Caspian Sea, according to ancient Ionian ideas, was located at the end of the earth, beyond which the ocean flowed around the earth, i.e. "where the border of the earth is" according to Hesiod. Atlas (after whom the sea is named) was exiled to the Mangyshlak rapids, not far from his brother Prometheus, chained in the Caucasus mountains.

"Atlas holds, forced to do so by a powerful inevitability,
On the head and hands of the tireless the wide sky
Where the border of the land where the singers live Hesperides,
For such a fate was sent to him by Zeus the Provident."

[Hesiod, Complete Collection of Texts, Works and Days, transl. by V. Veresaev., p.37]

The ancient geographical tradition, often dressed in a mythological veil, saw in the Pillars maintained by Atlas natural objects (mountains, islands) "enclosing the natural limits of the ecumene (Strabo III.5.5). In this regard, it is noteworthy that Dionysius Periaegetes mentions the Pillars of Dionysus on the eastern border of the ecumene" [14]. The pillars could have been rocks on both sides of the strait along the Paleo-Volga channel through the Mangyshlak rapids. Constant fogs near the Northern Caspian Sea created the appearance of the edge of the world, where earth and sky are united. On the Mangyshlak

rapids there was Atlas, exiled by Zeus, who held the sky on his shoulders - clouds, fogs.

Navigators noted the Sargasso Sea near the islands with tin deposits.

- there are no wind currents to drive the ship;
- the bottom of the sea is not very deep here, and the shallow water barely covers the ground;
- Darkness dresses the air as if it were some kind of garment, always a thick fog hangs over the abyss, and gloomy days do not disperse the clouds over it. (Avien, The Shores of the Sea, verses 387-389) [3, p.330].

The Sargasso Sea is marked on ancient maps near Meotis - "starting in the Northern Ocean, it flows into the Meotis, next to the ethnonym Seracoe" [13, p.160]. The description of the Sargasov Sea and the Atlantic Sea corresponds to the shallow depth of the Kuma-Manych depression and the Northern Caspian.

The country of Ethiopians. "settled in two ways". One of the most exciting legends of gold mining is woven with the legend of the love of King Solomon and the Ethiopian Queen of Sheba. Where did the Ethiopians live? To which group of peoples did they belong?

Aeschylus in "Prometheus Chained" notes the Ethiopians living in the east: "a tribe of blacks near the morning Lives the dawn." Homer in the Odyssey gives a version of the Ethiopians, "settled in two ways":

"But at that time he was in a remote country of the Ethiopians
(The extreme people, who are settled in two ways: one, where he descends
The light-bearing God, others, where He sprouts)"

Strabo (Book I, ch.2.24) repeated Homer's opinion about the Ethiopians: "He believes that there are two peoples of the Ethiopians..."

Ethiopians in the north-west of Persia.

In the 5th century BC, Herodotus (Book VII., 70), reporting on the tribes in the army of Xerxes, also notes the location of the Ethiopians in the east and their proximity to the Aryan tribes. Herodotus (Book Three, Phalia, 94)

mentions the people of the Paricans and the Asiatic Ethiopians in the seventeenth district of the Persian Empire. According to Dyakonov, these are the inhabitants of the kingdom of Manna. [15, pp. 248, 338, 447]. Melikov R., comparing the ethnonyms of the Paretakens and the Parikanis, also localizes them in Southern Azerbaijan. Consequently, the so-called Asiatic Ethiopians lived in a nearby territory, in the same district. [1, p.69].

Nearby, in the eighteenth arrondissement, Herodotus places: Mathien, Saspeir, Alarodii. In the Lesser Caucasus, not far from Media, Herodotus (Book III., 94). He places India: "The Indian people, the most populous of all those known to us, paid the largest tax in comparison with the rest, namely, three hundred and sixty talents of golden sand; This is the twentieth arrondissement".

Herodotus notes the "Ethiopians bordering on Egypt", separating them from the "long-lived Ethiopians" who occupy the region of Nysa in the neighborhood of the Indians and together bring tribute. Here he writes about the Colchians. (Book III, 97) "The following peoples were not at all taxed, but made voluntary offerings to the gifts: the Ethiopians, bordering on Egypt, who were subjugated by Cambyses during his campaign against the long-lived Ethiopians; they occupy the region of Nysa and hold festivals in honor of Dionysus. These Ethiopians, as well as their neighbors, sow the same seeds as the Kalantian Indians, and they live in underground houses. Both these peoples together brought gifts every other year, and still do, two henics of native gold, two hundred ebony trunks, five Ethiopian boys, and twenty large elephant teeth. The Colchians also imposed voluntary offerings on themselves, as did their neighbors to the Caucasian Range..."

Herodotus clearly distinguishes between the Asiatic Ethiopians in northwestern Persia and the Ethiopians near Egypt. «... the Ethiopians bordering on Egypt" made voluntary offerings to the Persian king, and the Asiatic Ethiopians, in the seventeenth district, "paid four hundred talents of tribute." Moreover, the Ethiopians and Indians brought tribute together in the form of golden sand, because they lived next to each other near Media. This indicates large reserves of this metal in the Lesser Caucasus. This gold was brought by the Queen of Sheba as a gift to King Solomon.

In 1864, N.O. Emin put forward a hypothesis about the Ethiopian origin of the Kushans, "comparing the African Kushites of the Achaemenid inscriptions with the name "Kushans". [31, p.132]. Consonant with the Kushans

and African Kushites, the tribes of the Hephthalites – Ethiopians, were located by ancient authors in the Caspian region. The Iranian group of ethnic groups – Persians, Parthians, Chionites, Alans, Hephthalites (Asian Ethiopians) – were Aryans of Indo-Iranian origin. Therefore, in a number of paintings, the Aryan queen - Ethiopian is depicted with white skin.

Chionites, Kidarites (Kushans) and Hephthalites in the Greater Caucasus Mountains.

According to one of the theories, the main population of the Greater Caucasus came from the south, from "Assyro-Babylonia and Mesopotamia and the Asia Minor countries adjacent to them from the north and west" [19, p.20]. In a Syrian source (Life of Peter Iberus), the "White Huns" are noted next to the Iberians, with the help of whom "Farsman reigned over the Iberians." Latin and Syrian sources called the Chionites, Kidarites, and Hephthalites "White Huns". The same group of tribes included the Kadusii-Kudishai living in Nisibis."Taking into account the identity of the Caspices with the Cadusii, the Nisibine Cadusii, as well as the Chionites and Hephthalites, can be considered the successors of the Hyrcanian Cadusii or the Caspians" [29, p.131]. In the Greater Caucasus, the "White Huns" living "next to the Iberians" (Iberia) were considered "the successors of the Hyrcanian cadusii or the Caspians". As I.G. Aliev noted in his "History of Media" (p.104), the ethnonym "cadusia" was common to several related tribes, including the Gels and Legs. It was suggested that the peoples of the Lezgin group originated from India and Iran [19, p.20].

In the time of King Solomon (10th century B.C.), a lot of gold, silver, tin, and lead were exported from Tarshish (Tarshish) (I Sam., 10:22; 22:49; Jeremiah, 10:9; Ezek., 27:12). Tarshish or Tarshish is considered in the well-known genealogical table of peoples to be the second son of Javan (Javan, the grandson of Japheth). Javan, together with his sons, Tarshish and Elisha, are traditionally considered the ancestors of the Greek tribes (Gen. 10:4; I Chron, 1, 7). [44], [43]. Mythological and biblical tradition leads us to the Caucasus Mountains, where the ship of Noah, the father of Shem, Japheth and Ham, landed. Tarshish is consonant with the name of the river Phashish. The capital of the Colchis king Aeetes (Koteia - Kutaisi) was on the Phasis (Rioni) River, where legends preserved the memory of the Golden Fleece.

Solomon had a "ship of Tarsis," which once every three years, together with the ship of the Tyrian king, Hiram, went to Ophir for gold, silver, and so on. (I Kings, 10:22 = II Chron., 9:21). [44]. According to the Fragment (I Sam., 22, 49), Jehoshaphat built "the ship of Tarshish" to sail to Ophir [44]. What is the country of Ophir, where Solomon's ships sailed, the route to which is shrouded in mystery?

The country of Ophir.

Titan Gods and gods born of Cronus:
Glorious Titan gods - from the highest Ophrian mountain,
The gods born of Rhea the fair-haired by Cronus,
The givers of all blessings — from the tops of the snowy Olympus.
[11, p.39].

What is the "Highest Mount of Ophria" where the "Titan Gods and gods born of Cronus" come from. Pliny's work "Natural History" mentions the Lag River near the Caucasus Range, into which the Ofar River flows, where the Ofarite tribes live (VI, 21).

«... from the Katei Mountains (flows) the river Lag, into which the Ofar flows; ... there are the tribes of the Opharites." The Ofar is a tributary of the Lag River; The Opharites were a tribe that occupied the Gorge of Ofar. These names are consonant with the name of the river Lik and the tribe of Ofr, the name of the Katei Mountains is consonant with the Kitei Mountains. In the name of the Colchis Kit or Kitei there is an echo of the name Kutaisi. Kutaisi, translated from ancient Georgian: Aya, Kutaia, Koytaia. The city of Eeta-Eya was located not at the mouth of the Phasis, but inland along the Phasis River (Tarsis, Tarsis near modern Kutaisi). The connection of the Caucasus Mountains with the Titans can be traced in Apollonius of Rhodes, "The Campaign of the Argonauts". "131 "Far from the Titanic land"]. The river Titan, from which the country was called Titanic, is mentioned by Eratosthenes in his Geography. The river Lycus, rushing from the Araks, joins the Phasis and, thus losing its own name, flows into the sea..." [21, p.278]. Perhaps this reflects the knowledge of the Homeric era, when Phasis was depicted flowing into the Ocean (through a system of tributaries it was connected with the Kura, flowing into the basin of the Southern Caspian. Apollonius concretizes the description of the Titanic land, placing it not so far from Colchis, since the hiss of a dragon was heard

when he saw the Argonauts approaching. «IV, 131—135. Lik River. The hissing of the dragon was also heard by those who lived very far from the Titanic Aea in the Colchis land at the mouth of the Lycus, which, deviating from the noisy river Araks, merges its sacred waves with Phasis; both of them, uniting into one river, flow into the Caucasian Sea" [21, p.274]. The Caucasian Sea is the Caspian Sea, and the Hellenes called the Black Sea Pontus. The territory of the Opharites is the Titanic land, where the Ofar River flows into the Lik River (Big Liakhwe) further into the Kura, which connects with the Araks. In the South Ossetian Nart epic "Song of the Heroic Women of the Narts", armed girls fight with giants-uaigs (avtarons). [37, p.32]. The giants of the "seven mountains" (seven five-thousand-strong peaks of the Caucasus), the Uaigs from the Avtaron tribe, have consonances with the names Avars, Obrs, and Abaras, who live along the Ofar (Ofra) River, which flows down from the Ophrian Mountains. The country of the Opharites (Ophir) was located in the mountains of the Greater Caucasus near the tributaries of the Phasis (Tarshish, Tarsish).

"Titanic land" of OBRs (OFRs).

According to the chronicle "Kartlis Tskhovreba" by the ancient Georgian historian of the XI century Leonty Mroveli, all the Caucasian peoples descended from Torgam, the great-grandson of the biblical Noah (Nukh), the grandson of his son Japhet, who had eight sons, each of whom laid the foundation for one of the peoples of the Caucasus. One of the eight, Lekos, was considered the common ancestor of the peoples of Dagestan. In ancient sources, the country of the leagues is noted. Pyotr Uslar identifies the ancient Leks with the modern Lezgins: "The Lezgins, Ligas, and Leks gave their name to the mountain range separating the Kura basin from the Rion basin. Colchis was sometimes even called by poets Lyistica, i.e., the land of the leagues. It is very likely that the leagues of which Herodotus speaks were Lezgin natives" (based on the book by P. K. Uslar, The Oldest Tales of the Caucasus, Tiflis, 1881, pp. 539-540). [19, p.31]. Strabo, Pliny, Ptolemy, Plutarch and others report that in the first millennium BC Scythian tribes lived on the territory of Northern Azerbaijan and the south of Dagestan - Leks, Gels, Didurs, Caspians, Garagari, Kadusii, Albans, Utii, etc. From them were born the baramizhi and Lezgins, who live in gorges and ambushes" [19, p.20]. Georgian sources note in Hereti

"the king of leko Ipajaja" or "the leader of the Leks, born in the Khuzan and sorcerer", who is identified with "Khozonik of the Lekan clan". For example, the "leader of the leks of the huzankh" can be considered a Persian marzban of Chionite origin. The Ksani eristavs were erected to them, who, relying on the "lexic" army, opposed the Georgian kings. The Chronicle of the Ksani Eristavs calls these Goliaths (Jalut Rostam) settled in the Isroli Pass "Bibilu" and speaks of the large buildings-houses that they erected. Bibilu corresponds to the old name of Jara in Vakhushti, Pipineti, and Mount Pipan in this area. [30, p.133]. It is possible to assume a connection between the origin of Zeus from the Ophrian Mountains (Greater Caucasus), Mount Pipan and the name of Zeus by the Scythians - Papai [9, IV.59]. Called "Goliaths" (very tall people), the inhabitants of the Avar Jar, descendants of Lekos and Khozonik on the border of Dagestan and Georgia, who build large houses, remind of the Titans in the Titanic land in the poem of Apollonius of Rhodes about the Argonauts. The existence of the Titans in Colchis is noted by Apollonius of Rhodes. "11. ARGO or EET. You also see Aeetes on quadruplets, huge and [exceeding all men], clothed in military armor, I think, one of the giants, for their supernatural size leads us to suppose so; his face burns with anger, he almost does not throw fire from his eyes; with his right hand he shakes the torch, threatening to burn the Argo together with the swimmers, and the spear stands ready at the rim of the chariot" [21, p.711].

"In the 6th century, the "pseudo-Avars" ("Varhuns") came to Europe through the Northern Caucasus - a nomadic people from Central Asia of "proto-Mongol-East Iranian origin, who absorbed a certain number of the so-called "Sino-Caucasians" of the road [40]. Here the state of the Avar Khaganate (VI-IX centuries) arose. The name Avara means obry in Russian. [41]. Lev Gumilev noted that: "The true name ab ap is not avars, but abar – obry" road [12, pp. 129-140]. Theophylact Simokattus and Menander believed that the European Avars were not real Avars; They were Turks, but "they took the name of Avars in order to instill fear in other peoples" Dorog [24, p.303]. Why would numerous nomadic tribes take on the name of a small tribe? The answer is given - "to inspire fear". And they inspired fear with their strength and great height. In the "Tale of Bygone Years" the chronicler wrote: "The cliffs were great in body, but proud in mind, ..." [42]. The country of Ophir, where the Titans lived - the Obrs (Ophras) has a certain geographical landmark: the Titan

River, the Lycus River, the country of the Ligas, the mountain range separating the Kura basin from the Rion basin, around which the descendants of Lekos lived: modern Lezgins, Laks, Avars, as well as Japhetic and Semitic tribes. In general, the name of the country Ophir was transferred to the entire Caucasus region, where the Queen of Sheba was from. The "White Huns" (Chionites, Kidarites (Kushans) and Hephthalites - Ethiopians) lived "next to the Iberians" (Iberia - Eastern Georgia). With the help of the "White Huns", called "Goliaths" (very tall people) descendants of Lekos and Hosonich, "Farsman reigned over the Iberians". "Ethiopians in the Atlanta River". Dionysius Periegetes reports about the gold mining by Ethiopians (Chionites, Kushites, Hephthalites) on the islands of the Mangyshlak rapids - in the "Atlas Current". "On the bull-abounding Erithia, which [lies] in the course of the Atlantean, dwell the pious Ethiopians, the glorious sons of the Macrobii, who once came here after the death of the indomitable Geryon. And beyond the Sacred Cape, which is called the "peak" of Europe (beyond the Caucasus – author's note), rich descendants of the glorious Iberians (eastern Georgia – author's note) inhabit the Hesperides Islands – the place of tin mining" [14].

Dionysius Periegetes notes in one geographical region: the island of Erithia, the pastures of the bulls of Geryon, the Caucasus, the Iberians on the islands of the Hysperides, where tin is mined. Both the island of Erithia and the islands of the Hesperides in the Northern Caspian Sea - the place of tin mining - are the places of the exploits of mythical heroes, located in the northeast of the Ecumene known to the Greeks. Dionysius' singling out the Ethiopians who came to the islands in the Northern Caspian Sea allows us to take a different look at the legend of King Solomon and the Ethiopian Queen of Sheba. In the Greater Caucasus, the "white Huns" - the Ethiopians lived near the Iberians and at the end of the II millennium BC (after the campaign of Hercules and the death of Geryon) came to the islands of the Mangyshlak rapids ("during the Atlant" - Volga). The Iberians settled nearby on the "islands of the Hesperides - the place of tin mining".

Geographical realities of the Caspian Sea in antiquity.

According to the calculations of S.N. Muravyov, "at the level of the Caspian Sea below -38 m abs. the entire Northern Caspian could be completely

separated from the Middle Caspian by the Mangyshlak rapids" [23, p.129]. In the third century B.C., the Sarmatian tribes penetrated along the Mangyshlak Poroog "to the Mangyshlak Peninsula and the Ustyurt Plateau, where they left their stone statues" [8, p.95]. From the Caucasus to Mangyshlak passed "followers of Zoroastrianism, who built here the Dakhma (Tower of Death)" [28]. Archaeological artifacts found in 1957 on the island of Kulaly indicate the possibility of the existence of the land Mangyshlak rapids. In Pahlavi literature, Kangdej (Khorezm) appears as a place of settlement of the Iranians "after they crossed the "sea" of Voorukash" [5, p.2.3]. The Voorukash Sea is a basin of the Middle and Northern Caspian. It could be crossed along the Mangyshlak rapids. A. E. Astafiev and E. S. Bogdanov put forward a version of the route of the Huns in 421 with Vasikh and Kursikh "along the land "bridge" - the Mangyshlak rapids. [6, p.34] According to ancient sources, the Caspian Sea was divided by the land Mangyshlak and Absheron rapids. The Northern Caspian Sea is an integral part of the "ocean"; Middle Caspian Sea – Caspian Sea; Southern Caspian Sea – Hyrcanian Sea. [35] A map of the early 18th century (Fig. 1)

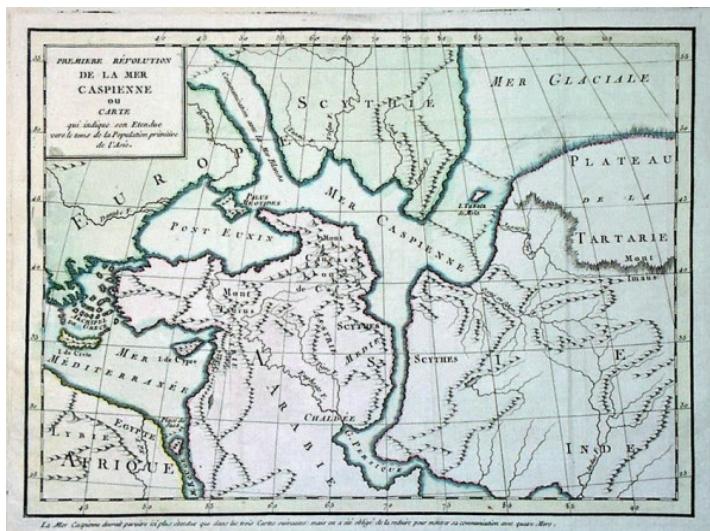


Fig. 1. <https://mislpronzaya.livejournal.com/389481.html>

called "Premiere revolution de la mer Kaspienne" ("The first revolution of the Caspian Sea"), the original of which is kept in the university library of the

Swedish city of Uppsala, demonstrates a number of mysteries. On the one hand, it connects the Caspian Sea with the Baltic Sea and further with the Atlantic. On the other hand, a detail of the map is a strange channel from the Caspian Sea to the Persian Gulf (Fig. 1).

The connection of the Caspian and Black Seas with the Western Ocean was already known to ancient historians and geographers. In particular, Adam of Bremen in his work "The Acts of the Archbishops of the Church of Hamburg".

Book IV (c.1075), referring to Einhard, or Einhard (c.770-840), a Frankish historian, notes a strait from the Western Ocean "as far as Greece" for a long distance like a belt. However, the strait from the Caspian Sea to the Persian Gulf seems to be a geographical mystery, and this route becomes real in Scylacus' description of his journey along the Kura from Kaspapir and the Hyrcanian Sea to Egypt.

The project of the Caspian-Persian Gulf canal, put forward at the end of the nineteenth century (Fig. 2), attracts attention. The scheme of the channel project resembles the map "Premiere revolution de la mer Kaspienne" (Fig. 1). Probably, the canal was supposed to be laid along the old riverbeds that took place in ancient times. Quite a fantastic journey, however, its reality in antiquity requires additional consideration.

"The 2nd book of Chronicles (2 Chron. 20:36, 37) testifies that Jehoshaphat began to build ships to be sent to Tarshish at Ezion-geber (on the Red Sea, not the Mediterranean), which implies an eastern direction of the route. [38]

There was no access from the Red Sea to the Mediterranean Sea and further to the Atlantic. The Judean king Yehoshaphat built ships in Etzion Geber to sail to Tarshish.

This harbor lay at the northeastern end of the Red Sea, not far from Israel, and could not serve as a starting point for the voyage to Spain and further to the Atlantic Ocean. [39] The route of this ship fit into the sea route reflected in the Scylacus periegas about the continuous waterway from India along the Indus (along the Kura) to Egypt.

Along this route, ships from Ezion-Geber could reach Tarshish and bring gold to Israel from the Greater Caucasus and the Caspian Sea. These are the so-called "gold mines of King Solomon".



Fig.2. <https://ifmr.uz/archives/central-asian-news/persi>

Conclusion.

The distinctive features of the fifth and sixth centuries were destructive earthquakes and volcanoes, which led to a decrease in the transparency of the atmosphere and a sharp drop in temperature. Procopius of Caesarea, in the tenth year of the reign of Justinian I (536/537), reported: "In this year the greatest miracle took place: all year the sun emitted light like the moon, without rays..." [45]. Similar accounts can be found in Chinese, Irish, and Middle Eastern historical records. Earthquakes also occur in the Caspian Sea, which led to the emergence of a single basin of the Caspian Sea. In the settlement of Karakabak (second – third centuries), on the northern slopes of Mangystau, the following were found: tamgas, of the Sarmatoid type, numerous traces of metallurgical production. It was an outpost connecting the Black Sea region, Iran, Central Asia and China. A large craft center with a settled population fulfilled orders "... for the nomadic population from the Volga and further to the west" [6]. It became a port city after a powerful earthquake in the fifth century, which later led to the extinction of life in the settlement. [46]

Surviving reports about the sea voyages of the Phoenicians, Carthaginians, the voyage of the Punic Himilco to Tartes for tin, suggest that the target was the islands on the Mangyshlak rapids. The path beyond the

Pillars of Hercules to the Atlantic, to Tartes, leads to the west to deceive other sailors. In fact, they were trying to reach the Atlantic Sea (Northern Caspian), where the pillars of Atlas and Hercules stood on the Mangyshlak rapids and the Casterid Islands were located. And some islands in the Caspian Sea had gold-bearing land. As Strabo noted (XI, 7.2.): "Islands on the sea are convenient for settlements, and, according to some, their land contains gold." Gold mining in the Caucasus and the islands of the Caspian Sea and its further transportation to Israel is interrupted due to changes in the geodynamics of the Caspian Sea. Returning to her homeland, the Queen of Sheba sends her son (and the son of King Solomon) as king to modern Ethiopia, which finally confuses the origins of receiving gold from the Queen of Sheba from the Caucasus and the Caspian Islands.

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WATER RESOURCES SECURITY IN CENTRAL ASIA IS A MAJOR FACTOR OF GEOPOLITICS

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Abstract

This article deals with the problems of water security in the Central Asian region in the use of a rational approach to water resources of transboundary rivers. According to the author, this problem is a real threat to the geopolitical position of Central Asia, since the deterioration of the quality and reduction of the amount of water resources can destabilize the political situation and economic potential of the region. A comprehensive analysis of the state in the field of water resources safety, focused on constructive analytical coverage, public involvement in water resource management and quality issues, gives the author the opportunity to develop scientifically based arguments and information about the real state of transboundary rivers.

The author analyzes the current state of water resources management on large transboundary rivers of the Caspian basin, identifies key aspects of water policy in the region's countries, and establishes the connection between applied aspects of water security and the concept of sustainable development. The water security surveys of Central Asian countries are considered as part of the formation of an integrated approach to the management of transboundary freshwater resources, taking into account their sustainable development. As an additional solution within the framework of the emerging water shortage, the article considers the advantages and disadvantages of desalination, while noting that for the closed hydrological system of the Caspian Sea, desalination processes are inevitable, but far from the best solution from the point of view of ecology.

Key words: water security, irrigation, transboundary rivers, sustainable development, transboundary water resources management, freshwater resources, water diplomacy, water cooperation.

Introduction

Among the reasons that determine the relevance of water resource safety analysis, we should highlight the need to solve an important methodological problem-integrating heterogeneous knowledge about the nature of rational use of water resources in conditions of increasing water scarcity and obtaining its system characteristics in order to create a theoretical model that can be a cognitive tool in further scientific research of this object. Water is the main and non-alternative resource for the sustainable development of Central Asia. The relevance of the chosen topic is also dictated by the fact that water security is a powerful factor in consolidating the multinational composition of the Central Asian region. The diverse priorities and objectives of water management at the national level can undermine water security in the region through excessive demands and unilateral initiatives.

The relevance of the chosen topic is also dictated by the fact that water is the main factor in the well-being of Central Asian countries; it has limited resources, and is considered one of the most pressing problems of the geopolitical region. In the context of water scarcity, water security should be considered as one of the components of the national security of the Republic of Kazakhstan. The issue of ensuring the safety of this natural wealth is very important, and the misuse of this vital resource can provoke social and political conflicts in the Central Asian region. This trend is a real threat to the geopolitical position of Central Asia, as deterioration in the quality and quantity of water resources can destabilize the political situation and economic potential of the region. Solving the problems of sharing water and energy resources in Central Asia is not only of crucial economic, but also of great environmental, political, and international importance. Water is becoming a key issue that will reveal whether Central Asia is dominated by a commitment to mutually beneficial cooperation or selfish competition. Water can either become a source of escalation in the event of poor use of water resources, or a driving force for regional integration.

Central Asia's water problems have become one of the "threads in the tangle" of the security architecture. The water problem has divided the region into two categories: countries that own water resources and countries that receive water. The main contradiction lies in the discrepancy between their interests. Some states want to use water in irrigation mode, while others – in energy mode. Each of the countries of the Central Asian region seeks to solve the water problem unilaterally, which is beneficial only to them.

Kazakhstan, with a population of more than 18.8 million people, 43% of whom live in rural areas, has 8 water basins, 7 of which are transboundary. Meanwhile, only 60% of the rural population in the republic is able to use centralized water supply. Others use water from local sources (*wells, springs, rivers and ponds*) or imported water. Therefore, providing the population with water is one of the strategic state tasks.

The unsettled water distribution regime of Central Asia's largest rivers, which flow through several countries and serves as an important source of energy, has become a problem in recent years, despite international support for these countries, potentially undermining the stability of the region. The Central Asian states are interested in minimizing conflicts in the development of hydroelectric potential, as well as in the sustainable and fair regulation of the regime of transboundary rivers. At the same time, they themselves, in all likelihood, cannot develop a new approach to joint development of the energy potential of the region and a mechanism for managing water and energy resources that would meet the political, economic and environmental goals of each state.

However, at present, each of the countries of the Central Asian region seeks to solve the water problem unilaterally, which is beneficial only to them. Kazakhstan, Uzbekistan, and Turkmenistan, located in the lower reaches of the rivers, are experiencing rapid economic development, which relies on energy production and a more advanced industrial system; while Tajikistan and Kyrgyzstan, located in the upper reaches, are dealing with food problems and the energy crisis, geographical conditions and limited natural resources have driven the two states into a difficult situation. Development of water resources for Kyrgyzstan and Tajikistan is a reduction in economic growth, but if the supply of irrigation water in the upper reaches of the rivers is reduced, it will be a serious blow for the countries in the lower reaches.

The Central Asian water problem has divided the region into two camps: countries that own water resources and countries that receive water. The main contradiction is that the interests of countries that use water resources do not coincide. Some countries want to use water in irrigation mode, while others - in energy mode. As a result, a conflict situation arises.

In Central Asia, the water problem is of a diverse political and economic nature. Central Asian specifics give the problem an ethno-political perspective. Experts even introduced the concept of "energy separation" in Central Asia. Growing water conflicts may threaten the independence of Central Asian countries in the future. Water is becoming a key issue that will reveal whether Central Asia is dominated by a commitment to mutually beneficial cooperation or selfish competition. Water can either become a source of escalation in the event of poor use of water resources, or a driving force for regional integration. In the long run, the problem of water use in the Central Asian region will be exacerbated by high population growth. According to experts, the demographic factor in Central Asia will increase the need for water by 40% in the next 20 years. This situation can serve as a catalyst for inter-state conflicts, given that Kyrgyzstan and Tajikistan, located in the runoff formation zone, are interested in energy, while Uzbekistan, Turkmenistan and Kazakhstan are interested in irrigation use of water resources.

The importance of the agricultural sector to the regional economy will ensure continued interest in irrigation investment. Agriculture in Central Asia is the main consumer of water: 100.4 out of 127.3 km³/year, or 80% of the water used in the region, was used for irrigation purposes in 2020. Irrigation has historically been crucial for agriculture and food security in the region.

The area of irrigated land in Central Asia is 10.1 million hectares, or about 2.9% of the world's irrigated land. These lands account for almost 66% of the region's gross agricultural output in value terms. At the same time, the irrigation infrastructure of Central Asia is characterized by high physical deterioration and insufficient technical level. It is poorly equipped with irrigation water metering and distribution facilities and monitoring its use in the field. The average age of irrigation infrastructure exceeds 50 years. Up to 50% of the irrigated land is subject to salinity. The economic efficiency of water use in agriculture is low, 40% of water is lost in the irrigation canal system (1).

A comprehensive analysis shows that the share of hydroelectric power in the total energy output of the Central Asian region reaches 27.3%; it is 75-90% in Tajikistan and Kyrgyzstan, but the share of hydroelectric power in Kazakhstan, Uzbekistan and Turkmenistan is small and amounts to no more than 10-15% of the total electricity generation. For Tajikistan and Kyrgyzstan, it is important to use water mainly for the development of hydropower, and for Uzbekistan, Kazakhstan and Turkmenistan – for irrigated agriculture. Turkmenistan and Uzbekistan have disagreements over water sharing in the lower reaches of the Amu Darya River, as Turkmenistan diverts water into the water-intensive Karakum Canal. Another source of potential escalation of tension is Ashgabat's plans to create an artificial "Golden Century Lake". Its volume is of 132-150 cubic kilometers, which will be powered by catchment channels and, possibly, by the Amu Darya (2). The current state of affairs on water resources in the region seems to lean more towards coordination of the five national water strategies and less towards regional cooperation in water resources management. The common desire of all five countries to promote economic well-being and growth at the national level is also likely to benefit future water security and regional planning.

Materials and methods

If we look at Central Asia as a whole, there is no shortage of water or energy. The problem is, *first*, the unequal distribution of water resources among the five republics. *Secondly*, a serious obstacle to the implementation of multilateral cooperation in an intraregional format is not only the unequal opportunities of Central Asian states to adequately deal with water problems, but also poorly compatible approaches of different countries to ensuring water security in the region.

At the present stage of water cooperation between the Central Asian countries, there has been a decline. In recent years, no significant documents on the problems of transboundary water use have been adopted or signed. Each State in the region often ignores the problems of its neighbors when implementing activities within the framework of its national programs.

The International Fund for Saving the Aral Sea (IFSA) is the only platform for cooperation between the five Central Asian countries in the field of joint use of water and hydropower resources, environmental rehabilitation, as

well as support and implementation of projects aimed at ensuring socio-economic development in the Aral Sea basin.

However, Kyrgyzstan in 2016 froze its participation in the Fund's activities. Despite this, four countries (Kazakhstan, Uzbekistan, Turkmenistan, and Tajikistan) at the government level in 2021 approved the Action Program for Assistance to the countries of the Aral Sea basin (PBAM-4), and in 2022 – the Regional Program for Environmental Protection for Sustainable Development of Central Asia.

In this regard, IFSA and their partners (UN, SCO, World Bank, international American, European and Asian environmental organizations, etc.) should step up cooperation in the implementation of the active phase of PBAM-4 projects until 2030.

Given the important interrelationships between water, food, energy, and public health and their direct impact on the stability, security, and prosperity of the region, joint and concerted efforts by the Fund's founding States, including Kyrgyzstan, are needed to give the organization a new positive impetus. Since the beginning of 2024, Kazakhstan has assumed the chairmanship of the International Fund for Saving the Aral Sea (IFSA). Kazakhstan intends to implement initiatives to create an international water and energy consortium in the region, which will take into account the interests of all Central Asian countries. The country aims to deepen cooperation with both Central Asian states and international organizations and financial institutions to create a sustainable regional cooperation mechanism for the effective use of Central Asian water and energy resources in the fields of irrigation, hydropower and ecology.

In the long run, the problem of water use in the Central Asian region will be exacerbated by high population growth. According to experts, the demographic factor in Central Asia will increase the need for water by 40% in the next 20 years. This situation can serve as a catalyst for inter-state conflicts, given that Kyrgyzstan and Tajikistan, located in the runoff formation zone, are interested in energy, while Uzbekistan, Turkmenistan and Kazakhstan are interested in irrigation use of water resources.

Issues of water relations, improving the socio-economic and environmental well-being of Central Asia are always a priority of cooperation between the countries of the region. Only through mutually beneficial regional

cooperation, one can avoid unjustified and costly measures to provide the population, economic sectors and natural ecosystems with water resources and energy.

An analysis of current realities shows that the Interstate Water Coordination Commission (IWCC) of experts from Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan cannot reach a consensus on a mutually acceptable and mutually beneficial comprehensive document, mainly due to Kyrgyzstan's suspension of its participation in the IWCC for the past four years. At the same time, Kazakhstan, Uzbekistan and Turkmenistan are experiencing a shortage of fresh water, the main reserves of which are located in the upper reaches of the Syr Darya and Amu Darya rivers. The situation is particularly difficult for Uzbekistan and Turkmenistan, where almost 90% of their renewable water resources are supplied from outside.

The construction of the Chui bypass canal is fraught with a number of problems: *first*, there will be a shortage of irrigation water in the southern part of Kazakhstan; *second*, the water level in the Tasotkel Reservoir will decrease; and *third*, the ecological situation in the lower reaches of the Chu River will worsen.

Modern water problems in Central Asia have a rather long history. Back in the 30s of the twentieth century, the construction of irrigation channels began in this region, and since the 50s, reservoirs and hydroelectric power stations began to be built. So, in 1952-1956, the Kairakkum reservoir was built on the territory of Tajikistan. This reservoir serves the needs of Tajikistan for only 30%, working mainly for the Syrdarya GRES (hydroelectric power station) and water management purposes of Uzbekistan and Kazakhstan. This happened because the reservoir was built within the framework of a single country and was intended to serve the needs of all neighboring republics, because the borders between them were administrative.

After gaining independence in Tashkent, the construction of the Rogun hydroelectric power station was declared almost the main threat to the existence of the Uzbek state. Uzbeks fear that due to the construction of the station, the flow of the Amu Darya, which is already quite drained of blood, will decrease even more.

Tashkent even attracted experts from the United States to assess the possible consequences, who estimated that if the hydroelectric power station is

launched, Uzbekistan will lose \$ 600 million annually - water shortage will lead to a reduction in agricultural production and a decrease in gross domestic product (GDP) by 2 percent. At the same time, about 300 thousand people will be left without work. According to the calculations of American scientists, the level of the Amu Darya River will decrease by 18 percent in summer, and increase by 54 percent in winter, which is fraught with droughts and floods. Huge territories in Karakalpakstan, Khorezm and Bukhara regions will be under the threat of desertification (3).

Discussion

The situation with water resources in Central Asia has become one of the main sources of possible inter-State conflicts. Access to water resources, especially those of transboundary rivers, is becoming increasingly competitive. For example, in recent years, the waters of the Syr Darya barely reach the middle of the territory of Uzbekistan, whose western regions are almost completely dehydrated. According to forecasts, in 15-20 years the region's water resources will be reduced by at least a third. By 2040, according to the UN, the volume of Kyrgyzstan's annual runoff will amount to 19 cubic km. In 2006, this figure was 55 cubic km. However, only in the next ten to fifteen years the regional demand for water may increase by 40%, which will affect the conflict potential in Central Asia.

The lack of water resources largely limits the economic development of Kazakhstan also due to the four reservoirs located on the territory of the Russian Federation in the Orenburg and Chelyabinsk regions. According to the Institute of Steppe of the Ural Branch of the Russian Academy of Sciences, there are about 18 large reservoirs in the Ural River basin. The fullest flowing of them is the Irklinsky reservoir with an area of 260 square kilometers and an annual flow of 3.26 billion cubic meters of water. The next largest reservoir is Verkhneuralskoye, with an area of 75 square kilometers and an annual volume of 3,26 billion cubic meters. The third is Magnitogorsk reservoir (an area of 33 square kilometers, a volume of 189 million cubic meters of water) and the fourth is Verkhnekumakskoye. The significance and implications of the study have shown that most of the problems faced by Kazakhstan and the whole of Central Asia cannot be solved without resorting to technical solutions.

Ecosystem capabilities have their limits, and there are points of no return beyond which ecosystem changes become irreversible. This situation once occurred with the Aral Sea. In the 1960s, the maximum length of the Sea was 428 km, width-284 km, and depth in some areas reached 68 meters. By the early 2000s, the lake was divided into two parts, the Northern and Southern Aral, fish almost disappeared, and only thanks to the construction of the Kokaral dam in 2005 did a slight improvement occur. The water level in the Small Aral Sea increased from 38.8 to 42 meters, the water mirror area - from 2414 to 3288 square kilometers, and the salinity decreased from 23 to 5.5–7.5 g/l (4).

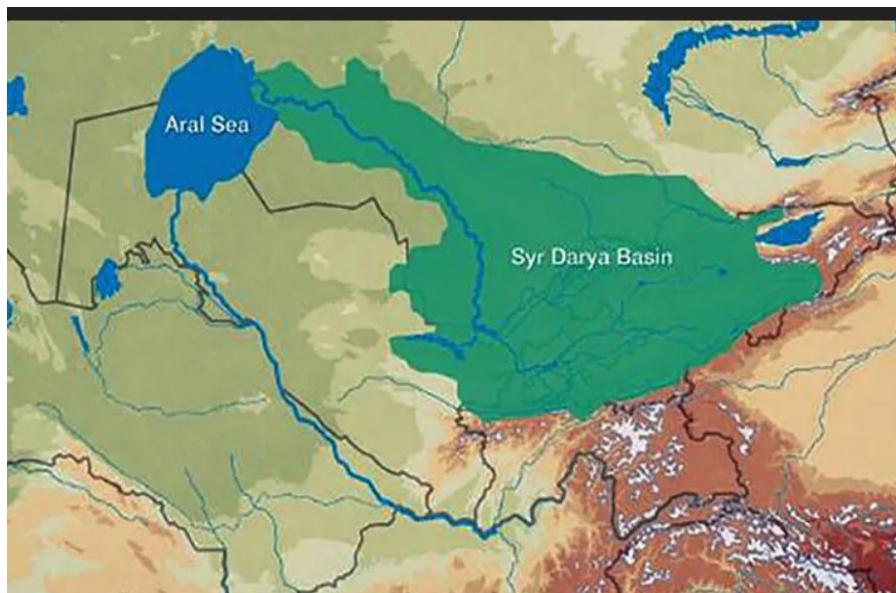
Thus, in the case of the Aral Sea, the crucial role was played solely by the engineering solution. However, experts are not inclined to underestimate the importance of natural mechanisms. The water sector in Central Asian countries has undergone a major transformation, and major reforms are still ongoing. Many researchers have observed these changes through the lens of standard international processes, such as the transfer of irrigation system management and participatory irrigation management. However, most of these prospects were short-lived, as the trajectory of transformation of the water sector in Central Asia was focused on strengthening the role of the state in the day-to-day management of water resources.

For a general understanding of the scale of the water resources sphere, a digital water drawing has been compiled specifically for this article, which includes detailed information about the current state of water objects.
drawing

This is a world map showing the level of water scarcity by 2040.

I would like to remind you that now 50% of water resources are formed outside of our state, that is, half of the Water is formed not on our territory and we are directly dependent on the policies of neighboring states. The territory of Kazakhstan is divided into eight water management basins. A basin - is an area of the earth's surface from which all surface and ground water flows into a given body of water or watercourse. Each such area consists of thousands of rivers, lakes, reservoirs, canals, etc. Thanks to "efficient" management, we have lost exactly half of these resources. According to FAO, the amount of water resources in Central Asian countries per capita is considered sufficient

(approximately 2.3 thousand m³). This means that improving the efficiency of water and land use in the region can save more than 50% of water and ensure its energy security.



Kazakhstan is on the 20th place in this list.

Results and discussion

Analysis of existing definitions and indicators of water security proposed by international organizations or used in other countries, and development of a definition and national indicators, first; will be consistent with the relevant Sustainable Development Goals (SDGs 6 and 11.5) and national Green Growth Indicators (GGIs); second; will take into account the country's specifics as much as possible, its water security needs and priorities; and third; can be easily calculated using existing reporting and statistical systems or can be easily integrated into a national reporting and statistical system. Comparison of the interpretation of the concept of water safety allows us to conclude that this concept is used in the existing regulatory legal acts of the Republic of Kazakhstan and the definition used is the same as that reflected in the countries of Central Asia. For example, the concept of "security" is interpreted in existing documents as a "state of security" (a matter of vital interests).

Taking into account the above and the fact that the concept of security in many academic, encyclopedic and legal dictionaries is defined primarily as a state of security, the following definition is proposed for consideration: The proposed definition of "Water security": "Water security is, first, a reliable satisfaction of the needs of individuals, the economy, society and the state in water resources at an affordable price to ensure the health and vital activity of people and socio-economic development of the country, and, secondly, the state of protection of their vital interests from such properties of water bodies that may, if necessary, lead to an increase in the number of under certain conditions, cause harm and damage, as well as from anthropogenic and natural adverse events and processes caused by the natural properties of water". Definition of the concept "vital interests" - a set of needs, the satisfaction of which reliably ensures the existence and opportunities for the progressive development of the individual, society and the state.

The choice of the proposed method is explained by its greater instrumentality in comparison with alternative definitions and approaches. This method is somewhat adapted to the conditions of Central Asia; it is possible to find ways to solve water problems. They boil down to the following:

1. In order to eliminate existing water disputes between the Central Asian states, it is necessary to develop a joint program for rational water use in the region;
2. Upstream countries should use water reasonably and fairly, and not harm downstream countries. In the event of any project that may reduce water levels and harm the downstream countries, inform and consult with the downstream countries in a timely manner;
3. Central Asian countries should contribute to the construction of the Rogun nuclear power plant so that the entire region is provided with electricity;
4. The Republic of Tajikistan has one of the largest lakes – Sarez Lake, known for its fresh drinking water and dangerous location in Central Asia.

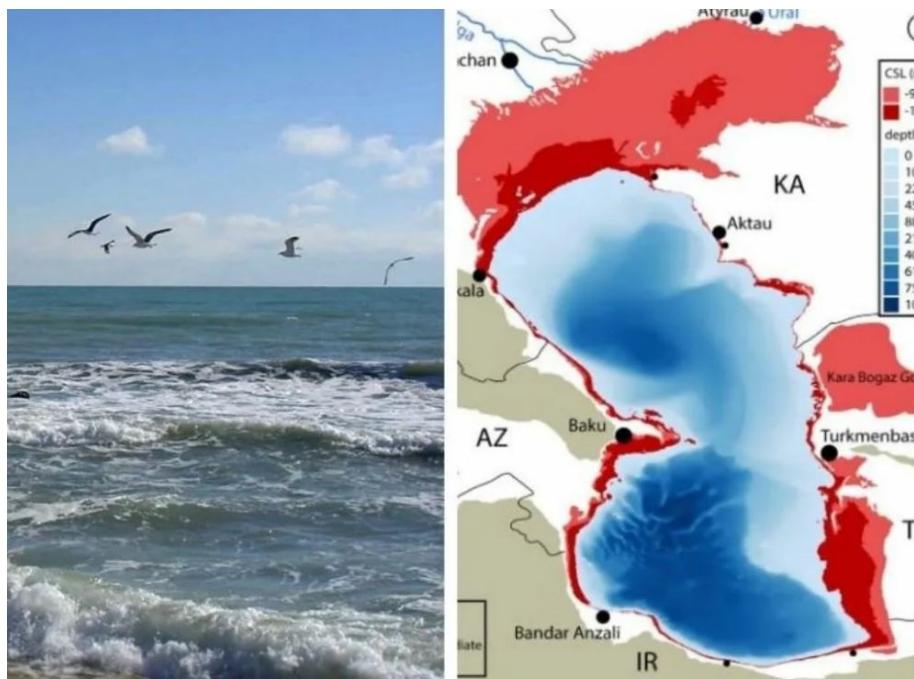
It would be in the best interests of the countries of the region to find a large investor to use its water reserves efficiently.

In addition, I cannot ignore the surveys of rising water levels in the Caspian Sea, which needs to be addressed by the heads of the five Caspian littoral states. At the initial stage, it is necessary to conclude a memorandum of

cooperation on the inflow of water intake. Currently, many countries have begun to build a reservoir along their banks for their own purposes, without taking into account the opinion of other neighbors. In this regard, it is necessary to bring the problem to the interstate level, and the countries of the Caspian region need to work on updating the water use strategy, using new reclamation technologies aimed at saving water resources. The main reason for the shallowing of the Caspian Sea is anthropogenic interference (irrational use of water for industrial purposes, etc.) and climatic conditions, which together pose a threat to the environmental security of the Caspian Sea. At the same time, in addition to active agriculture, population growth in areas bordering water bodies and rivers, and inappropriate use of water resources, the Caspian Sea faced such a problem as "artificial blocking" of river water supply. It should be noted that the situation related to the state of the Caspian Sea concerns all the Caspian littoral states (Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan).

Conclusions

Several efforts are currently being made to transform the water sector in Central Asia, with varying levels of success in each case. It is significant that attempts have been made to "export" the experience of water resources management from other regions with similar characteristics of Central Asia. While some initiatives have been well received, in other cases water sector reforms in Central Asia seem mostly endogenous. In addition, the concept of water-energy-food interconnection was recently introduced in Central Asia as a paradigm for solving major water security and management problems. However, there are concerns that outdated infrastructure in all sectors (irrigation, energy, and food processing) may pose major challenges rather than benefit from cross-sectoral cooperation. Another reason for water scarcity is the worn-out energy system of countries, which causes an additional need to store water in reservoirs in spring and summer for efficient electricity generation in winter. However, this approach conflicts with the need for water for irrigation of agricultural land. At the same time, electricity consumption is projected to increase by 2030 in a number of Central Asian countries that rely on hydropower. Kazakhstan is expected to grow by 20-22%, to 136 billion kilowatt-hours. Uzbekistan is projected to grow 1.7 times, to 120 billion kilowatt-hours, and Kyrgyzstan by 50% from the level of 2020.



If the current situation persists, an increase in energy consumption can cause water shortages to worsen. Central Asia has been experiencing a prolonged period of low water supply for several years, which in 2023 led to significant costs in agriculture. From 2028-2029, the commissioning of the Kosh Tepa irrigation canal in Afghanistan will significantly reduce river flow in the Aral Sea basin. It is predicted that up to 10 km^3 of the total volume of 22 km^3 formed annually in Afghanistan may be lost, which is a significant part of the average annual flow of the river (80 km^3). As a result, starting from 2028-2029, the region may enter a state of acute chronic shortage of water resources, which experts estimate at $5-12 \text{ km}^3$ per year (4). The problem of water scarcity is recognized at the highest level, which allows us to hope that sufficient resources will be allocated to solve it. Taking all these factors into account, the implementation of a water conservation strategy is becoming extremely important for maintaining the sustainability of agriculture and water supply in Central Asia. We expect continued long-term interest in investing in this sector. The most promising areas of investment in the development of this

trend will be projects related to the organization of water metering, restoration and improvement of irrigation assets and infrastructure, as well as the production of modern irrigation equipment. The Eurasian Development Bank has signed a memorandum of cooperation with the Ministry of Water Resources and Irrigation of the Republic of Kazakhstan in order to attract investment in the field of water resources and irrigation. In 2023, the EDB has already started financing the construction of the Kulanak hydroelectric power station with a capacity of 100 MW in Kyrgyzstan (5). It should be noted that the formation of a mechanism for a joint management of water and energy resources in the region could create conditions for sustainable development and reduce the potential for conflict. Accordingly, the development of joint actions on the use and protection of the water resources of the Amu Darya and Syr Darya rivers remains a key task for the five Central Asian States. *First*, despite the fact that 70% of the total water resources are surface runoff in Central Asia (*130 cubic km*) are formed on the territory of Tajikistan and Kyrgyzstan, more than half of it is consumed by Uzbekistan; *Secondly*, the potential threat of runoff reduction due to the construction of new hydroelectric power plants in Kyrgyzstan and Tajikistan creates a negative attitude of Tashkent towards these countries. *Third*, after gaining independence, Kyrgyzstan and Tajikistan faced the problem of insufficient funds to maintain the proper technical condition of these hydraulic structures. This problem poses a direct threat to the region, as in the event of an accident, more than 50% of the territory of the Fergana Valley may be flooded. Effective joint management of water and energy resources is of strategic importance. The Aral Sea basin is home to 81% of the region's population. According to the Food and Agriculture Organization of the United Nations (FAO), Central Asian countries are among the ten largest water consumers in the world: Turkmenistan consumes $5319 \text{ m}^3/\text{year}$, Kazakhstan $2345 \text{ m}^3/\text{year}$, Uzbekistan $2295 \text{ m}^3/\text{year}$, Kyrgyzstan $1989 \text{ m}^3/\text{year}$, Tajikistan $1895 \text{ m}^3/\text{year}$. Generally accepted climate models indicate a high probability of water resource reduction. The reason is not only global climate change, but also the projected increase in population, accompanied by the process of urbanization, as well as the growth of agriculture and industry. The pressure on water resources will continue to grow in some regions by 2040 it will more than double the current value (6). At the same time, it is clear that most of the problems faced by Central Asia can be solved technologically. Ecosystem

capabilities have their limits, and there are points of no return beyond which ecosystem changes become irreversible. In general, the instruments of natural regulation can be applied in Kazakhstan and Central Asia, but if the states of the region do not find a compromise solution within 5-10 years, then this problem, taking into account the increasing water needs, demographic trends, on the one hand, and plans for the construction of new hydroelectric power plants in the upstream countries, on the other, can create a conflict potential in relations between the Central Asian republics. Thus, only through the formation of a mechanism for joint management of water and energy resources can the countries of the region create conditions for sustainable development and reduce the potential for conflict. Central Asian countries should avoid direct comparison of price parameters for water and energy resources supplied, as this makes it difficult to develop an agreed mechanism for their use. In addition, the countries of the region should take into account the indirect losses associated with the consequences of disruption of access to water and energy resources. The construction of water and energy facilities by the upstream countries will further infringe on the interests of the downstream countries, which, under the current regime of using existing reservoirs, already have no prospects to improve the situation with access to water resources. Accordingly, the development of joint actions on the use and protection of the water resources of the Amu Darya and Syr Darya rivers remains a key task for the five Central Asian States. Negotiations between upstream and downstream countries should go beyond the amount of water discharged and the amount of electricity generated. The common desire of all five countries to promote economic well-being and growth at the national level will benefit future water security and regional planning. Only in this case will the Central Asian countries be able to remove sharp contradictions and establish good-neighborly cooperation. Otherwise, energy blackmail will continue to be used in relations between the countries of the region. In summary, the problem of the transboundary watercourse management system should be raised to a qualitatively new level. The solution is possible, *firstly*, by searching for tools to ensure mutual trust in order to achieve better synergy, *and secondly*, by providing a coordinated objective assessment of the main sources of threats to water security in Central Asia. In my opinion, scientists from Asian countries need to consolidate in order to minimize conflict situations in the development

of hydropower potential and ensure sustainable and fair regulation of the regime of transboundary rivers. The scientific community of the East and West should create an analytical platform for developing new approaches to joint development of the energy potential of the region and a mechanism for managing water and energy resources that would meet the political, economic and environmental goals of all Central Asian states. A comprehensive analysis of the reasons for past failures in the establishment of a multilateral mechanism for resolving disputes between Central Asian countries in the use of transboundary water resources is needed. It is desirable to hold a new round of negotiations on ensuring the safety of Central Asian water resources in the near future, as well as for the scientific community to organize an expert discussion of the ongoing processes in order to timely identify trends that contribute to the economically efficient and environmentally safe use of water resources and sustainable socio-economic development of the countries of the region.

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**SCIENCE WITHOUT BORDERS. Transactions of the International Academy of
Science H&E.2023/2024. Vol.7, Innsbruck, SWB, 4, 350p.**

International Publishing House “Science Without Borders” (SWB)

Meinhardstrasse 10, A-6020 Innsbruck, Austria,

Office in Baku: Fuad Ibrahimbekov str., 19/21, Baku, AZ1065, Republic of
Azerbaijan Azerbaijan Section of IASH&E

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Date of an

order:

15.08.2024 Or

der: 21/033

Size: 70×100/16

Offsetprinting

Book Sponsor: “Biological Medicine”
(clinic), LLC, Baku, Republic of
Azerbaijan

ISSN2070-0334

ISBN978-9952-451-09-2



9 789952 451092