European Science Review

№ 9–10 2022
September – October

PREMIER
Publishing

Vienna
2022

European Science Review

Scientific journal

№ 9–10 2022 (September – October)

ISSN 2310-5577

Editorial office

Premier Publishing s.r.o. Praha 8 – Karlín, Lyčkovo nám. 508/7, PSČ 18600

E-mail:

pub@ppublishing.org

Homepage

ppublishing.org

European Science Review is an international, German/English/Russian language, peer-reviewed journal. It is published bimonthly with circulation of 1000 copies.

The decisive criterion for accepting a manuscript for publication is scientific quality. All research articles published in this journal have undergone a rigorous peer review. Based on initial screening by the editors, each paper is anonymized and reviewed by at least two anonymous referees. Recommending the articles for publishing, the revЬIewers confirm that in their opinion the submitted article contains important or new scientific results.

Premier Publishing s.r.o. is not responsible for the stylistic content of the article. The responsibility for the stylistic content lies on an author of an article.

Instructions for authors

Full instructions for manuscript preparation and submission can be found through the Premier Publishing s.r.o. home page at: http://www. ppublishing.org.

Material disclaimer

The opinions expressed in the conference proceedings do not necessarily reflect those of the Premier Publishing s.r.o., the editor, the editorial board, or the organization to which the authors are affiliated.

Premier Publishing s.r.o. is not responsible for the stylistic content of the article. The responsibility for the stylistic content lies on an author of an article.

Included to the open access repositories:

Google scholar eLIBRARY.RU EBSCO A-to-Z CYBERLENINKA INDEX COPERNICUS INTERNATIONAL

GIF GLOBAL IMPACT FACTOR The journal has the GIF impact factor 1.47 for 2021.

Typeset in Berling by Ziegler Buchdruckerei, Linz, Austria.
Printed by Premier Publishing s.r.o., Vienna, Austria on acid-free paper.

Section 1. Biotechnologies

https://doi.org/10.29013/ESR-21-9.10-3-7

Martirosyan Hamlet Sargis,
Associate Professor, Department of Plant Growing and Soil Science,
Armenian National Agrarian University, Yerevan, Armenia
Sadoyan Ruzanna Robert,
Doctor of Biological Sciences,
Dean of the Faculty of Biology, Chemistry and Geography,
Armenian State Pedagogical University
named after Kh. Abovyan, Yerevan, Armenia
Shogheryan Sirine Armen,
Doctor of Philosophy in Biology, Associate Professor,
Head of chair of Ecology and Sustainable Development,
Armenian State Pedagogical University
named after Kh. Abovyan, Yerevan, Armenia
Avetisyan Arevhat Semyon,
PhD student at the Faculty of Biology, Chemistry and Geography,
Scientific Laboratory for the study
of Biologically Active Compounds and Biosafety,
Armenian State Pedagogical University
named after Kh. Abovyan, Yerevan, Armenia

THE EFFECT OF "COMPLEX-CO" PREPARATION ON THE TILLERING AND EFFICIENCY INDICATORS OF A FEW SPIKED CEREALS (BARLEY, EMMER, WHEATGRASS). THE FIRST MESSAGE

Abstract. The influence of the "Complex-Co" preparation, on the yield of some grain crops by the method of pre-sowing seed treatment under irrigated conditions of Armenia was studied. The data showed that at different stages of ontogeny grain cultures displayed positive results. Further research is needed for the preparation widespread use in agricultural production.

Keywords: "Complex-Co", growth stimulant, seed disinfectant, barley, emmer, wheatgrass.

Introduction

The increase of grain production is considered to be one of the main strategic directions for the development of agriculture in the country, which primarily contributes to the solution of food security problems. A country is considered a developed agricultural one if it has a stable grain economy. The increase in grain volume is largely connected with the

use of intensive crop cultivation technologies, which can help to accelerate plant growth at high yields in dry conditions and to increase efficiency indicators [8, 38–46; 7, 582–588]. In addition to increasing the volume of the product, it is also important to obtain the quality indicators of the harvest, the chemical composition, the reduction of the remaining quantities of harmful, undesirable compounds in it, the exclusion of which can be achieved through the use of organic preparations during plant cultivation.

Organic agriculture strictly follows the universally recognized and approved principles adopted by the International Federation for Development (IFOAM) aimed at improving socio-economic, geographical, ethnic and cultural issues. Organic agriculture is an ecological system of production management, which promotes biodiversity, activates vital processes in the soil and plants [12; 13]. Organic preparations not only contribute to the intensive growth and development of crops, increasing the yield of field-perennial fruits by 8–15%, but also greatly promote the efficient assimilation of microelements in the soil [9, 702–707]. In contemporary intensive agriculture, the role of microelements is great, which is the primary guarantee for obtaining high quality crops [11, 39–42; 6, 29–32]. The latter, being a structurally important component of enzymes, play an important role in a number of biochemical processes in the plant and are essential throughout the vegetation of crops at all stages of their growth and development [10, 117–119]. Although the soil contains a certain amount of microelements (zinc, manganese, iron, copper, etc.), their solubility and availability to plants is very low, and scarcity of different microelements in crops is manifested by very different symptoms [1, 72–79; 4, 21–30].

We have studied the effect of "Complex-Co" preparation, a natural stimulant-disinfectant, on the tillering of grainy cereals and on the efficiency indicators.

The Material and Method

The "Complex-Co" preparation, which contains microelements, was obtained in the basic research laboratory of "Acquisition of Quality Pesticides and Quality Control" of ANAU Foundation with affordable technology of acid processing of wine-yeast sediment [2, 116–125]. There has also been studied the susceptibility of spring barley "Araratyan", emmer "Garni", "Branched" varieties of autumn wheatgrass to a plant-derived preparation of natural origin, which stimulates plant growth. The experiments were carried out in the conditions of watery, cultivated-irrigated lands of Echmiadzin region of Armavir marz of RA. Experiment was conducted over three years. For this purpose, a 1.5% solution of this preparation was used to make pre-sow treatment of the seeds of grainy cereals (barley, emmer, and wheatgrass) [3, 1–7; 4, 21–30]. The sowing of autumn wheatgrass was done every year in the second ten days of October – 6.0 million viable seed, and the sowing of spring wheatgrass in the second ten days of March, respectively 5.0 and 4.5 million with germinal grain norm. The experiments were carried out in three versions, with four replications; with 25 m2 of planting area. During the tillering period on the site in late autumn (11/29/21) and early spring (03/06/22), the vegetation cover was treated with a 1% solution of the same preparation for external root feeding.The received data were estimated according to the mathematical processing Dospekhov [5, 352].

Results and Discussion:

During the vegetation period, the process of seed germination, plant tillering, and their growth was studied and the average results of three years of research are summarized in Table 1.

The data in the Table 01 clearly show that the number of sprouts in per unit area of all tested variants was significantly higher than in the controlled ones of the same crop. That difference was 39.5 for barley; 27.5 for emmer and 41.4 for wheatgrass. Accordingly, there was a noticeable increase in the percentage of field germination of seeds in the varieties cultivated with the preparation "Complex-Co", which increased 6.1–7.9% compared with the controlled variants of the three breeds of cereals.

Table 1.– The effect of "Complex-Co" preparation on the germination and germination time of grainy cereals

Crop	Option	Number of sown seeds 1m², pcs	Number of sprouts 1m², pcs	Field. Germination%	Germination duration:, day	Duration between germination and tillering
Barely	Controlled	500	451.0	90.2	9	16
	Cultivated		490.5	98.1	7	13
	The smallest Average Difference ($SAD0_5$)		42.7	–	1.4	1.8
Emmer	Controlled	450	393.3	87.4	9	15
	Cultivated		420.8	93.5	8	13
	The smallest Average Difference ($SAD0_5$)		44.3	-	1.3	1.7
Wheatgrass	Controlled	600	530.4	88.4	8	18
	Cultivated		571.8	95.3	7	14
	The smallest Average Difference ($SAD0_5$)		48.5	–	1.3	1.9

The tested organic preparation had a noticeable beneficial effect on the germination time of seeds, accelerating this process for cereals by an average of 1–2 days. As a result, there was a reduction in the transition period to plant tillering, which was more pronounced here; these differences between the "controlled" and "tested" versions have already been 2–4 days.

Table 2. – The effect of "Complex-Co" preparation on the efficiency indicators of cereals

Crop	Option	Plant height in tillering stage, cm	Degree of tillering		Plant height in spike stage	Spike height, cm	Grain number in spike, psc.	Disease-infected, unit
			General	Effective				
Barely	Controlled	13.5	2.11	1.97	71.4	7.4	31.2	4.7
	Cultivated	16.7	3.22	2.24	88.3	9.8	39.8	4.9
	The smallest Average Difference ($SAD0_5$)	2.7	1.2	1.3	12.7	1.7	4.3	–
Emmer	Controlled	12.0	1.91	1.02	64.3	5.3	24.7	4.8
	Cultivated	14.7	2.42	1.91	71.3	6.4	30.1	5.0
	The smallest Average Difference ($SAD0_5$)	2.4	1.3	1.2	14.5	1.6	4.3	–
Wheatgrass	Controlled	17.9	3.24	2.01	161.3	9.7	45.4	4.9
	Cultivated	20.9	4.15	2.97	197.4	11.9	55.5	5.0
	The smallest Average Difference ($SAD0_5$)	2.7	1.6	1.4	24.2	1.8	7.8	–

The results of the effect of "Complex-Co" preparation on the efficiency indicators of cereals are given in Table 2.

The data in the Table 2 show that the preparation "Complex-Co" had a significant effect on the height of the plants during both the tillering and the heading stage. The height of the plants increased by 2.2–3.0 cm compared to the controller in the tested versions, while in the spike stage this difference became more obvious. Thus, if the "Complex-Co" preparation at the stage of spike contributed to the increase in the height of emmer plants by 7.0cm, barley plants by 16.9 cm, then in wheatgrass, the difference reached an unprecedented size of 36.1 cm, which also plays a big role in obtaining a high crop of straw.

Similar patterns have been observed in the case of general, effective tillering of cereals. The amount of effective tillering plays a very important role in the formation of the grain crop; it had an unprecedented high result in the tested versions, reaching 1.91–2.97.

In the formation of the expected crop no less importance has the length of the spike, the number of grains in it, which are the main guarantees of a high yield.

It should be noted that the spike length of all varieties of cereals developed with the preparation "Complex-Co" was increased by an average of 1.1–2.4 cm compared to control, which is due to the positive effect of the used stimulant. It is known that the spike is formed during the embryonic stage and in the embryonic state it is disposed in the tillering node, and the applied stimulant at this stage greatly contributes to the increase of the length of the newly hatched spike. From this point of view, the "Branched" variety of wheatgrass stood out, where the spike length was increased by 2.4 cm relative to the control, and the average number of grains per grain was 10.1, compared to 5.4 emmer, barley for 8.6 grains.

"Complex-Co" is distinguished by its excellent seed disinfectant properties, which are best manifested in the processing of cereal grains, these data are given in Table 02. Here it is clear that in the cultivated versions the plants were not infected with fungal diseases at all, in this respect they were rated the highest with 5 points. During one year of barley studies only, a few traces of stem rust were observed, which was due to the unprecedented high amount of precipitation that year.

Thus, summarizing the results of many years of research, it can be concluded that at different stages of ontogeny, grainy cereals have high sensitivity to the "Complex-Co" preparation. Without the use of mineral fertilizers or pesticides for seed disinfection, the use of "Complex-Co" leads to a positive result, which contributes to the production of efficient and environmentally friendly products, at the same time saving significant funds and reducing the cost of the product. It is recommended to widely use the product of organic origin "Complex-Co" in production as a growth stimulant and valuable disinfectant.

References:

1. Abdelhameed R. M., Abdelhameed R. E. and Kamel H. A. Iron-based metal-organic frameworks as fertilizers for hydroponically grown Phaseolus vulgaris. Materials Letters.– 237. 2019.– P. 72–79. DOI: https://doi.org/10.1016/j.matlet.2018.11.072
2. Babayan B. G., Mikaelyan A. R., Asatryan N. L. and Vardanyan A. S. The Effect of New Complex Phytostimulator on Plants of Different Taxonomic Groups Based on Natural Tartaric Acid. Mikayel Nalbandian Shirak State University Collection of Scientific Papers.– 2. 2019.– P. 116–125. URL: http://shsu.am/media/journal/2019n2a/12.pdf
3. Babayan B. G., Mikaelyan A. R., Asatryan N. L., Melkumyan M. A., Bagdasaryan S. A. and Grigoryan A. M. Tartaric Acid New Synthetic Derivatives Antibacterial Activity against the Phytopathogenic

Pseudomonas syringae. 2nd International Conference on Advanced Research in Science, Engineering and Technology (ICARSET). 2021.– P. 1–7. DOI: https://www.doi.org/10.33422/2nd.icarset.2021.03.120

4. Babayan B. G., Mikaelyan A. R., Asatryan N., Soghomonyan T., Melkumyan S. A., Bagdasaryan S. and Grigoryan A. M. Tartaric Acid Synthetic Derivatives for Multi-Drug Resistant Phytopathogen Pseudomonas and Xanthomonas Combating. International Journal of Sciences: Basic and Applied Research (IJSBAR).– 52 (1). 2020.– P. 21–30. URL: https://www.researchgate.net/publication/341540717_Tartaric_Acid_Synthetic_Derivatives_for_Multidrug_Resistant_Phytopathogen_Pseudomonas_and_Xanthomonas_Combating
5. Dospekhov B. A. The methodology of field experiment (with the basics of statistical processing of research results).– Moscow. 2012.– 352 p.
6. Geiger E. Yu., Varlamova L. D., Semenov V. V., Pogodina Yu.V. and Sirotina Yu. A. Chelate-based micro-fertilizers. Experience and Perspectives of use. Agrochemical Bulletin.– 2. 2017.– P. 29–32. URL: https://cyberleninka.ru/article/n/mikroudobreniya-na-helatnoy-osnove-opyt-i-perspektivy-ispolzovaniya
7. Martirosyan H. Evaluation of the technological and economic efficiency of the cereal crop varieties resistant to abiotic factors. International journal of Agriculture and environmental research.– 06(04). 2020.– P. 582–588. (English) URL: https://ijaer.in/2020files/ijaer_06__42.pdf
8. Martirosyan H., Hovhannisyan M., and Abovyan M. Evaluating the efficiency and resistance towards the abiotic factors in the newly bred varieties of the cereal crops. International journal of Agriculture and environmental research.– 06 (01). 2020.– P. 38–46. DOI: https://doi.org/10.46609/ijaer.2020.v06i01.004
9. Mikaelyan A. R., Babayan B. G., Asatryan N. L., Vardanyan A. S., Amyan A. M. and Nazaretyan A. H. (). Study of Stimulating Growth Plants on the Basis of Natural Wine Acids. NPUA Bulletin, Collection of Scientific Papers.– 2. 2019.– P. 702–707. URL: https://www.researchgate.net/publication/335313490_issledovanie_stimulatora_rosta_rastenij_na_osnove_prirodnoj_vinnoj_kisloty
10. Regidin A. A. and Streltsova L. G. Prospects for the use of chelated microfertilizers. Scientific and technological approaches in the development of agrarian science. 2014.– P. 117–119. URL: https://docplayer.com/26703632-Nauchnye-i-tehnologicheskie-podhody-v-razvitii-agrarnoy-nauki.html
11. Wildflush I. R. and Batyrshaev E. M. Influence of microfertilizer "Vitamar-3" on the yield and grain quality of winter wheat. Soil, fertilizer, harvest: materials of the international scientific and practical. conf. 2010.– 39 p. URL: https://elib.baa.by/xmlui/bitstream/handle/123456789/1962/%d0%91%d1%82%d1%8039–42.pdf?sequence
12. URL: www.ecoglobe.am
13. URL: www.eaeunion.org/.lang=en

Section 2. Medical science

https://doi.org/10.29013/ESR-21-9.10-8-11

Zhanabayeva G. U.,
Republican Skin and Venereological Dispensary of Nukus
Akhmedzhanova Z. I.,
Institute of Human Immunology and Genomics
of the Academy of Sciences of the Republic of Uzbekistan
Danilova E. A.
Institute of Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan

THE RESULTS OF STUDIES OF MACRONUTRIENTS (MAE) IN THE HAIR OF PATIENTS WITH PSORIASIS, DEPENDING ON THE CLINICAL FORM

Abstract. Psoriasis is accompanied by a pronounced imbalance of micro- and macro elements both in erythrocytes and blood plasma, and in the parakeratotic stratum corneum. Studies of the macronutrients sodium, chlorine, calcium and potassium in patients with psoriasis living in the territory of the Aral Sea region were carried out. The imbalance of macronutrients Na, Cl, Ca, K depending on clinical forms was revealed.

Keywords: macronutrients of hair, psoriasis, clinical forms, types, Aral Sea region.

Psoriasis is one of the most common chronic dermatoses of a multifactorial nature, in the most severe cases leading patients to various variants of psychological maladaptation and disability [1]. According to literature data, up to 5% of the world's population suffers from psoriasis [2].

Normally, micro- and macro elements are in a balanced state in the body, participate in the regulation of metabolism, ensuring the activity of many enzymes, and in intracellular bioenergetics processes. All immunological reactions are based on biochemical processes caused by mineral-containing enzymes. The assessment of the elemental status of a person is the main issue of determining the impact on human health of deficiency, excess or violation of the tissue distribution of micro- and macro elements [3].

Aspects of the violation of essential structural elements in psoriasis are also poorly studied, and therefore, we conducted a study of some macro in the hair of patients with psoriasis.

The purpose of the study: The study of the content of sodium, chlorine, calcium, potassium in the hair of patients with psoriasis living in the Aral Sea region.

Materials and methods: We examined 74 patients with psoriasis, aged 18 to 65 years, who were treated at the Republican Skin and Venereological Dispensary of the city of Nukus. Among the surveyed men there were 28 (38%), women – 46 (62%). All patients were examined clinically and laboratory (general blood test, enzymes, bilirubin, blood sugar, immunoglobulin E). The study of macronutrients in hair was carried out at the Institute of Nuclear Phys-

ics of the Academy of Sciences of the Republic of Uzbekistan by neutron activation method.

The results of clinical studies of patients living in the Aral Sea region found that 89% had a vulgar form of psoriasis and 11%. -palm-plantar shape. Among the severe forms: psoriatic arthritis was detected in 12%, erythroderma in 8% of the examined patients. The majority of the examined patients had a progressive form of psoriasis (in 85% of cases). The stationary stage is established in 15% of cases.

The course of psoriasis is characterized by seasonality. The analysis of types taking into account seasonality showed that in patients with psoriasis living in the Aral Sea region, the mixed type was established in 31 patients, which was 42%, the autumn-winter type in 29 patients (39%), the spring-summer type was established in 14 patients (19%).

Thus, among all the patients examined for macronutrients, women prevailed, of which the largest number (89%) were patients with a vulgar form. When distributed by seasonality, the largest number of patients were of mixed type (42%).

When studying the elemental composition of the hair of patients with psoriasis, an imbalance of MaE of varying severity was revealed, which had its own characteristic distinctive features in each individual clinical form.

Nagornaya N. V. and co. [4] found that sodium, potassium, calcium and magnesium play an extremely important role in maintaining acid-base balance, osmotic pressure in the cytoplasm and other biological fluids (blood, urine, gastric juice), in the blood clotting system and are crucial in creating and maintaining the constancy of the internal environment of the body [4; 5].

When analyzing the results of the study, it was revealed that in all clinical forms of psoriasis, the content of Ca, K was significantly reduced. It is known that potassium participates in maintaining the constancy of the internal environment of the body in a certain ratio with sodium and chlorine, and deviations of its content from the norm, both in the direction of excess and deficiency, can equally adversely affect the health of people [3]. We found a significant decrease in K in the general group of patients with psoriasis, a decrease in the content of more than 2 times was detected in the vulgar (370 ± 60) and palmar-plantar form (360 ± 110), as well as in the control group (340 ± 120); the greatest decrease in potassium by 4 times was noted in erythroderma (200 ±75), psoriatic arthropathy (197 ± 63). Potassium is the main cation providing the membrane potential of cell rest, the revealed violations indicate a change in the cell rest potential in all clinical forms of psoriasis. Hypokalemia is also manifested by disorders of the cardiovascular system[6]. Chronic hypokalemia may be manifested by dysfunction of the central and peripheral nervous system [7; 8].

Sodium is also responsible for preserving the bioelectric potential of cell membranes, which affects vascular tone. Thanks to this trace element, the effect of adrenaline is enhanced. Sodium also has a positive effect on digestive enzymes, which contributes to the formation of hydrochloric acid, which means it improves digestion. Sodium is also a conductor of glucose into cells [9]. In our study, the Na content was normal in all patients with psoriasis and in the control group.

Chlorine participates in the metabolism in the body, together with potassium and sodium regulates the water-electrolyte balance, participates in maintaining the pH balance of cells and promotes the elimination of toxins and toxins from the body. In our study, the Cl content exceeded the permissible values in vulgar (2300 ± 280) and palmar-plantar (2800 ± 510) forms of psoriasis, and in psoriatic arthropathy (1900 ± 440), erythroderma (1570 ± ± 350) and in the control group (1700 ± 360), the Cl content had a normal value.

A significant decrease in calcium content was revealed in all clinical forms, the greatest decrease in the palm-plantar form (2.5 times), erythroderma (2 times), psoriatic arthropathy (1.8 times), vulgar form (1.6 times), and in the control group a normal Ca val-

ue was revealed (1200 ± 340). A decrease in calcium in all clinical forms of psoriasis indicates impaired calcium metabolism, which is associated with other important metals and anions: potassium, sodium, magnesium, iron, cobalt, which affects the processes of homeostasis and metabolic processes of the body, which are interrelated with the immune system [10].

One of the factors of the pathogenesis of psoriatic arthritis is considered to be a violation of calcium homeostasis. A decrease in calcium absorption in the intestine was detected in 98.3% of patients with psoriatic arthritis. One of the reasons for the violation of calcium metabolism is a decrease in fat absorption and a change in protein metabolism [11].

The normal functioning of the body is ensured by the constancy of the internal environment. At the same time, along with proteins, nucleic acids, lipids, carbohydrates, minerals play an important role, the lack and excess of which cause various pathological conditions. The minerals necessary for the normal functioning of the body include sodium and potassium [12].

Conclusion: Thus, studies have shown that in the hair of patients with psoriasis, there is an imbalance of such macronutrients as: Na, Cl, Ca, K. Various changes in macronutrients have been revealed depending on the clinical forms. They were found in all clinical forms of psoriasis and in the control group the sodium content was normal. An increase in Cl concentration was observed in the vulgar form (2300 ± 280) and palmar-plantar form (2800 ± 510) of psoriasis, and in psoriatic arthropathy (1900 ± ± 440), erythroderma (1570 ± 350) and in the control group (1700 ± 360) it was within the reference values. In all clinical forms of psoriasis, the concentration of CIS was significantly reduced by 2–3 times in comparison with reference values ($P < 0.01$).

References:

1. Features of the methodological approach in the development of therapeutic and preventive measures to optimize nutrition and individual components of the lifestyle of patients with psoriasis / S. G. Lykova, O. B. Nemchaninova, T. G. Pavlova [et al.] Clinical dermatology and venereology.– Vol. 17.– No. 2. 2018.– P. 108–113.
2. Schafer T. Epidemiology of psoriasis. Reviev and German perspective. Dermatology – 212(4). 2006.– P. 327–37.
3. Graudal N. A. Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride / N. A. Graudal T. Hubeck-Graudal G. Jurgens.– Willey,– Issue 11. 2011.– 287 p.
4. The role of mineral substances in the physiology and pathology of a child / N. V. Nagornaya, A. V. Dubovaya, V. V. Alferov [et al.] // Child health.– No. 6 (15). 2008.– P. 62–67.
5. Himova Yu. A. The state of free radical oxidation and the antioxidant system in healthy children of the Smolensk region / Yu. A. Himova, E. M. Pleshkova // Doctor-graduate student.– No. 2.1. 2013.– P. 181–184.
6. Shilov A. M., Melnik M. V., Osia A. O., etc. Treatment of cardiovascular diseases in the practice of a primary care physician: the place of potassium and magnesium preparations (Panangin). RMJ.– 3. 2012.– P. 102–7.
7. Buldakova N. G. Potassium and magnesium deficiency in cardiovascular diseases and methods of its correction. RMZH.– 29. 2008.– P. 1956–8.
8. Ukholkina G. B. The role of magnesium in diseases of the cardiovascular system. RMZH.– 7. 2011.– P. 476–80.
9. Plahotnik V. M., Martynova E. Yu., Poteshkin Yu. E. Sodium-glucose cotransporter 1: role in the pathogenesis of 2nd type diabetes mellitus and other diseases and a potential target for therapeutic effects. Effective pharmacotherapy.– 18(2). 2022.– P. 42–54.

10. Zangieva Z. K., Torshin I. Yu., Gromova O. A., Nikonov A. A. The content of trace elements in nervous tissue and ischemic stroke. Journal of Neurology and Psychiatry named after S. S. Korsakov. – 113(3–2). 2013. – P. 30–36.
11. Bakulev A. L., Shagova Yu.V., Kozlova I. V. Psoriasis as a systemic pathology Saratov Scientific Medical Journal – No. 1 (19). 2008. January-March.
12. Maltsev V. I. Kazimirko V. K. Sodium and potassium homeostasis in the body, its disorders // Medical newspaper "Health of Ukraine". – Kiev, – No. 2. 2004. – P. 15–18.

https://doi.org/10.29013/ESR-21-9.10-12-16

Saidkhodjayeva Dilfuza Mirtahirovna,
Institute of Plant Chemistry named after academician S. Yu. Yunusov,
Academy of Sciences of the Republic of Uzbekistan
Shakhmurova Gulnara Abdullayevna,
Professor of Tashkent state pedagogical university named after Nizami,
Rakhmanberdiyeva Rano Karimovna,
Professor of Institute of Plant Chemistry named after academician S. Yu. Yunusov,
Academy of Sciences of the Republic of Uzbekistan
Syrov Vladimir Nikolayevich,
Professor of Institute of Plant Chemistry named after academician S. Yu. Yunusov,
Academy of Sciences of the Republic of Uzbekistan

AN INFLUENCE OF TOTAL POLYSACCHARIDE PREPARATIONS ISOLATED FROM PLANTS OF THE GENUS FERULA ON THE STATE OF IMMUNE REACTIONS IN THE BODY OF EXPERIMENTAL ANIMALS

Abstract. The total extractive preparations of polysaccharides isolated from *Ferula kuhistanica* and *F. tenuisecta*, widely distributed in the Central Asian region, when administered to mice once (per os, 250 mg/kg) with simultaneous immunization of animals with ram erythrocytes, have a pronounced activating effect on the process of primary antibody formation, increasing in the spleen, the number of antibody-forming cells. At the same time, an increase in the cellularity of the central and peripheral organs of immunity was also observed, and the content of erythrocytes and leukocytes increased in the blood. Both studied polysaccharide preparations slightly stimulated changes in the delayed-type hypersensitivity reaction, increased the number of phagocytic peritoneal macrophages, increasing their absorption activity.

The polysaccharide preparation from *F.kuhistanica* in its effect on the immune reactivity of the organism was superior to the effect of the polysaccharide preparation from *F. tenuisecta*, as well as the corresponding effect of the reference preparations: immunal and plantaglucid. The polysaccharide preparation from *F.tenuisecta* had a similar effect to immunal and outperformed the effect of plactaglucid.

Keywords: *Ferula kuhistanica, Ferula tenuisecta*, total polysaccharide preparations, immunostimulating effect.

Currently, plant polysaccharides are widely studied biologically; they are quite common plant metabolites that play an important role in their life activity [1; 2]. Polysaccharides have various types of pharmacological activity, and therefore some of them are used in medicine and are used in the production of various drugs [3; 4]. The extremely wide range of biological activity of polysaccharides suggests that they also have immunostimulatory properties, as evidenced by some literary sources [5]. In this regard, the aim of this work was to study two new polysaccharide complexes isolated from *Ferula kuhistanica* and *F. tenuisecta* on some indicators of the functional state of immunity, as well as the

formation of antibody-forming cells in the spleen, delayed-type hypersensitivity reaction and phagocytosis. All experiments were carried out in comparison with known herbal preparations containing active polysaccharides, immunal (which is an active immunomodulating agent [6]) and plantaglucid [7].

Materials and research methods

The influence of total extractive preparations of polysaccharides, isolated from widely distributed in Central Asian region: plants of *Ferula kuhistanica* and *F. tenuisecta* [8] on the primary immune response we studied in male mice (18–20 g), immunized intraperitoneally with ram erythrocytes (2×10^7 cells per mouse). We have defined that the magnitude of the immune response was assessed in the 5^{th} day by the number of antibody-forming cells in the spleen after antigen injection [9]. Total polysaccharide preparations were administered through a special probe into the stomach simultaneously with immunization. In these experiments, the number of cells in the central (thymus, bone marrow – the femur was used) and peripheral (spleen, mesenteric lymph nodes) organs of immunity were counted in experimental animals using a Goryaev camera. We counted the number of erythrocytes and leukocytes in peripheral blood. The delayed-type hypersensitivity reaction was reproduced as described in the literature [10]. Mice were sensitized by intravenous administration of ram erythrocytes (10^6 cells per mouse). To test the reaction after 4 days from the day of sensitization, the animals were subcutaneously injected into the pad of the left hind paw with a permissive dose of antigen (10^8 ram erythrocytes) in 25 μl of a sterile 0.9% NaCl solution. The same amount of solvent was injected into the pad of the right hind paw (control). The severity of the delayed-type hypersensitivity reaction was assessed 24 hours after the administration of the resolving dose of the antigen by the difference in the degree of swelling of the paws of mice in the experimental and control groups using an MK-0.25 micrometer. As in the first case, the preparations were administered simultaneously with the antigen.

To study the effect of the studied polysaccharide preparations on the functional activity of peritoneal macrophages, they were removed by washing the abdominal cavity of mice with 3 ml of agent 199 with heparin; it was washed twice with chilled water, and brought to the required cell concentration. Researches of the functional activity of phagocytes were carried out using standard latex microspheres with a diameter of 1.2 μm [11; 12]. The percentage of activity of phagocytic cells of the peritoneal exudate and the phagocytic index corresponding to the number of latex particles absorbed by one phagocyte were calculated. In this case, the drug was administered a day before the experiment.

The researched polysaccharide preparations from *F.kuhistanica* and *F. tenuisecta* were used at a dose of 250 ml/kg, reference preparations: immunal and plantaglucid were administered in a similar regimen at doses of 50 and 500 mg/kg, respectively.

Removal of animals from the experiment, it was done by cervical dislocation under light ether anesthesia. The results of the experiments were subjected to statistical processing using Student's t-criteria.

Results and discussion. The research results show that the total polysaccharide preparations, isolated from *F.kuhistanica* and *F. tenuisecta*, when injected into the stomach of mice immunized with sheep erythrocytes, they quite effectively activate the process of primary antibody formation, by increasing the number of antibody-forming cells secreting IgM in the spleen in the experiments. This can also be seen when calculating the number of antibody-forming cells per entire spleen and per 1 million splenocytes, the level of which also had a clear upward trend. The total preparation of polysaccharides from *F. kuhistanica* showed a more pronounced effect in this respect than the polysaccharide preparation from *F. tenuisecta*, and its effect also significantly exceeded the corresponding effect of the reference preparations: immunal and plantaglocid. The sum of polysaccharides from *F. tenuisecta* had an immunostimulatory effect at the

level of immunal and exceeded the effect of plantaglucid (Table 1).

The researched polysaccharide preparations, like immunnal and plantaglucid, but in varying degrees of severity, along with the stimulation of humoral immunity, had a slight activating effect on the cellular link of immunity, which could indicate an increase in the functional activity of T-lymphocytes. This was indicated by changes in the severity of the delayed-type hypersensitivity reaction, which was manifested by an increase in swelling of the paws of mice, respectively, by 20.6%($p < < 0.05$), 17.2%($p < 0.05$), 16.8%($p < 0.05$). 0.05) and 14.6% ($p > 0.05$).

The presented figure shows data on the effect of the researched polysaccharides and known drugs containing polysaccharides on the absorption function of peritoneal macrophages, one of the most ancient cells responsible for nonspecific resistance of the organism.

Table 1.– The reaction of the immune system of mice to immunization with sheep erythrocytes with the simultaneous administration of total polysaccharide preparations from *Ferula kuhistanica*, *F. tenuisecta*, compared with immunal and plantaglucid (M ± m, n ± 6)

Conditions of experiment	Number of nucleated cells in the spleen, × 10^6	Number of antibody-forming cells		Number of thymus cells, × 10^6	Number of bone marrow cells, × 10^6	The number of cells of the mesenteric lymph nodes × 10^6
		on the spleen	per 1 million splenocytes			
Intact mice (control)	155.7 ± 6.8	4236 ± 254	27.3 ± 1.6	30.3 ± 2.7	11.2 ± 0.9	17.6 ± 0.8
Polysaccharides from *F. kuhistanica*	220.7 ± 10.1[1,2,3,4]	8200 ± 441[1,2,3,4]	37.7 ± 3.2[1]	52.6 ± 2.1[1,2,3,4]	19.7 ± 1.4[1,2,3,4]	34.8 ± 1.6[1,2,3,4]
Polysaccharides from *F. tenuisecta*	180.2 ± 4.8[1]	6618 ± 386[1,4]	36.7 ± 2.6[1]	44.8 ± 1.8[1,4]	15.8 ± 0.2[1,4]	27.6 ± 2.4[1]
Immunal	177.3 ± 7.3	6403 ± 646[1]	36.3 ± 3.8	42.7 ± 2.1[1]	15.5 ± 0.4[1]	28.8 ± 2.0[1]
plantaglucid	160.2 ± 3.8	5218 ± 292[1]	32.6 ± 2.4	38.2 ± 1.6[1]	14.0 ± 0.2[1]	22.5 ± 1.8[1]

Note: [1] – Significantly in relation to the corresponding indicators in the control; [2] – significantly between the corresponding indicators in groups of animals treated with polysaccharides from Ferula kuhistanica and F. tenuisecta; [3] – significantly between the corresponding indicators in the groups of animals treated with polysaccharides from F. kuhistanica and immunal; [4] – significantly between the corresponding indicators in the group of animals treated with polysaccharides from F. kuhistanica, as well as polysaccharides from F. tenuisecta and plantaglucid (significance level accepted at $p < 0.05$)

Under the influence of polysaccharide complexes from *F. kuhistanica* and *F. tenuisecta*, a noticeable increase in the number of cells capturing latex particles was noted, as well as an increase in the phagocytic index, which indicates an intensification of the phagocytosis process under their influence. Immunal and especially plantaglucid acted noticeably weaker in this regard. Of the other revealed facts of the primary assessment of the immunobiological properties of the total polysaccharides of preparations from *F. kuhistanica* and *F. tenuisecta*, it should be noted that they increase the total cellularity of the central and peripheral organs of immunity under their influence, as well as the stimulation of erythropoiesis and leukopoiesis (in the latter case), which is also more pronounced, than under the influence of reference – preparations (especially plantaglucid) (Table 1.2).

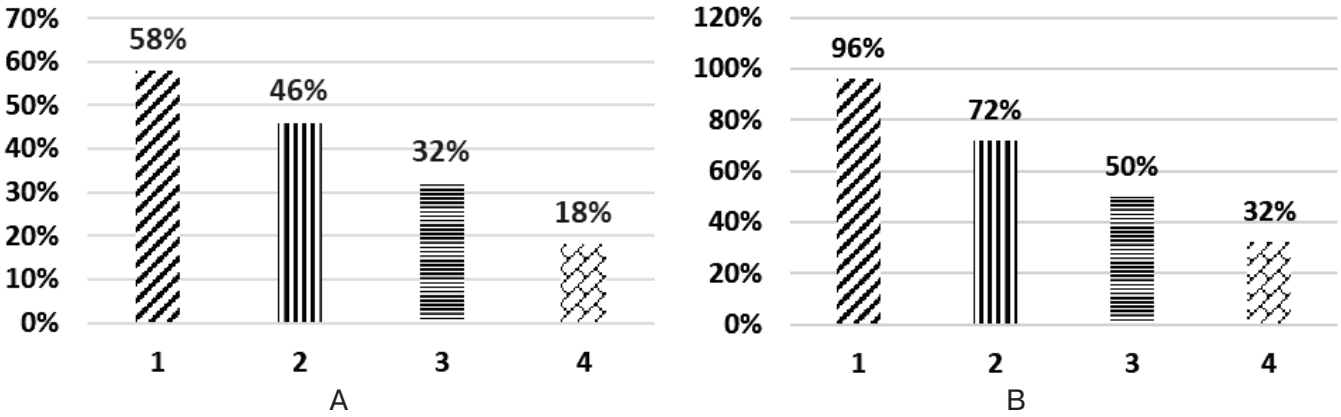


Figure. The influence of total polysaccharide preparations from *Ferula kuhistanica* (1), *F. tenuisecta* (2) and drug preparations: immunal (3) and plantaglucid (4) on the functional activity of peritoneal macrophages. Along the y-axis: A – actively phagocytic cells,%; B – phagocytic index,% (in relation to the corresponding indicators in intact animals). Along the x-axis – the tested agents

Thus, the total polysaccharide-containing preparations isolated from *F. kuhistanica* and *F. tenuisecta* are clearly immunoactive agents that they are superior (or not inferior) in their activity to known drugs containing polysaccharides.

Table 2.– Effects of total polysaccharide preparations from *Ferula kuhistanica* and *F. tenuisecta* compared with immunal and plantaglucid on the content of erythrocytes and leukocytes in the blood of mice, on the 5th day after their immunization with ram erythrocytes (M ± m, n ± 6)

Conditions of experiment	**Erythrocytes x 10^9/мл**	**Leukocytes × 10^6/мл**
Intact animals (control)	7.2 ± 0.5	8.0 ± 0.4
Polysaccharides from *F. kuhistanica*	8.7 ± 0.3^{1}	$7.2 \pm 0.3^{1.2.4}$
Polysaccharides from *F. tenuisecta*	8.3 ± 0.2	$9.8 \pm 0.3^{1.4}$
Immunal	9.0 ± 0.4^{1}	10.0 ± 0.6^{1}
Plantaglucid	7.8 ± 0.4	8.8 ± 0.2

Note: The designations are the same as for Table 1

The obtained data open the prospect of using polysaccharide preparations from *Ferula kuhistanica* and *F. tenuisecta* as new and quite effective immunomodulating agents.

References:

1. Ovodov Yu. S. Polysaccharides of flowering plants: structure and physiological activity // Bioorganic chemistry,– Vol. 24.– No. 7. 1998.– P. 483–501.
2. Vasfilova E. S. Fructose-containing plant carbohydrates: biological activity and use in medicine // Plant resources,– Vol. 57.– No. 3. 2021.– P. 195–210.
3. Krishtanova N. A., Safonova M. Yu., Bolotova V. S., Pavlova E. D., Sakanyan E. I. Prospects for the use of plant polysaccharides as therapeutic and therapeutic-prophylactic agents // – Bulletin of the Voronezh University. Series: Chemistry, Biology, Pharmacy,– No. 1. 2005.– P. 212–221.
4. Paulsen B. S., Barsett H. Bioactive pectic polysaccharides // Adv. Polym. Sci.– Vol. 186. 2005.– P. 69–101.
5. Ovodov Yu. S., Golovchenko V. V., Gunther E. A., Popov S. V., Pectin substances of plants of the European North of Russia.– Ekaterinburg: Ural Branch of the Russian Academy of Sciences, 2009.– 112 p.

6. Demin M. S., Osipov V. I., Demina N. B. Composition of metabolites of the lipophilic fraction of *Echinacea purpurea* fruits // Issues of biology, medicine and pharmaceutical chemistry,– No. 5. 2010.– P. 52–56.
7. Mashkovsky M. D. Medicinal plants.– Moscow: RIA "New Wave", 2008.– 337 p.
8. Yorkulov Z. E., Malikova M. Kh., Rakhmanberdiyeva R. K. Carbohydrates of the aerial parts of plants Ferula kuhistanica and F. tenuisecta // Chemistry of natural compounds,– No. 2. 2011.– P. 169–174.
9. Jerne N. K., Nordin A. A. Plaque formation in agar by single antibody – producing cell // Science,– Vol. 140. 1963.– P. 405–407.
10. Ratnikova L. I. New aspects of pharmacocorrection of immunosuppressions of infectious and non-infectious genesis: Abstract of the thesis. … doctor of medical sciences,– Moscow, 1989.
11. Pasteur E. U., Gadfly V. V., Pozur V. K., Vikhot N. E. Immunology: Workshop.– Kyiv, 1989.
12. Freidlin I. S. Mononuclear phagocyte system.– Moscow, 1984.

https://doi.org/10.29013/ESR-21-9.10-17-19

Suleymanov Suleyman Fayzullayevich,
PhD, Senior Researcher, Associate Professor
of the Chair of Microbiology, Virusology and Immunology of the Bukhara State
Medical Institute named after Abu Ali ibn Sino, Bukhara, Uzbekistan

USE OF IMMUNOCORRECTION IN PATIENTS WITH DUODENAL ULCER

Abstract. The values of the immune system (SI) were determined in 52 patients with chronic duodenal ulcer (CDU) and in 27 healthy individuals in patients of 2 groups noted deep suppression of the total pool of T(CD3)-lymphocytes, its subpopulations, inversion of the immunoregulation index, as well as the stress of the humoral component of SI. Conventional methods of treatment did not lead to the elimination of immune disorders in patients of the 1st group with CDU.

Included in the treatment regimen of the 2nd group CDU domestic immunopreparat Thymoptinum had a beneficial effect on immune parameters and condition of patients. It effectively eliminated immune disorders, increased all links of T – and B-cell immunity, had immunocorrecting and eradication effect.

Keywords: peptic ulcer, duodenum, immune system, Thymoptinum, Helicobacter pylori, immune deficiency, eradication, immunocorrective.

It is known that the etiology and pathogenesis of duodenal ulcer (DU) is closely related to Helicobacter pylori (HP) infection. At the same time, the researchers revealed damage to the mucous membrane of the duodenum and its colonization with cytotoxic strains of HP. With a sharp decrease in the immunoreactivity of DU patients, the manifestation of the cytotoxic properties of HP occurs, i.e. HP infection is involved in immune processes in patients with the above pathology [1–6].

The purpose of the study: to study the immune system (IS) in patients with chronic DU (CUD) and to study the effects of immunostimulating therapy (IST) and anti-Helicobacter therapy (AHBT).

Materials and methods. IS parameters were studied in 52 patients with a diagnosis of CUD aged 33 to 54 years. 34 patients were male (65.4%), 18 (34.6%) were female. The duration of peptic ulcer was 5.6 ± 2.7 years. The average size was 1.4 ± 0.5 cm.

Patients, depending on the treatment performed, were randomized into 2 representative groups. There were 28 patients in the 1st group and they received CUD from omeprazole (40 mg/day), de-nol (480 mg/day), tinidazole (1500 mg/day) for tech. 12–14 days; The 2nd group (24 patients) received a therapy regimen similar to the 1st group, but it also included the immunodrug Thimoptinum (Uzbekistan) (1 ml of 0.01% solution subcutaneously every other day; for a course of 10–12 infusions) as an additional means of treatment and immunocorrection.

When determining the main parameters of the cellular component of IS, monoclonal antibodies to the surface cluster of CD receptors (Sorbent-Servis LLC, Russia) were used: T-lymphocytes with the CD3 phenotype; T-helpers with the CD4 phenotype; T-suppressors with the CD8 marker; B-lymphocytes with the marker CD19, also the immunoregulation index (IRI) is the ratio of CD4/CD8. The levels of serum

immunoglobulins (SI) – Ig – classes A, M and G were assessed by the method of double radial immunodiffusion according to Mancini (1968). Immune parameters were determined before and after 1 month of treatment. The control group for comparison of immunological parameters consisted of 27 healthy individuals (21–52 years old).

Results and discussion. The conducted studies indicated that the exacerbation of CUD led to immunosuppression of the total pool of CD3-lymphocytes up to 38.6 ± 1.8% at a rate of 52.4 ± 1.9%. We demonstrated lower values of T cells with the CD3 phenotype in the 1st group, in contrast to the 2nd group of patients.In two representative groups, disturbances in the functioning of T-lymphocyte subpopulations were observed in the form of imbalance and inversion of IRI. At the same time, a decrease in the level of T-helpers with the CD4 phenotype and an increase in the number of Ts(CD8) was noted; also verified a statistically significant decrease in IRI to 1.3 ($p < 0.01$) due to a decrease in the relative proportion of Th(CD4).

With regard to the production of B(CD19)-lymphocytes, one can also state their noticeable decrease to 12.3 ± 1.5% (the norm is 14.8 ± 1.1%), which, of course, indicates a noticeable decrease in most cellular parameters of immunoreactivity in patients with CUD.

In the acute phase of CUD in patients of two groups, a decrease in two parameters of humoral immunity, namely IgA and IgM, was noted. At the same time, there was a tendency to increase the production of antibodies of class G – IgG – 15.27 ± 1.6 g/l at different levels of significance – $p < 0.01$ in the 1st; $p < 0.001$ in the 2nd group, which directly indicates a disorder of the immune system in the humoral link of immunity.

We found that healing and / or scarring of the ulcer in a short time with successful AHBT and effective HP eradication was achieved in the 2nd group, where the eradication efficiency (EE) was 76% in 16.7 ± 0.9 days, and in the 1st EE group was low – 58% and it was achieved in 27.3 ± 1.8 days.

At the same time, we note a decrease in the number of lymphocytes in the same group 1, where the level of T-lymphocytes with the CD3 marker was reduced to 41.5 ± 1.6%, helper fraction Th(CD4) ($p < 0.01$) was also reduced against the background of high values of suppressor cells – Ts(CD8). A decrease in IRI to 1.5 at a rate of 2.1 indicates an imbalance in the CD4/CD8 ratio in patients with ineffective eradication.

In patients of the 2nd group who took IST, a significant increase in the total pool of lymphocytes T(CD3) was observed: up to 64.3 ± 2.4%, B(CD19) up to 18.5 ± 1.7% with a parallel increase in Th(CD4) and IRI up to 2.4 (norm 2.1), which was, of course, higher than similar values in the 1st group with a high level of significance ($p<0.001$).

It is likely that the marked positive shift in the functioning of the T-cell component of immunity (an increase in the levels of CD3, CD4 and a decrease in the proportion of CD8) IST makes its own adjustments to the processes of HP eradication in the 2nd group.

Moreover, in this group, there was an increase in B-lymphocytes (CD19) and IgA levels to 2.8 ± ± 0.64 g/l compared with pre-treatment data of 2.2 ± ± 0.29 g/l ($p < 0.001$).

Summarizing the above data, it can be concluded that CUD in the relapse stage is characterized by a significant depression of the majority of SI with high HP infection of the duodenal mucosa. Criteria for ineffective or ineffective eradication are depressive processes in the immune system of patients with CUD. Conversely, the remission of patients with CUD of the 2nd group was accompanied by a significant increase in cellular humoral immunity, which, apparently, contributed to the improvement of treatment results in them.

References:

1. Vasilevsky I. V. New approaches to the eradication of Helicobacter pylori using nifuroxazide // International Reviews: Clinical Practice and Health.– No. 1. 2013.– P. 8–14. (In Russian).
2. Dudnikova E. V., Shestopalova M. A. The role of Helicobacter pylori in the etiology and pathogenesis of chronic gastroduodenal pathology // Med. vestn. South of Russia.– No. 3. 2011.– P. 4–7. (In Russian).
3. Suleymanov S. F. The immune status in patients of duodenal ulcer desease and influence on its eradication and immunomodulatory therapy // European Science.– Vol 32.– No. 10. 2017.– P. 53–56.
4. Suleymanov S. F. The use of immunocorrective and eradication therapy in patients with duodenal ulcer // Journal of Theoretical and Clinical Medicine.– No. 4. 2018.– P. 117–118. (In Russian).
5. Suleymanov S. F., Kodirov M. D., Usmonova N. S., Sharipova D. Sh. Immunocorrective therapy in patients with duodenal ulcer // Questions of science and education.– No. 27 (39). 2018.– P. 117–119.
6. Suleymanov S. F. Analysis of the degree of immune disorders and the application of immunocorrectors in deseases of digestive system // European Science Review.– Vienna, Austria.– No. 9–10. September-October. 2021.– P. 12–15.

Section 3. Technical sciences

https://doi.org/10.29013/ESR-21-9.10-20-23

Deryaev Annaguly Rejepovich,
Candidate of Technical Sciences, Senior Researcher,
Scientific Research Institute of Natural Gas
of the State Concern "Turkmengas", Ashgabat, Turkmenistan

MONITORING OF THE TECHNOLOGICAL REGIME OF WELLS AND BOREHOLE EQUIPMENT

Abstract. to monitor the operation of wells, control and measuring equipment and devices for taking wellhead samples of extracted products are installed. The binding of wells should ensure the conduct of a complex of studies: individual measurement of the flow rate of liquid and gas, waterlogging, (echometry, dynamometry, descent of deep instruments, etc.).

During the operation of wells, their research is carried out in order to monitor the technical condition of the production column, the operation of equipment, to check the compliance of the parameters of the wells with the established technological regime, to obtain information necessary to optimize these modes.

Keywords: hydro-gas dynamics, inflow profile, bottom-hole zone, backwater overflow, oil and gas saturation, wellhead pressure.

In order to study the nature of changes in the oil and gas value of formations and for the most complete recovery of reserves in the process of developing oil and gas deposits, it is necessary to carry out complex hydro-gas dynamic, field-geophysical and laboratory studies.

Control over the development of oil and gas deposits, the condition and operation of wells and downhole equipment should include the following minimum of research on existing producing wells:

– systematic and periodic control measurements and determinations of reservoir, bottom-hole and wellhead pressures. Bottom-hole pressure should be measured in the form of one-time studies for all new producing wells and after they are out of repair, as well as systematically in existing wells at least twice a year. Determination of reservoir pressure should be carried out in the form of one-time studies on all wells that have opened productive formations (including in the legal area), after their exit from drilling or repair work and systematically in operating producing wells at least once a half-year; studies by the method of established sampling should be carried out as one-time for all new wells, as well as for existing wells before and after repairs, geological and technical measures (GTM) related to changes in the state of the bottom-hole zone, and systematically for existing producing wells at least once every two years;

– studies of wells by the pressure recovery method are carried out in the form of one-time studies on all new producing wells, as well as wells that have

come out of repair and systematically on existing producing wells at least once every two years.

In addition, the dynamics of changes in current and accumulated oil, water and gas production is monitored for the deposit as a whole, for individual layers, sections, and individual wells [1]. For wells opening multi-layer objects, pressure recovery studies should be carried out simultaneously with studies of the inflow profile by the geophysical service:

– the study of inflow profiles should be carried out as one-time studies on all new producing wells and after GTM associated with the impact on the bottom-hole zone, and systematically on existing wells equipped for the production of depth measurements at least once a year.

– These studies can be carried out either in combination with studies using the method of steady-state sampling and pressure recovery, or independently:

– monitoring of the position of the WOC, GOC and GWC measurements of oil and gas saturation should be carried out using a set of geophysical methods for observation wells, wells of the reference network at least once a half-year, as well as for producing wells in the GTM process;

– determination of the sources and intervals of watering, opened by perforation, is carried out both in the process of studying the inflow profiles, and independently when watering the production of wells;

– determination of the temperature along the trunk of a working well is carried out selectively for individual wells at least once a year;

– determination of reservoir and bottom-hole temperature is carried out in the process of measuring bottom-hole and reservoir pressure at least once a half-year;

– inspection of the condition of production columns should be carried out according to the fund of producing wells in the process of repair, GTM and suspected defect formation. The study reveals the damage to the columns, the condition of the cement ring and the location of the column flows;

– revision of gas lift valves and determination of the place of gas input into the lift is recommended to be carried out after the descent of the elevator and in case of a sharp decrease in the flow rate of the well;

– deep oil sampling and their subsequent analysis should be carried out on specially selected reference wells, the total number of which should be at least 5% of the total fund of producing wells;

– it is recommended to take wellhead samples of oil, gas and condensate to determine physico-chemical properties in surface conditions once a year through the wells of the reference network.

The analysis of geological and field materials shows that there are a number of wells in the operational fund with hydrodynamic imperfections in the degree and nature of the opening of the productive reservoir. When drawing up a project for the development of gas condensate deposits of the field in order to increase the productivity of wells, it is recommended to determine the objects of completion and shooting of the productive horizon in the gas environment with enhanced charges [2].

To increase the productivity of low-flow wells, it is recommended to conduct clay acid treatments of the bottom-hole zone of the formation and hydraulic fracturing.

Based on the obtained positive results of using the method of simultaneous operation of wells, the Altyguyi deposit in the pipe and annular space is also recommended to continue its implementation in low-flow wells.

During the operation of wells, their research is carried out in order to monitor the technical condition of the production column, the operation of equipment, to check the compliance of the parameters of the wells with the established technological regime, to obtain information necessary to optimize these modes.

a) the technical condition of the well and the installed equipment is checked (tightness of the cement stone, casing and tubing, condition of the bottom-hole formation zone, contamination of the

borehole, pump supply, operation of valves installed at depth and other devices);

b) the compliance of the operating parameters of the installed equipment with the production capabilities of wells and the specified technological regime is checked;

c) the reliability and operability of the equipment units is evaluated, the inter-repair period of the equipment and the well is determined;

d) information is obtained that is necessary for planning various types of repair and restoration and other work in wells, as well as for establishing the technological effectiveness of these works.

The types, volume, and frequency of studies and measurements in order to monitor the operation of equipment for all methods of well operation are established by oil and gas production departments together with research organizations and geophysical enterprises in accordance with the recommendations of project documents and approved by the management of the association [3].

Research on monitoring the operation of producing wells should be carried out in full compliance with the safety rules in the oil and gas industry, in compliance with the requirements of subsurface and environmental protection.

The documents regulating the scope, methods and technology of research are the existing mandatory complexes, instructions and other guidance documents on technological, hydrodynamic and laboratory studies, observations and operations.

Materials for monitoring the operation of equipment are systematically analyzed and used by the engineering service of oil and gas producing enterprises to ensure the established technological modes of operation of the well.

All primary research materials are subject to mandatory storage throughout the entire period of well operation (except for echograms and dynamograms, the shelf life of which is set at least three years).

The comprehensive implementation of the above measures will allow maintaining gas production at the Altyguyi field at the project level [4].

For the idle and inactive fund of oil wells and for the fund of wells under development after drilling, it is recommended to carry out works on their restoration, development and commissioning: well returns to the above and below horizons, water isolation works based on a complex of geophysical studies of wells (GSW), inspection of production columns, extraction of emergency tubing and packers. All work on the wells should be carried out taking into account the GSW materials carried out during the repair process. During repairs, it is necessary to apply new technologies ("Slickline" technology, flexible tubing, etc.) [4].

The timing of repair work will be determined by many factors, both geological (the development of the operated facility, the absence of nearby wells at the return facility, the results of testing it at this site, etc.) and technical (the condition of the well, the availability of the necessary equipment, etc.), therefore, it is not possible to predict them for specific wells in the future. The possibility and expediency of the work, and the timing of their execution will be determined during the operation of the field specifically for each well.

Recently, a large amount of work has been carried out at the Altyguyi field on the geochemical determination of the composition of oil, gas and condensate, as well as hydrodynamic studies. The results obtained made it possible to determine the reserves of condensate and free gas, as well as their calculated parameters.

References:

1. Мирзаджанзаде А. Х. Моделирование процессов нефтегазодобычи. Нелинейность, неравновесность, неопределенность / А. Х. Мирзаджанзаде, М. М. Хасанов, Р. Н. Бахтизин. – Москва-Ижевск: Институт компьютерных исследований, 2004. – 368 с.
2. Нефтепромысловое оборудование. Справочник / Под редакцией Е. И. Бухаленко – М: Недра. 1990.

3. Игнатенко Ю. К., Акопян Н. Р., и др. Временная инструкция по удалению жидкости из газовых и газоконденсатных скважин с помощью пенообразующих веществ. – Ставрополь. 1977.
4. Зотов Г. А., Алиев Э. С. Инструкция по комплексному исследованию газовых и газоконденсатных пластов и скважин. – М., «Недра», 1980.

https://doi.org/10.29013/ESR-21-9.10-24-28

Pulatov Abror,
Faculty of Energy, Tashkent State Technical University, Uzbekistan
Shamiev Murat,
Faculty of Energy, Tashkent State Technical University, Uzbekistan
Mirsaidov Ulugbek,
"Techno Energo Group" LLC, Uzbekistan

SOFTWARE FOR CONTROL, ACCOUNT AND RATIONAL USE OF GROUNDWATER USING AN AUTOMATED ASYNCHRONOUS ELECTRIC DRIVE FOR WEEP HOLES

Abstract: The article deals with the issues of account, control and rational use of groundwater, using new elements of automated asynchronous electric drive with program control.

Keywords: groundwater, automated electric drive, program control, frequency converter, soft starter, saving resources, saving electricity, pumping station automation, well pumps, holes.

Introduction. One of the key problems humanity will face in the future is the lack of electricity and water. According to experts, the reserves of fresh water necessary for drinking, agriculture and energy production are catastrophically reduced every year. According to the UN (published in June 2018) the shortage of drinking water will be felt as early as 2030, and by 2050 half of the world's population will not have access to clean water. In addition, there is another environmental problem associated with land degradation and soil salinity. Taking into account the data of the International Institute for Environment and Development and the World Resources Institute, about 10% of the continents surface is covered with saline soils, and this value is growing every year [1].

The problem of clean drinking water and the degradation of cultivated lands and pastures also exists in the Republic of Uzbekistan. Land degradation is primarily associated with the natural and climatic features of the region. It is also worth noting that pollution, salinity, erosion, deforestation are associated with human activities.

The intensive development of industry and agriculture over the past 50 years has had a negative impact on the state of fresh groundwater. This led to a reduction in it reserves by 35 percent and the depletion of individual deposits due to unauthorized construction of water intake facilities and uncontrolled water take-off. In some areas of the republic, due to the unsatisfactory condition of the surface water diversion network and drainage systems, the intensive rise in the level of groundwater, as well as the lack of systematic hydrogeological monitoring, some cities and other settlements are sometimes flooded [2].

In recent years, a number of large-scale measures have been taken to provide the population of most regions of the republic with centralized water supply. At the same time, the needs of the population of 69 cities, 335 settlements and 2902 rural settlements are met by groundwater reserves [2].

The legislative base for the prevention of ecological catastrophe has been fixed. One of the recent measures to create an effective system to combat land degradation was the Decree of the President of the Republic of Uzbekistan No. PP-277 dated June 10, 2022 "On measures to create an effective system to combat land degradation". In order to combat land degradation, preserve and restore soil fertility, and

prevent desertification, the republic uses advanced scientific developments in this area [3].

In Uzbekistan, there are about 100 groundwater deposits, of which 77 are fresh groundwater. The predicted groundwater resources in the republic with a salinity of up to 5 g/l are 66 million m^3/day, of which with a salinity of 1 g/l is 24.4 million m^3/day. Basically, groundwater is concentrated in the Fergana Valley (34.5%), Tashkent (25.7%), Samarkand (18%), Surkhandarya (9%), Kashkadarya (5.5%) regions [4; 5].

To date, there are more than 27 thousand operating holes for various purposes in Uzbekistan. In 2017, the State Committee of the Republic of Uzbekistan for Geology and Mineral Resources conducted an inventory of more than 10 thousand holes. As a result, it was found that there is no proper control and account for the use of groundwater, the lack of operating pumping stations automation for drainage, ensuring the reliability and uninterrupted operation of their work, etc.

Methods. If we analyze the existing drain wells (vertical, horizontal or combined drainage), designed and operated in the republic, we can conclude that all pumps used to supply water are driven by an asynchronous electric drive. The induction motor, used in both well pumps and horizontal pumps, is the most common electric motor in such installations. This is due to the fact that an asynchronous motor is cheaper, more reliable, and more convenient to operate and repair.

Most of the pumping units operate directly from the network – the pump asynchronous motor is connected to the electrical network directly through the switching equipment. At the same time, it should be noted the presence of large hydraulic shocks, mechanical overloads and over-starting currents, which adversely affect the operation of the pump, electric motor and electrical substation. It is high starting currents that can make it impossible to use alternative energy sources to power remote weep holes, since they require a larger power reserve. The lack of automation at existing holes leads to unreasonable water take-off. As a result, electricity is consumed, since the pump works around the clock.

Results and Discussion. In this article, the authors propose the improvement of the existing system of weep holes. The purpose of the modernization is to optimize the consumption of electricity by pumps, monitor and control the level, volume, as well as the quality or degree of salinity of water in holes.

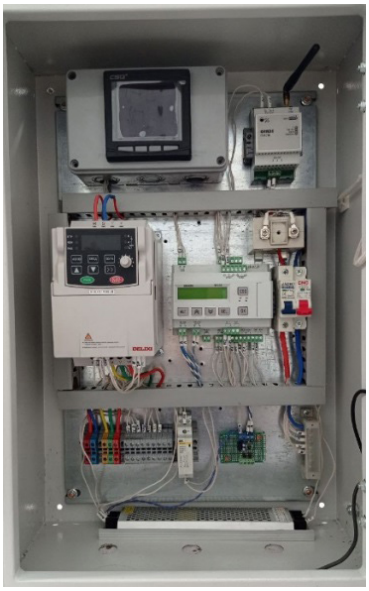


Figure 1. A general view of the control cabinet

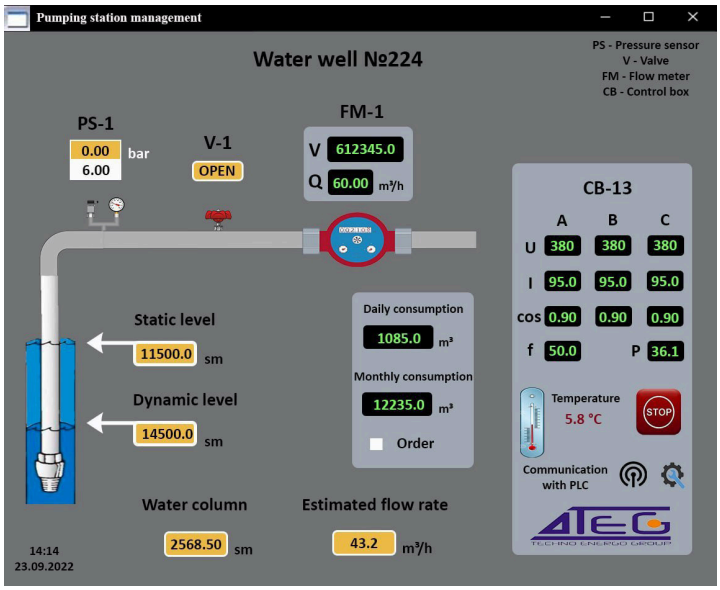


Figure 2. A general view of the software package for a pumping station with a well pump

Figure 1 shows a general view of the control cabinet and automation of the pumping station, Figure 2 shows a general view of the software package for a pumping station with a well pump "Monitoring, control and management of groundwater parameters".

The pumping station control cabinet is designed for switching the pumping unit (enable/disable), protection against abnormal modes (for example, overload, phase failure, deviation from the nominal values of the supply voltage, "jamming" of the shaft of the well pump), transferring the status of the pumping unit and operating parameters of the pump, transferring the state of the hole (water level, current flow rate of the hole (debit), temperature, composition of water salinity) over long distances (Fig. 3).

The control and monitoring cabinet includes:

– switching and protective equipment (circuit breakers, contactors, phase control relays, etc.);

– energy-efficient soft starter and speed control of asynchronous motor;

– a modem for transmitting information over distances;

– a programmable controller for interconnecting the cabinet with sensors and transmitting information to the control room;

– external water level control sensors, flow meter, water temperature and salinity sensor.

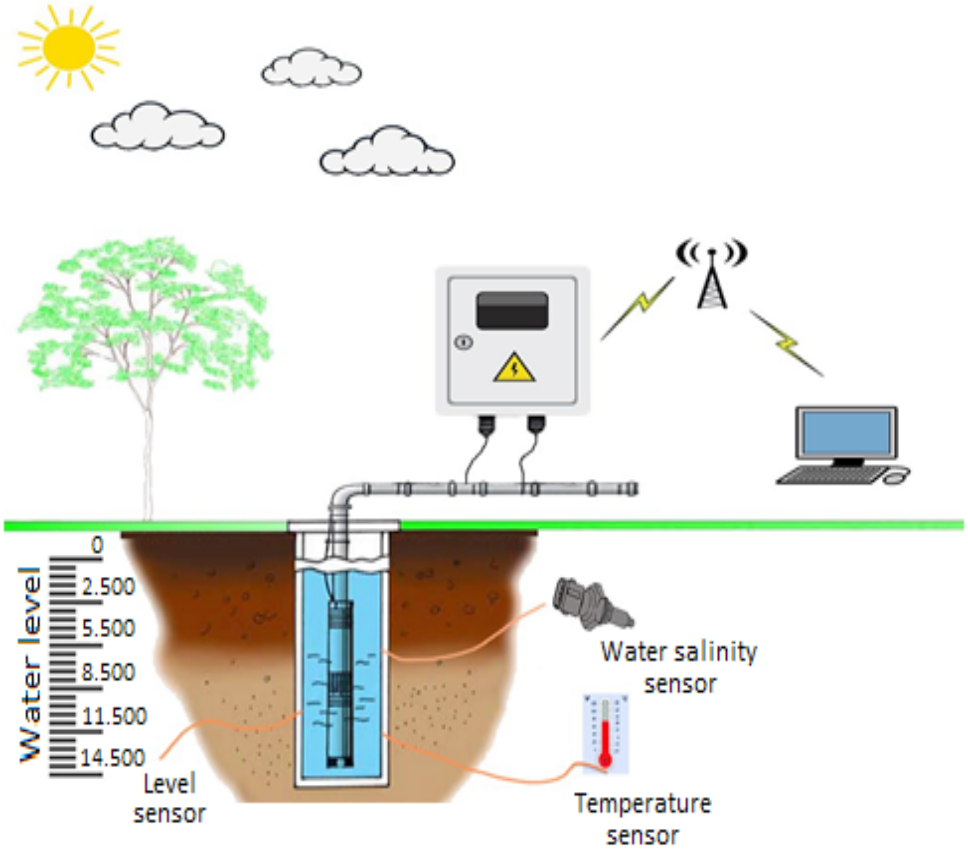


Figure 3. General view of the interaction of the pumping station with the control room

A distinctive feature of the pump control system from the existing ones are the following features:

– soft start of the pumping unit. The need for a soft start is primarily associated with extending the life of the motor and the pumping unit as a whole. As you know, asynchronous motors are started with large starting currents, which exceed the nominal value by 5–7 times. This leads to a rapid aging of the winding insulation and a decrease in the mains voltage. Direct start of the pump is associated with

mechanical loads on the pump shaft and bearing assemblies. Ensuring a smooth start of the pumping unit eliminates these disadvantages.

– regulation of the volume of water produced from the hole within a wide range by regulating the speed of rotation of the asynchronous electric motor of the pump.

Compared to the operation of existing electrical control cabinets, this pump operates in discrete mode. When the water level reaches the upper level, the pump automation turns on the electric motor. After the time has elapsed, the water level drops, automatics work and the pump turns off. Thus, the required level of groundwater is maintained with periodic switching on and off of the pump.

The control cabinet with an energy-efficient asynchronous electric drive operates as follows. At the moment the pump is turned on, the asynchronous motor of the pumping unit starts smoothly, without jerks, the starting current does not exceed the rated value. This is achieved through the use of frequency regulation by an asynchronous motor. Depending on the water level in the hole, the pump starts to work at a certain speed. At the initial moment, the pump rotation speed will be maximum. As the water level decreases, the speed of the pump rotation, and, accordingly, the volume of liquid pumped out will decrease. In fact, the operation of the hole can be balanced and the water level can be maintained at the same value. The dynamics of the hole operation becomes continuous, the fluctuation of the groundwater level is reduced compared to operation in the usual discrete mode without controlling the pumping unit speed. Also, it should be noted that with a decrease in the speed of the pumping unit rotation, the electric energy consumed by it also decreases in a cubic dependence. In practice, the average speed of the pumping unit is at the level of 35–45 Hz. The expected average saving of electric energy in the hole can be at the level of 30–40% [6].

Conclusion. Modern level gauges installed in the hole, sensors of dry running, temperature, water salinity, connected to the pumping station control system can provide the necessary information about the state of groundwater.

The presence of a programmable controller and a modem for communication can remotely transmit information to the control room and control the automation of the system.

The software of the system for monitoring, control and rational use of water resources allows continuous polling of several hundred holes, clarifying the hole flow rate and processing the received data.

The automated system will provide:

– remote control of turning on, turning off and adjusting the speed of the pumping unit;

– monitoring and control of hole parameters, such as water level, temperature, current flow, electrical parameters of the network, such as voltage, current, power consumption, etc.;

– saving electricity and water resources (by adjusting the speed of the pump, the consumption of electrical energy changes and water extraction becomes more rational);

– automatic recording of hole parameters, its archiving, etc.

The widespread introduction of domestic development will make it possible to rationally approach the issues of groundwater level control, obtain savings in electrical energy and water resources, and gradually switch to alternative power sources for underground holes. In addition, it is possible to equip not only pumping stations with this equipment, but also manholes for high-quality monitoring of groundwater.

References:

1. Lopatovskaya O. G., Sugachenko A. A. "Soil reclamation. Saline soils" tutorial. Irkutsk. Irkutsk State University Publishing House. 2010.
2. URL: https://lex.uz/docs/3193343

3. Decree of the President of the Republic of Uzbekistan No. PP-277 dated: 10.07.2022
4. URL: https://www.gazeta.uz/ru/2011/10/19/water
5. Khidirov A. A. "Research on the state and use of groundwater resources of the Republic of Uzbekistan". Young scientist.– No. 12 (116). 2016.– P. 438–441.
6. Khashimov A. A., Mirisaev A. U., Kan L. T. Energy-saving asynchronous electric drive "Fan va texnologiya", 2011.

Section 4. Transport

https://doi.org/10.29013/ESR-21-9.10-29-34

Tarh Humphrey Ntantang,
(Ph.D), Economic and Social History
University of Yaounde I
Chu Rogers Che (M.A.),
Ph. D. Research Fellow, University of Yaounde I
Political History and International Relations

TRANSPORT AGAINST A BACK DROP OF CRISIS IN NORTHERN CAMEROON

Abstract. The paper examines transport challenges against a backdrop of crisis in Northern Cameroon. As in many parts of Cameroon, mobility is not a new phenomenon in Northern Cameroon rather, the country has an extended history of mobility both within and across its national borders. While economic prosperity, security and better life have always been the key determinants of mobility, there have been at the same time instances of involuntary mobility engendered by domestic and Trans-Atlantic slave trade. This mobility is orchestrated by both desired (the search for advanced education, medical attention economic prosperity, security, better life among others), and undesired (Trans-Atlantic Slave Trade, Inter-Tribal Wars, religious persecution, invasion, Islamisation) motives. For people to move conveniently from one place to another, they must use roads, railways or water ways. To this end, this paper argues that the enclaved nature of some parts of Northern Cameroon has compelled some people in certain areas to unwillingly stay on the spot. Through the examination of primary and secondary sources which were interpreted following a qualitative analyses and presented thematically, the study resonates in sorting solutions to contribute to this knowledge generation agenda as an imput into the debates on strategies for a sustainable solution to transport crisis in Northern Cameroon, exacerbated by the Boko Haram insurgency and refugees crisis emanating from Central African Republic and Nigeria, and of late the ethnic clashes in the town of Kousseri, Logone and Chari Division, between the herders and farmers over water resources that has become scarce as a result of the climate change. The violence has displaced more than 100.000 people both inside Cameroon and across the border into Chad according to United Nations High Commission for Refugees in Cameroon (UNHCR) [2].

Keywords: Transport, Challenges, Crisis, Northern Cameroon, Infrastructure.

Significance, Methodology and Structure of paper

The study undertakes a quantitative and qualitative analysis of transport as a catalyst for crisis in Northern Cameroon before and under the colonial administrative. It uses historical perspective to identify the problems and challenges faced in the sector. The government policies and regularization.

The material for this paper was gathered from different repositories, the Buea National Achieves, located in Buea, capital of the South West Region of Cameroon, the library of the University of Yaounde I. Information was also culled from newspapers articles, journals, books, which had a bearing on some aspect on the subject under study.

The paper is structured into the following parts, the first part focuses on transport as a catalyst for crisis in Northern Cameroon. Then proceed to the crisis and challenges faced in the sector. The last section examines the perspective and conclusion.

Transport as a catalyst for crisis in Northern Cameroon: Accessibility of Northern Cameroon

The accessibility of the Northern part of Cameroon acted as a pull factor for the influx of herders into the area. The international trade that existed between Northern Cameroon and the Federal Republic of Nigeria favoured the development of path roads which later encouraged the herders to live Nigeria for Cameroon where they easily penetrated and settled in the North. The northern communities are just closer to Nigeria. People who live in these border towns found it easy to easily relocate in either side depending on the season. Distance is not a problem to them. It was due to this accessibility of the area under examination that encouraged the Fulani migrants to freely establish themselves in the area. As time went by, they studied and mastered the terrain and started doing things that led to conflict which escalated to crisis in some cases. This accessibility resulted from routes that connected both sites.

Independence Problems in Africa

One of the problems faced by some African countries after the achievements of independence was civil wars. Civil wars in Africa mostly took place in the 1960s and contributed greatly to political instability and why not to a standstill development if not a regressive one in the affected countries [1, 5]. Some of such countries that had road connection with Northern Cameroon include Nigeria and Chad. Unlike these countries, Northern Cameroon enjoyed relative peace given that there was no major political instability in the country. This acted as a pull factor to migrants who were seeking for peace.

The Biafran succession war of the late 1960s precipitated the displacement of people into Northern Cameroon. This would not have been possible without roads connecting the two counties. This civil war in Nigeria with the duration of three years provoked the passing on of some two million lives on to glory. It should be noted that during this war, human beings were left with no choice than to feed on rats, lizards and even on human flesh given the high degree of hunger and starvation that resulted from the aftermaths of the civil war. Just as the Biafran war, the Chadian civil war brought some Fulani and their cattle into Cameroon by 1880 s. [3]. It is therefore correct for one to establish the fact that political instability experienced by these aforementioned African countries orchestrated the influx of people into North Cameroon. This was successful thanks to the existence of transport infrastructure.

The Hunt for Water

There is no doubt that water constitutes one of the basic necessities of human life. Water comes next after grazing land as far as herders and their main economic activities in Kousseri, Logone and Chari Divisions are concerned. The Fulani see the provision of water as an antidote against the predicaments of marginal environments. The demand for water by Fulani seems to be higher than that of the early settlers. This is because the need for water is not just used by the Fulani but highly consumed by their cattle.

The physical environment of Northern Cameroon offered a green light for the implantation of herders in the area. Climate, vegetation, soils and hydrology

each in its capacity or in synergy with another pulled the herders into Northern Cameroon. On the slopes and top of the hills are found free grass for cattle to feed on. Visibility is another pertinent factor that influenced the implantation of Fulani in Chari division. On the rolling landscape it is possible to throw eyes from one end to another since there is no high vegetation in the intervals to impede visibility.

It is of utmost importance to note that the success of herders depends on natural forage place, quantity and quality. The rhythm of mobility and latitudinal oscillation of pastoral Fulani corresponds to the vacillation in moisture and forage conditions. Northern Cameroon provided just this much needed moisture and luxuriant vegetation to reduce the rate of mobility. This has made the Fulani to believe that if the move out they will be uncomfortable in their new sites. But with the change of climate, the resources have been reduced. Herders therefore resorted to depend to search for means and satisfy their desires even at the expense of the farmers thereby creating the atmosphere of animosity [1, 5].

Inadequate Communication Skills

Discussion between the Herders and the farmers was often hindered during the early years of Fulani presence in the area of study. Most *gainakohs* employed by Fulani breeders lack basic morals and could not express themselves even in pidgin English. This often resulted to tension especially in situation of conflict resolution. Information gathered from the field shows that misunderstanding was always the result of poor communication between the Fulani and indigenes. This therefore encouraged the Fulani to use language of hate and abuse the indigenes.

This poor communication stemmed from the inadequate education of both parties. The employment of unskilled and illiterate *gainakohs,* with the aim of minimizing cost contributed to crisis in Northern Cameroon. This was because the g*ainakohs* were young and usually ignorant of proper cattle control and management rules. This therefore accounts for their deliberate act of letting the cattle into the indigenous population's farms as reported by one of our informants. This pushed the farmers to retaliate as they considered the *gainakohs* to be primitive and ignorant.

The results of transport in crisis: Rural exodus

It is often said that communication connects people while transport is about the means of carrying goods and services from one place to another. The destruction of the middleman monopoly of trade by the Germans in the 1880 s offered a green light for the German explorers into the interior of the territory. Northern Cameroon was not left out. This was seen as Hans Dominik and Von Kampt explored the area starting from the Adamawa to the far North region where they conquered the Fulbe. As a result of this, roads were established to link the towns to areas where raw materials were found. In this line, rural areas were accidentally connected to the towns of Northern Cameroon. Information could easily flow from the towns to the rural areas that there is relative good life in towns [4].

This encouraged the inhabitants of the rural areas to move to towns of Northern Cameroon. If roods were not constructed to link the areas, information would not have rapidly reached them. People moved to towns in search of white collar jobs, salaries labour in petite jobs and to enjoy the recreational facilities of the towns. The result of this is the decline of the working population in the rural areas and low agricultural output which provokes food shortage. As people move out in the rural areas, they become susceptible to outsiders with evil intensions to cement themselves there. They employ efforts to master the terrain and terrorizing the autotones. This further provokes rural exodus as the atmosphere of animosity is not a friend to a cultured person.

Road accidents and arm robbery

Construction works geared towards the development of transport infrastructure necessitated the meditation over the theory of comparative cost. This is greatly felt when evaluating their role in the economic and socio-political developments. This implies that the construction of transport infrastructure

gives room for road accidents. Though the causes of these accidents could be attributed to reckless driving or enclave nature of roads, it must be pronounced that hitherto the construction of the roads, inhabitants of Northern Cameroon were trekking and minimal cases of accidents were recorded.

It is true that the establishment of roads accidentally created job opportunities especially for boys of the juvenile category, it also created a favourable ground for thieves to infiltrate the area and sporadically attack people riding motor cycles for commercial purposes at well calculated angles. Once one hesitated to adhere to their decision, he/she was wounded. This was not the situation hitherto the establishment of transport infrastructure. There is therefore no need to restate that transport infrastructures increase the degree of mobility. This also gives room for the transfer of negative aspects of life from towns to rural areas. Criminals in towns have taken rural sites as their refuge venues. They easily penetrate and perpetrate their evil acts [4].

Language

It is needless to mention that northern Cameroon is a cosmopolitan zone. The habitants of north Cameroon are from different cultural backgrounds given the connection it has with other areas. This has affected the main language of the place. It should be understood that before the relative improvement on transport infrastructures in the area, it was highly dominated by people who speak only Fulfulde. But as time went by and with the improved transport infrastructures, many people from different areas penetrated the area with different languages. For them to easily and effectively interact with the aborigines of the area, they had to employ efforts at the maximum level. This led to the pollution of languages. During the colonial period, Pidgin English developed along the coast of Cameroon and north Cameroon in particular. This was so because Cameroonians could not speak perfect English and French. It was during this era that northern Cameroon coincidentally experienced a tremendous increase in population due to the relative improvement on transport infrastructures. This adversely affected the dominant language of the area. Many people were bound to communicate with the influx migrants through French. These migrants equally gave a distance to their original language and embraced the Fulfulde or Hausa, the predominant language in northern Cameroon.

Religion

Transport infrastructures paved the way for the proliferation of churches in north Cameroon. New churches were introduced in the area. Most of these new churches are said to have migrated from Nigeria, as most of their leaders are Igbos. These new churches are nuisance to some Muslims who are the original settlers of the area. The proliferation of churches has not only caused suspicion amongst the migrants and the initial settlers as the Hausa say their religion is fetish. Some migrants who initially detested Islam have now embraced it. Their relatives accused them of not mourning their ancestors.

The ventilation of diseases and vices

The dynamics in the spread of diseases has it dependency on a multitude of socio-cultural factors but transport as an economic factor stands out as the main one. Migrants come along with negative behavioral patterns and intoxicate the original inhabitants of northern Cameroon. The poor behavioral patterns of the people vis-à-vis personal, social and nutritional hygiene especially of the affected population of Maroua exposes them to the infection of vibrio-cholera as well as transmission from person to person. Such behavioral attitude is responsible for the contamination of the surroundings that later become a threat to the health of those that inhabit the area. Poor public and nutritional hygiene propagates diseases.

Northern Cameroon plays a vital role in hosting a large number of pilgrims, feast and funeral ceremonies. People become sick after being to ceremonies, restaurants and road sides where they consume liquor and food. Traders, nomads and even refugees walk into and out of the area in their numbers. During ceremonies like death, pilgrimages or feasts,

certain cultural practices and exchanges take place. During such forums, an infected person can transmit a disease to other participants if care is not taken [4].

Traders, nomads and refugees regularly move into and out of the city and are themselves potential carriers of the disease causing virus. Much potential were traders who did business in and out of the town and move across borders from where they can also carry such viruses to north Cameroon. The nature of trade and daily interaction of some individuals placed them at risk of infection by the virus in the northern part of Cameroon. Different people are exposed to different circumstances and situations that affect their health.

A good number of people in northern Cameroon do not have a good financial situation. The level of unemployment is very high and more than half of the population is involved in informal activities just to sustain live. Many victims in the area expressed their desire to live other life style than that which they are in, but said they could not because of the cost involve. This stems from the crises that characterize the area stemming from transport infrastructures [4].

Perspectives

Transport infrastructure play a vital role in the sale of agricultural produce as it facilitates the movement of produce from areas of surplus to areas of deficit. It is told that the development of transport system enlarges the horizon of exchange. This is equally accompanied by economic mutations given that new markets are developed through expeditions. Since roads are widely used for different purposes and are in poor states, it is of prime importance to focus on their maintenance. It was revealed that lack of farm to market roads have resulted to low outputs from marketing.

This could be minimized by encouraging the maintenance of the available roads. Most areas in the north are connected to others by seasonal roads. This is because most usable roads are path ones dug manually with the use of crude tools. These roads are often abandoned to the main users, farmers, who sort to maintain them by constructing bridges and culverts. This situation could be ameliorated if the council steps in and consider the maintenance of the roads as their main assignment. The construction of viable transportation network could guarantee the commercialization of agricultural products. This is not the case in northern Cameroon. So it is important that the state should see into it.

Land transportation is the most used means in northern Cameroon and the state of the roads is very poor. The government needs to put in place a maintenance committee. Some of these roads are highly seasonal and are always in the process of rehabilitation. They have a lot of dust in the dry season and become muddy and slippery with pod holes in the rainy season. This is highly noticed in the farm to markets or village to town roads. People who can't afford for the hiring of cars to transport their goods go in for the services of motor cycles, trucks, wheelbarrows among others which can't carry a good quantity. Thus, some goods end up decaying before reaching the end points. If these roads are tarred, the situation could be minimized. The council needs to get into partnership with developmental companies.

In some cases, farmers transport goods on their heads and wheelbarrows. Movement to the markets with heavy load of goods is organized in such a way that the porters from various homes get up earlier in days they are to market their goods and each carry a given quantity. This is a big problem as the quantity that reaches the market is insufficient as compared to demand. Wheelbarrows are used where the roads are relatively good but when the roads are quiet bad, people tend to carry the load on their heads. This is exhaustive and strenuous. Head loads and wheelbarrows have inconveniences in that they are slow and time consuming in nature and only allows for the transportation of small quantities.

Some people equally use motor cycle means to transport their produce from farms to markets. This is when a family is able to afford hiring the services of a motor cycle. It is chosen for the fact that it is able to reach the inaccessible part of rural areas and it is also

a fast means of transportation. Motor cycle transport all sort of goods although putting some flagger goods at high risk. This risk could be minimized by constructing goods roads so that vehicles could do the transportation at ease, motor cycles transport fare varies in quantity to be transported and of the nature of the roads to be used. Though this means of transportation is very high, the tendency for it to cause destruction is equally high.

Government policies and regularisation in the transport sector arise because of the importance of transport in virtually every, aspect of economic social and political activities of the nation. Transport is taken by government of all inclination from those that are interventionalist to the most liberal, as a vital factor in economic development. Transport is seen as a key mechanism in promoting, developing and shaping the national economy. Government transport policy has been developed to prevent or control the inherent monopolistic tendency of many transport modes. Unrestrained competition commonly leads to market dominance by a company, thereby achieving (close to) monopoly power. Such dominance brings into question many issues affecting the public interest such as access (smaller actors prevented to access infrastructure) availability (smaller markets being less services, or services being discontinued, and price (the monopolist being able to charge high prices).

Conclusion

The goal of transport policy is to make effective decisions concerning the allocation of transport resources, including the management and regulation of existing transportation activities. Thus transport policy can be concomitantly a public and private sector endeavour. Still, the Cameroon government is often the most involved in the process since they either own or manage many components of these transport system and have levels of jurisdiction on all existing transportation modes. The government also often perceive that it is their role to manage transport systems due to the essential public service they provide in addition to impose a regulatory framework. All in all, the government of Cameroon should step up its commitment in this sector in order to provide a durable and sustainable solution plaguing the transport sector in Northern Cameroon.

References:

1. Mbile N. N. The other side of SCNC story, Limbe Printing, Press, 2001.– 45 p.
2. The Voice Newspaper.– No. 359. Tuesday, January 25, 2021.
3. Aichetou. "The Process of Implantation and Co-existence".– 59 p.
4. Tarh H. N. "Colonial Transport Policies and Development in Cameroon – A Historical Synthesis 1884–1961". Ph. D Thesis, University of Yaounde I. 2022.

Section 5. Physics

https://doi.org/10.29013/ESR-21-9.10-35-38

Azamatov Zakirzhan Takhirovich,
Doctor of Physical and Mathematical Sciences, Professor
Bazarbaev Nurlan Niyatullaevich,
Senior Researcher
Bekchanova Mira Ruzimovna,
phD student, Institute of Semiconductor Physics
and Microelectronics at NUUz, Tashkent, Uzbekistan

INVESTIGATION OF THE HOLOGRAPHIC CHARACTERISTICS OF CHALCOGENIDE GLASSY AS-SE SEMICONDUCTOR FILMS

Abstract. The possibility of using chalcogenide glassy semiconductor films (CSS) for recording and storing holographic information is considered. The dependences of the diffraction efficiency (η), the shift of the optical absorption edge (Δλ) of the films on the prehistory of the initial material and on the composite components of the film are shown.

Keywords: Chalcogenide glassy semiconductors (CGS), diffraction efficiency, arsenic selenide As-Se, hologram, sample transparency coefficient.

Introduction

The development of modern science and technology, which requires a significant increase in the volume of recording, storage and processing of information, necessitates the development and improvement of recording methods based on the use of various information carriers.

Currently, one of the effective ways to solve the problem of reliable, long-term storage of information with a high information density of media is the use of a holographic method of information storage. In recent years, a complex of theoretical and experimental studies has been carried out all over the world to develop holographic storage devices with ultra-high information capacity. Holographic methods make it possible to record, store and restore information presented in the form of pictures, wave fields, spatial images, etc. They show that chalcogenic glassy semiconductors (CGS) containing one or more chalcogens (S, Se, Te) are promising recording materials [1]. The development of semiconductor physics and the widespread use of complex solid-state materials in microelectronics products, in information storage and processing systems, and in various objects puts forward the study of the nature of processes in these materials [2; 3]. For this purpose, we studied the holographic characteristics of CGS films.

Experimental technique.

To determine the diffraction efficiency of holograms recorded on As-Se samples, a holographic setup was used, the scheme of which is shown in Fig. 1.

The entire scheme is placed on the working plate of the UIG-2M factory experimental setup. Holographic recording was made according to the standard

two-beam scheme. Convergence angle ≅ 30°. To eliminate vibrations of the optical scheme, all elements are fixed on the surface of the working plate, which is suspended according to the pendulum principle. For recording and reading information, a helium-neon laser He-Ne LG-38 (λ = 632.8 nm) was used.

The diffraction efficiency was estimated from the ratio of the radiation power of the reference beam, diffracted in the 1st order during the reconstruction of holograms, to the radiation power of the reference beam itself.

We have developed a technique for studying the optical and holographic properties of materials of the As-Se system in the form of thin films deposited by thermal evaporation in a vacuum (10^{-5} Torr) on unheated substrates. The investigated films of As_xSe_{1-x} systems had a thickness of 0.3–4.5 μ. The concentration of As and Se varied from 40 to 60 atomic percent and from 28 to 72 atomic percent, respectively.

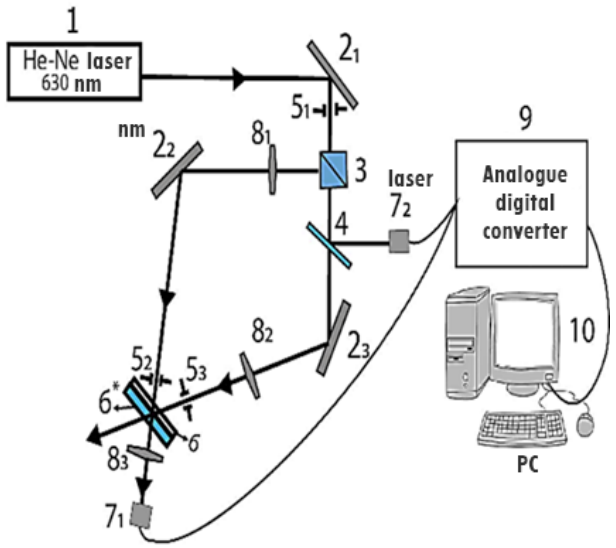


Figure 1. Experimental scheme for studying the holographic characteristics of CGS films. 1 – LG-38 laser; 2_1, 2_2, 2_3 – flat mirrors; 3-cubic prism; 4 – translucent plate; 5_1, 5_2 – aperture masks; 6 – sample, 6* substrate; 7_1, 7_2 – recording devices; 8_1, 8_2, 8_3 – shutters

The choice of the most suitable material for recording information with a laser beam of one type or another was determined by the spectral transmission characteristic of the resulting film. To fulfill this, a number of conditions are necessary: firstly, the condition of uniform absorption of the recording radiation to ensure efficient recording of holograms in the entire volume, and secondly, the condition of low absorption to obtain the highest diffraction efficiency. The fulfillment of these conditions in our case is realized by choosing the operating point in the region of the intrinsic absorption edge. Illumination of samples with helium-neon laser light in most cases was carried out in the region of the absorption edge, at large values of the absorption coefficient [4].

The transmittance of the initial samples and substrates was measured before recording the holograms using a probe beam that was attenuated by a light filter by a factor of twenty.

Results and its discussion

The installation worked in 3 modes:

1. Hologram recording mode; gates 8_1 and 8_2 are open, gate 8_3 is closed. 7_2 – the intensity of the recording beams is recorded.

2. Diffraction efficiency measurement mode (η); Gate 8_1 is closed, gates 8_2 and 8_3 are open. 7_2 registers the intensity of the reference beam, 7_1 registers the intensity of the diffracted beam.

3. Mode for measuring the transparency coefficient of the sample (T); Gates 8_1 and 8_3 are open, gate 8_2 is closed. 7_1 – registers the intensity of the incident, 7_2 – the intensity of the transmitted beam. The accuracy of determining the intensity of the diffracted beam was 1.6%. The size of the hologram was determined by the mask and was equal to ~1.5 mm.

The photo sensors and associated recording devices (7_1, 7_2) are used to measure the diffraction efficiency η, the sample transparency coefficient T, and the energy characteristics of the recording. They are calibrated taking into account the diaphragming effect of the masks (5_1, 5_2, 5_3).

To study the reversibility and erasure of the recorded holograms, a thermostatic furnace with glasses transparent to light was used.

The determined relative values of the diffraction efficiency η and the shift of the optical transmission edge Δλ in the 1st recording cycle are shown in Fig. 2. The scatter of their values is obviously due to some inhomogeneity of the film thicknesses. The maximum transmission was observed in films obtained from a sample with T_{sample}~500 °C.

It should be noted that complete erasure of the prehistory does not occur even after film annealing at the erasure temperature (T_{eras}). As a result, the magnitude of the reverse optical shift of the absorption edge after several "write-erase" cycles for all samples took the same value. As for the diffraction efficiency (η), it should be noted that the observed dependences of it on the thickness of the samples are approximately the same for all processing temperatures, i.e., backstories of the source material. However, the absolute values of η are different. They grow with increasing T, reaching a maximum value at T~500 °C (Figure 2).

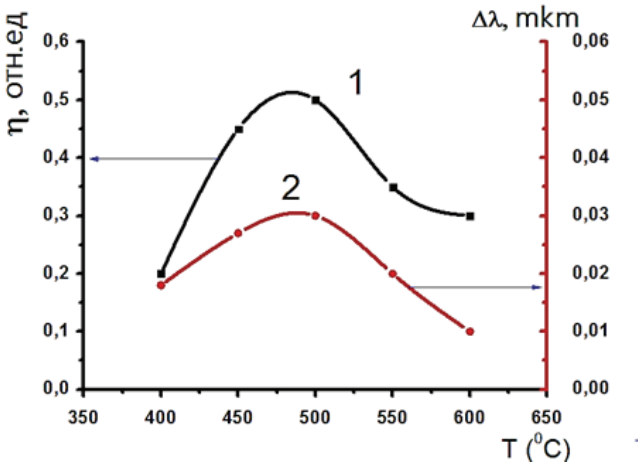


Figure 2. Change in diffraction efficiency (η) and shift of the optical absorption edge (Δλ) of films obtained from bulk materials with different prehistory

The spectral dependence of the optical transmission of freshly deposited, annealed films in the region of the fundamental absorption edge (0.4–1.0 μm) was studied on a Shumadzu spectrophotometer. On the curves of dependences of Δλ and η on T_{sample} (see Fig. 2), a maximum is noted in the region of ~ 500 °C. It is difficult to analyze the mechanism of the effect of structural features of bulk samples on the characteristics of photoinduced transformations in films in detail [5; 6; 7]. However, it is important to emphasize the presence of such a dependence and a significant, more than 2-fold, change in the diffraction efficiency with a change in the thermal history of the source material.

The compositional dependences of the diffraction efficiency and the shift of the optical absorption edge for films of the As-Se system (Fig. 3.) have a maximum for films with an arsenic content of ~ 65 at%. The decrease in the diffraction efficiency with an increase in the As content above 65 at% is obviously due to the instability of the films, the composition of which goes beyond the limits of their glass transition region. An increase in the diffraction efficiency with a change in the arsenic concentration from 40 to 65 at% is probably due to reasons similar to those considered for three arsenic selenides with different thermal prehistory [8].

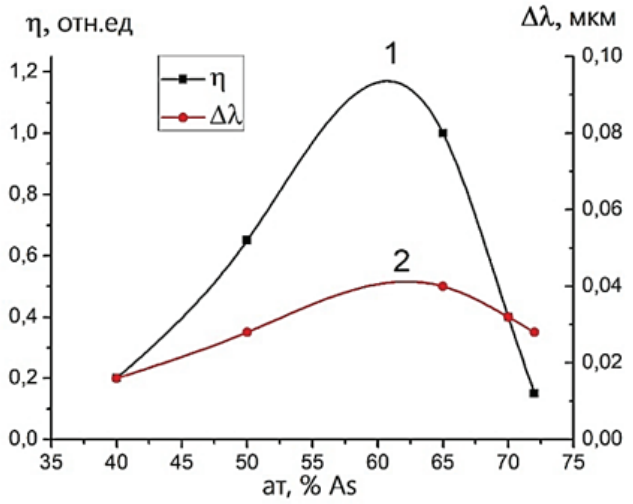


Figure 3. Compositional dependences of the diffraction efficiency (1) and the shift of the optical absorption edge (2) in As-Se films

Conclusions

It has been established that the dependences of the values of the diffraction efficiency of holograms and the shift of the optical absorption edge of As-Se films on the processing temperature of the initial ma-

terial have an extreme character with a maximum value at $T_{sample} \approx 500$ °C. It should be noted a significant, more than 2-fold change in the diffraction efficiency with a change in the thermal history of the source material.

The experimental results obtained testify in favor of a significant influence of the prehistory and volume content of chalcogens introduced into arsenic on the absolute values of the optical-holographic parameters of the materials under study.

The possibility of using such glassy chalcogenide semiconductors (As-Se films) as promising materials in optical processing and information storage systems is shown.

References:

1. Азаматов А. З. Т., Утамурадова Ш. Б., Базарбаев Н. Н., Бекчанова М. Р., Азаматов Т. З., Бахромов А. Б. Голографические свойства халькогенидных стеклообразных полупроводниковых пленок // Прикладная физика,– № 2. 2022.– С. 39–45.
2. Акаев А. А., Гуревич С. Б., Жумалиев К. М. Голографические системы хранения и выборки информации // Илим.– Бишкек; СПб., 2000.– 408 с.
3. Джаманкызов Н. К., Пецкус А. М., Гуревич С. Б., Жумалиев К. М. Влияние процессов записи на информационные характеристики записываемых голограмм // – Москва Диалогмифи. 2004.– 11 с.
4. Tanaka K. Have we understood the optical absorption edge in chalcogenide glasses // Journal of Non-Crystalline Solids.– No. 431. 2016.– С. 21–24.
5. Электронные явления в халькогенидных стеклообразных полупроводниках // под ред. К. Д. Цендина.– СПб.: Наука, 1996.– 486 с.
6. Lyubin V., Klebanov M., Shapiro L., Lisiansky M., Spektor B., Shamir J. Peculiarities of Photorefraction Effect in thick Glassy As_2S_3 Films // J. of Optoelectr. and Adv. Mater.– V. 1.– No. 3. 1999.– P. 31–35.
7. Anisimova N. I., Bordovsky G. A., Bordovsky V. A., Castro R. A. The Photoinduced Change of Dissolution Rate in As_2Se_3 Glasses // Radiation Effects and Defects in Solids.– V. 156.– No. 4. 2000.– P. 365–369.
8. Азаматов З. Т., Минаев В. С., Михалев Н. И. Влияния тепловой предыстории и состава на фотостимулированные превращения в пленках системы As-Se: // сб. «Аморфные и стеклообразные полупроводники в пленках системы As-Se».– Калининград, 1982.

https://doi.org/10.29013/ESR-21-9.10-39-43

Azamatov Zakirzhan Takhirovich,
Doctor of Physical and Mathematical Sciences, Professor,
Yuldoshev Murodzhon Akbarali ugli,
phD student,
Bazarbaev Nurlan Niyatullaevich,
Senior Researcher, Institute of Semiconductor Physics and Microelectronics at NUUz, Tashkent, Uzbekistan

OPTICAL AND HOLOGRAPHIC PROPERTIES OF A PHOTOREFRACTIVE CRYSTAL OF LITHIUM NIOBATE DOPED WITH IRON IONS

Abstract. The work is devoted to the study of the optical and holographic properties of an iron-doped lithium niobate crystal ($LiNbO_3$: Fe). The research results show that with an increase in the iron impurity concentration, the maximum diffraction efficiency is achieved at a lower exposure. The change in the refractive index of the crystal increased from 10^{-5} to $5 \cdot 10^{-5}$.

Keywords: Diffraction efficiency, refractive index, photosensitivity, photorefractive crystal.

Introduction

In holography, to form an interference pattern, two coherent beams are required, one of which is called the reference beam, and the other is called the object beam scattered from the object (extraordinary). The resulting interference pattern contains information about the amplitude and phase of the object beam. The intensity of an interference pattern can be recorded by placing an appropriate photosensitive material (such as photographic film or a photorefractive crystal) in the interference region. This recorded stripe pattern or grating is called a hologram. The recorded hologram, when illuminated by the same reference beam, can scatter light in the direction of the object beam. The diffracted beam contains information about the phase and amplitude of the original object beam.

The creation of optical information processing systems and the development of holography with its numerous applications set the task of searching for and developing materials that change their optical properties when exposed to laser radiation. The parameters of optical information processing systems are mainly determined by the characteristics of the recording media. For example, systems for online optical information processing require reversible media, unlike photographic emulsions, which have high sensitivity (10^{-5} j/cm^2) and resolution, but cannot be used multiple times. Recording materials for optical information processing systems should allow high-density recording of information, non-destructive reading, easy rewriting of information (10^7–10^8 cycles) with sufficient diffraction efficiency to reproduce information [1].

Photorefractive crystals, such as $LiNbO_3$ doped with iron ions in various concentrations, occupy a special place among promising recording materials for creating holographic systems for optical information processing [2]. The recording of information in ferroelectric crystals is based on the effect of a local reversible change in the refractive index in these crystals when illuminated by a laser beam. The photoelectric properties of ferroelectrics are affected by spontaneous polarization, with a change in which, under the influence of light, an internal field appears, which contributes to the redistribution of carriers

and the formation of a space charge. The space charge field due to the electro-optical effect causes a change in the refractive indices of the substance.

In a photorefractive single crystal, defects arise under the action of laser radiation in the illuminated region of the crystal, through which the laser beam passes, which is not the case outside the illuminated region of the crystal. These defects are fluctuating micro- and nanostructures with changed physical parameters (such as the refractive index, diffraction efficiency, photo- and electrical conductivity, etc.) [3; 4]. Increasing the sensitivity and speed of recording holographic information can be achieved by changing the composition of the crystal and the features of its structure. The most interesting part of it is the influence of the order of the units of the cationic sublattice along the polar axis on the properties of the photorefractive effect. Note that the order of units of the cationic sublattice determines the magnitude of spontaneous polarization in optically nonlinear crystals with an oxygen octahedral structure, as noted in [5].

Among the large number of photorefractive materials synthesized to date, promising as holographic materials, the oxygen-octahedral lithium niobate ($LiNbO_3$) single crystal stands out for its long-term memory due to high electro-optical and optically nonlinear coefficients [6; 7]. The photorefractive properties of $LiNbO_3$ can be controlled by changing both the stoichiometry (R = Li/Nb ratio) and doping [8; 9]. In this case, as noted above, the order of units of the cationic sublattice, the state of defects, and the magnitude of spontaneous polarization change significantly [9]. $LiNbO_3$ single crystals with a strong photorefractive effect can be obtained by doping with multiply charged transition metal cations. These cations (Fe, Cu, Mn, Ni, etc.) are called "photorefractive" and under the action of laser radiation change their charge in the crystal, improving the photorefractive effect.

The effect of photorefraction, the photo- and electrical conductivity of the $LiNbO_3$ crystal, depending on its composition and the state of defectiveness of the crystal lattice, vary over a very wide range. In this case, a change in the band gap should occur, which for a nominally pure crystal is 3.4 eV, which is close to the value characteristic of wide-gap semiconductors. By reducing the band gap, it is possible to bring the properties of the $LiNbO_3$ crystal closer to semiconductor properties, which makes it possible in principle to develop materials with cross-effects.

Experimental technique

Noting the above, we note that the interest in the studied mechanisms of holographic recording of information on lithium niobate crystals doped with iron ions is beyond doubt.

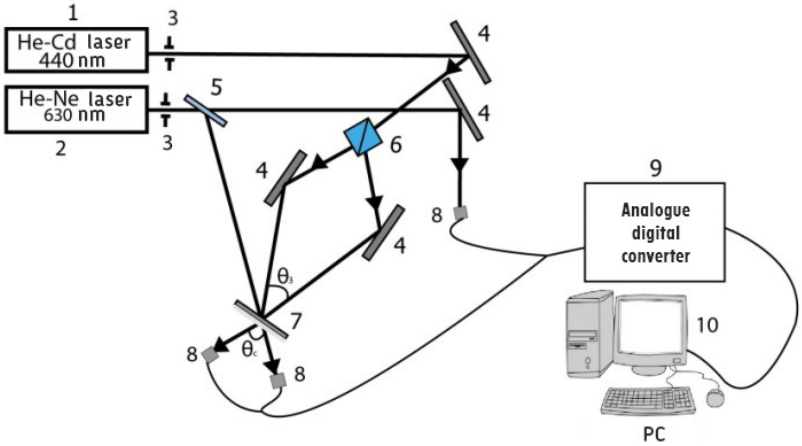


Figure 1. Scheme of the experimental setup: 1 – recording laser (He-Cd) λ = 440 nm, 2 –reading laser (He-Ne) λ = 630 nm, 3 – diaphragm, 4 – mirrors, 5 – filter, 6 – prism Vollaston, 7 – sample, 8 – photodetector, 9 – analog digital converter, 10 – computer

In experiments on the study of optical recording in $LiNbO_3$ crystals, the scheme shown in Figure. 1 was used.

The recording is made by a helium-cadmium (λ = = 440 nm) laser beam. At this wavelength, the crystals are highly sensitive to optical distortion. The reading is performed by a He-Ne laser with λ = = 630 nm, for which the sensitivity of the crystal is negligible, so the reading does not lead to erasure of the hologram. As a result of the superposition of two plane waves in a crystal, an interference pattern appears in the form of light and dark stripes. The diffraction efficiency – η of a sinusoidal grating, when read by an extraordinary beam with a given wavelength – λ, is given by the Kogelnik formula [10].

$$\eta = \sin^2\left\{\frac{\pi D\Delta n_e}{\left[\lambda\cos\frac{\theta}{2}\right]}\right\} \qquad (1)$$

where Δn_e is the modulation amplitude of the refractive index of the extraordinary ray, D is the crystal thickness.

Experimentally, diffraction efficiency is defined as the ratio of the intensity of the diffracted readout beam to the intensity of the beam that has passed through the crystal when the hologram is not recorded in the crystal. Our diffraction efficiency results were defined as the ratio of the diffracted beam to the intensity of the reference beam, i.e. without taking into account the reflection and scattering of light in the crystal.

Results and its discussion

The fundamental issue in the analysis of the mechanism of formation of optical damage Δn (changes in the refractive index) is the question of its dependence on the wavelength of the irradiating light λ. This dependence makes it possible to judge the exchange of electrons between excited and unexcited iron ions, with the transition of electrons to the conduction band.

On fig. Figure 2 shows experimental studies of the dependence of the influence of various concentrations of iron ions in $LiNbO_3$ on the diffraction efficiency of holograms – η, recorded (Fig. 1) by a helium-cadmium laser (λ = 440 nm) in the form of a plane wave front (sample 1–0.005 wt.% Fe, sample 2–0.020 wt% Fe).

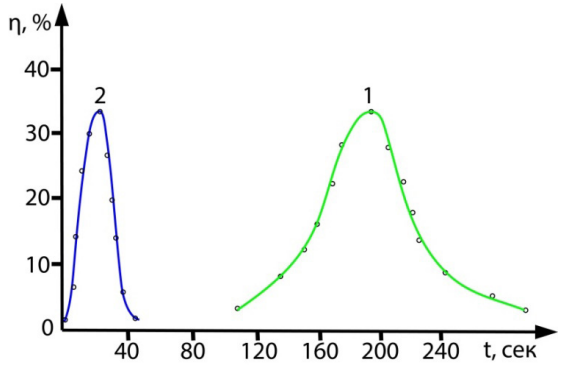


Figure 2. Experimental dependences of the diffraction efficiency of holograms on exposure at λ = 440 nm (sample 1– –0.005 wt.% Fe, sample 2–0.020 wt.% Fe)

The studied dependence of the diffraction efficiency on the concentration of introduced impurities showed that the obtained holograms recorded at a wavelength of λ = 440 nm differ significantly. As can be seen from Figure 2, the photosensitivity, and hence the diffraction efficiency, in sample 2 is 7 times greater than in sample 1. The maximum diffraction efficiency η = 34%, obtained at a wavelength of λ = = 440 nm, is achieved at various expositions.

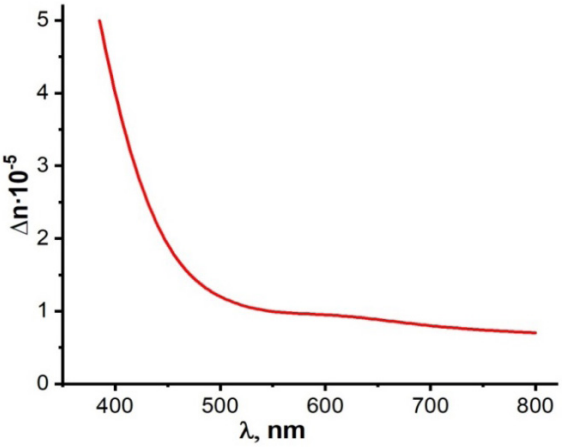


Figure 3. Dependence of the change in the refractive index of $LiNbO_3$: Fe crystals on the wavelength of the recording radiation

In our opinion, this is due to a significant increase in the change in the refractive index of $LiNbO_3$: Fe at $\lambda < 500$ nm, which is shown in Figure 3.

Using formula (1), one can find the change in the refractive index of the crystal:

$$\Delta n_e = \left[\frac{\lambda \cos\frac{\theta}{2}}{\pi D}\right] \text{arc } \sin\sqrt{\eta} \qquad (2)$$

where λ is the wavelength of the reading radiation; θ is the angle between the interfering beams. The values of Δn_e during the recording of information can vary from 10^{-5} to $5 \cdot 10^{-5}$.

Features of holographic recording in $LiNbO_3$: Fe are due to the anisotropy of the properties of the crystal and the specifics of the mechanisms of hologram formation. For practical applications of $LiNbO_3$: Fe crystals, it is important to know the mechanisms of change in the refractive index, which are studied by many researchers.

As is known [3], the use of transition metals as dopants is associated with their ability to reversibly donate d-electrons to the conduction band under the action of radiation. When a crystal is doped with Fe^{3+} ions, the absorption of light in it is caused by ionization. The light sensitivity of iron-doped crystals is determined by the concentration of Fe^{2+} ions, which have a broad absorption band in the lattice with a maximum at about 400 nm. Upon photoexcitation, Fe^{2+} donates a photoelectron to the conduction band, which is captured by the Fe^{3+} ion in the unilluminated region during diffusion. As the Fe^{2+} concentration increases, the absorption at the wavelength at which information is recorded increases, which leads to an increase in the sensitivity of the crystal to light.

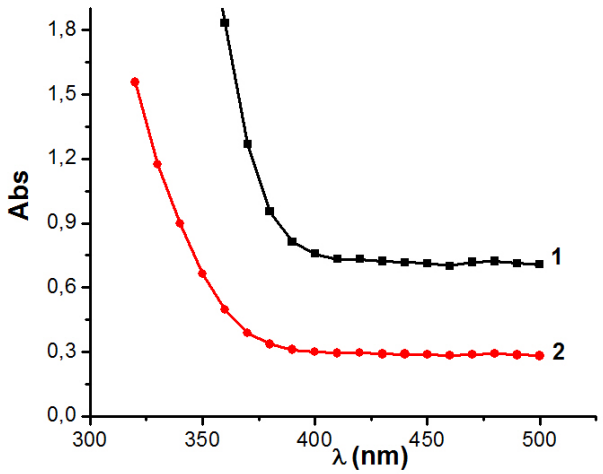


Figure 4. absorption spectra of nominally pure and iron-doped lithium niobate $LiNbO_3$: Fe

For comparison, in Figure 4 shows the absorption spectra of nominally pure and iron-doped lithium niobate $LiNbO_3$: Fe, from which it can be seen that the addition of an impurity significantly increases the absorption. Absorption begins to increase rapidly from 400 nm. Therefore, in the figure 4, the range from the short-wavelength range to 500 nm is taken.

Conclusion

An increase in the iron impurity concentration in lithium niobate leads to an increase in the diffraction efficiency. The maximum diffraction efficiency $\eta = 34\%$, obtained at a wavelength of $\lambda = 440$ nm, is achieved at different exposures, depending on the concentration of iron in the crystal, which is due to a significant increase in the change in the refractive index of $LiNbO_3$: Fe at $\lambda < 500$ nm. The values of the change in the refractive index, during the recording of information, can vary from 10^{-5} to $5 \cdot 10^{-5}$.

References:

1. Азаматов З. Т., Расулов.И.К. Голографическая запись информации на кристаллах ниобата лития // Изв. АН УзССР. Сер. Физ-Мат. Наук.– № 3. 1984.– С. 61–63.
2. Jonhston W. Optical index damage in $LiNbO_3$ and other phyroelectric insulators // Z.appl.phys.– V. 41. 1970.– 3279 p.
3. Azamatov Z. T., Yuldoshev M. A., Bazarbayev N. N. Prospects for holographic information storage systems // DAN AN RUz.,– № 1.– Toshkent, 2022.– P. 17–21.

4. Wong K. K. Properties of lithium niobate // The Institution of Electrical Engineers (London, United Kingdom) Book. 2002.– 411 p.
5. Khruk A. A. Structural disorder and optical processes in lithium niobate crystals with a low photorefraction effect (Апатиты on Moscow). 2015.– 149 p.
6. Volk T. and Wohlecke M. Lithium Niobate. Defects, Photorefraction and Ferroelectric Switching. – Berlin: // Springer; 2008.
7. Воронов В. В., Кузьминов Ю. С., Осико В. В. Оптически индуцированное изменение показателя преломление в сегнетоэлектрических кристаллах и его использование для создания обратимой голографической памяти // Квантовая электроника.– Т. 3. 1976.– С. 2101–2126.
8. Palatnikov M. N., Sidorov N. V., Makarova O. V. and Biryukova I. V 2017 Fundamental aspects of the technology of highly doped lithium niobate crystals // Institute of Chemistry and Technology of Rare Elements and mineral raw materials. Tananaeva I V. (Апатиты on Moscow) Book. – 241 p.
9. Sidorov N. V., Evstratova D. V., Palatnikov M. N., Syuy A. V., Gaponov A. Yu. and Antonycheva E. A. Investigation of lithium niobate photorefractive properties by photorefractive light scattering and raman spectroscopy // Ferroelectrics. Copenhagen University Library. 2011.– P. 148–155.
10. Kogelnik H. Coupled Wave Theory for Thick Hologram Gratings // The Bell System Technical Journal.– V. 48. 1969.– P. 2909–2946.

Section 6. Economics and management

https://doi.org/10.29013/ESR-21-9.10-44-49

Nozima Ragachurina,
senior teacher of Electronics and Radio-engineering Department
Tashkent University of Information Technologies
named after Muhammad al-Khwarizmi

ANALYSIS OF SPEECH PHONEMIC AND FORMANT STRUCTURES

Abstract. The article proposes a way to improve the accuracy of the analysis of the formant structure of speech sounds based on the formation of "idealized" phonemes obtained from quasi-stationary fragments of the original phonemes. It is shown that, based on the proposed approach, it is possible to refine the spectrum of any fragment of a phoneme, both for vocalized and non-voiced speech sounds, as well as for any stochastic signals using the standard Fast Fourier Transform (FFT) procedure in sound editors.

Keword: speech, phonemic, Fast Fourier Transform, spectrum, Discrete Fourier Transform.

Introduction

The most natural and popular means of communication between people has been and remains speech, therefore, interest in the development of speech signal processing technologies remains in the focus of attention of specialists in the field of infocommunication systems. This is evidenced by the presence of scientific publications on this topic, for example. Speech itself, by its nature, is a unique signal, and the essence of the process of verbal communication of people has not been fully disclosed. That is why the technologies used for the development of infocommunication systems are based on various approaches, including those based on the analysis of the phonemic and formant structures of speech. When training specialists in the field of speech infocommunication technologies, it is useful to demonstrate the phonemic and formant structures of speech. For these purposes, it would be logical to use audio editors that allow real-time analysis and processing of audio signals. However, an attempt to use them for the spectral analysis of speech sounds was not successful. This article discussed the reasons that did not allow us to demonstrate the formant structure of Russian speech sounds when using sound editors Adobe Audition®, Sound Forge®, Audacity® and the like. For the spectral analysis of sounds in these editors, the standard fast Fourier transform procedure is used, which provides for the division of the studied sound signal into segments of a given sample dimension N, moreover, a multiple of an integer power of 2, i.e. $N = 2n$. As a rule, values $n \geq 6$ can be set in sound editors, which allows forming segments of speech sounds from 64, 128, … 1024, etc. counts. This limitation on the segment size results in the impossibility of accurately matching the sample size to the duration of individual speech sounds, which is generally a random variable. As a result, certain segments of sounds are subjected to spectral analysis, the size of which is smaller or (most often) larger than the dura-

tion of real phonemes. In addition, it was shown that segments of speech sounds are subject to additional distortions resulting from the application of window functions necessary to eliminate the Gibbs effect. These distortions could be significantly weakened by increasing the sample size N so that it contains a large number of periods of the studied phoneme. However, this is rarely possible for two reasons. First, unvoiced speech sounds (short consonants "н", "к", etc.) have a short duration, so it is almost impossible to single out a sound segment containing several identical phonemes. Second, even in vocalized speech sounds, the shape of the phoneme undergoes significant changes in different parts of their sound, which are always accompanied by a redistribution of energy in the spectral region. In addition, of additional interest is the analysis of changes in the formant structure of the phoneme in various areas of its existence: attack, stationary part, decay. Attempts to improve the situation by varying the sample size N, increasing the sampling frequency of audio signals, and using various window functions did not lead to positive results. Therefore, the article concluded that the use of sound editors in the educational process to demonstrate the formant structure of speech phonemes is impossible, since the spectra calculated by them do not reflect the known results. To solve this problem, software should be used that provides the user with complete freedom in choosing the parameters of the sample size of the analyzed fragment and calculates the spectrum using algorithms that do not require a mandatory multiple of the FFT window size of a power of 2. Such conditions can be implemented, for example, in the MATLAB® program, which makes it possible to arbitrarily set the parameters of the discrete Fourier transform. The purpose of the article is to present a way to improve the accuracy of displaying the formant structure of speech sounds using the standard FFT-based spectrum calculation procedure used in audio editors. Statement of the problem aor research, the MATLAB® application program was used, in which all available algorithms for calculating the spectrum of signals are implemented. First of all, it was necessary to resolve the issue of choosing a criterion for assessing the accuracy of spectrum calculation. It is known that in the spectral analysis of deterministic signals, it is possible to analytically calculate the exact values of the coefficients of the Fourier series, which should be used as reference values when analyzing the results of calculating the spectrum of such signals in various ways. Phonemes, on the other hand, are not deterministic signals, since they do not have a stable form, which always changes depending on the place of the sound in the word, the features of the speaker's voice, and a number of other factors. In this sense, the phoneme is often compared to letters written by people with different handwriting. Therefore, the spectrum of each phoneme is unique and unpredictable.

Average spectrum estimates are possible and widely used in the development of infocommunication technologies and speech processing devices. However, in a number of cases, it is precisely the exact assessment of the formant structure of speech sounds that is of practical interest. For example, when solving the problem of identifying the speaker's voice, it is important to know exactly the unique features of the pronunciation of sounds or even their individual parts inherent in a particular person. It is precisely this goal – the preservation of the unique spectral parameters of the studied speech sounds – that the authors of this article set themselves. Considering the above, it was decided to assess the accuracy of spectrum calculation as follows: choose one of the spectrum calculation algorithms as a reference one, having previously determined the conditions for its application, and then compare the control results obtained with its help with the values obtained using other algorithms.

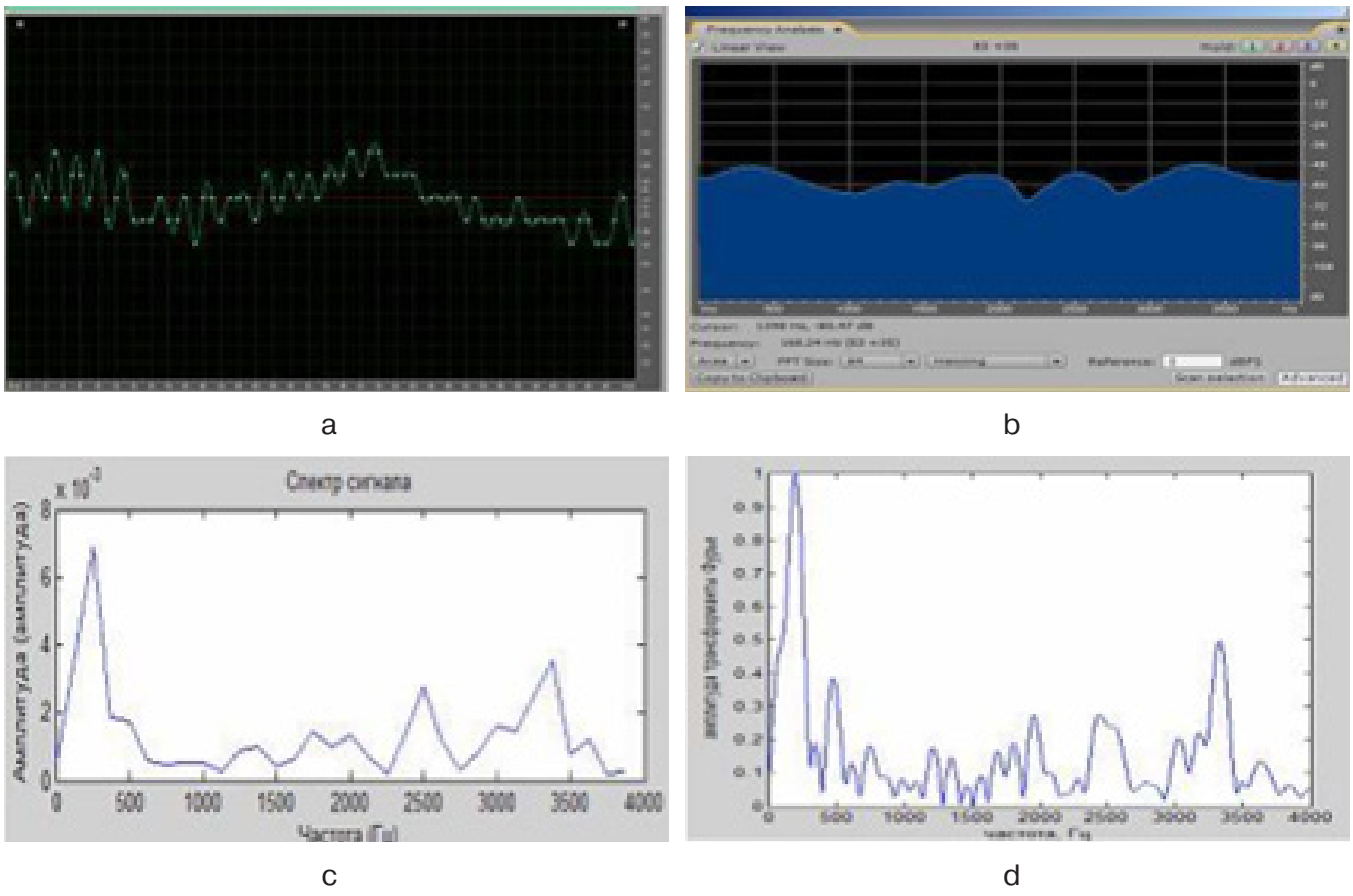
The article made an assumption that the distortion of the spectrum of the studied speech sounds is due to the use of the FFT algorithm, namely: the inability to match the size of the analyzed sample with the duration of the studied phoneme and the subsequent application of window functions to eliminate

the Gibbs effect. Therefore, the FFT algorithm cannot be chosen as a reference, but, on the contrary, the results obtained with its help should be compared with the control values obtained with the algorithm chosen as a reference. The further course of reasoning was as follows: in order to eliminate the distortions caused by the Gibbs effect, it is necessary to get rid of the discontinuity points of the first kind in the studied sound segments, i.e. signal voltage surges at segment boundaries. Then there is no need to use window functions that distort the shape of the analyzed segment.

The desired result can be achieved if the sound segmentation is performed manually, highlighting the beginning and end of the studied phoneme at the time moments when the levelogram graph crosses zero. This method of segmentation has one more advantage: it is possible to study the spectral structure of sound at any segment of its existence – attack, stationary part or attenuation. Obviously, the size of the signal sample obtained in this way will not be characterized by a multiple of a power of two, so the use of the standard FFT algorithm for audio editors is not possible. In this case, the spectrum can be calculated using the discrete Fourier transform formula:

$$F(k) = \sqrt{\left(\sum_{i=0}^{N-1} x[i]\cos\left(\frac{2\pi ki}{N}\right)\right)^2 + \left(\sum_{i=0}^{N-1} x[i]\sin\left(\frac{2\pi ki}{N}\right)\right)^2}$$

The results of calculation according to formula (1) should be used as control ones, and the DFT calculation method itself should be considered as a reference one. Results of computational experiments To carry out computational experiments, the Adobe Audition® sound editor and the MATLAB® program were used, in which the spectrum was calculated in two ways: using the built-in function FFT, which implements the FFT algorithm with a rectangular window; using a written program that implements the calculation of the DFT according to formula (1).



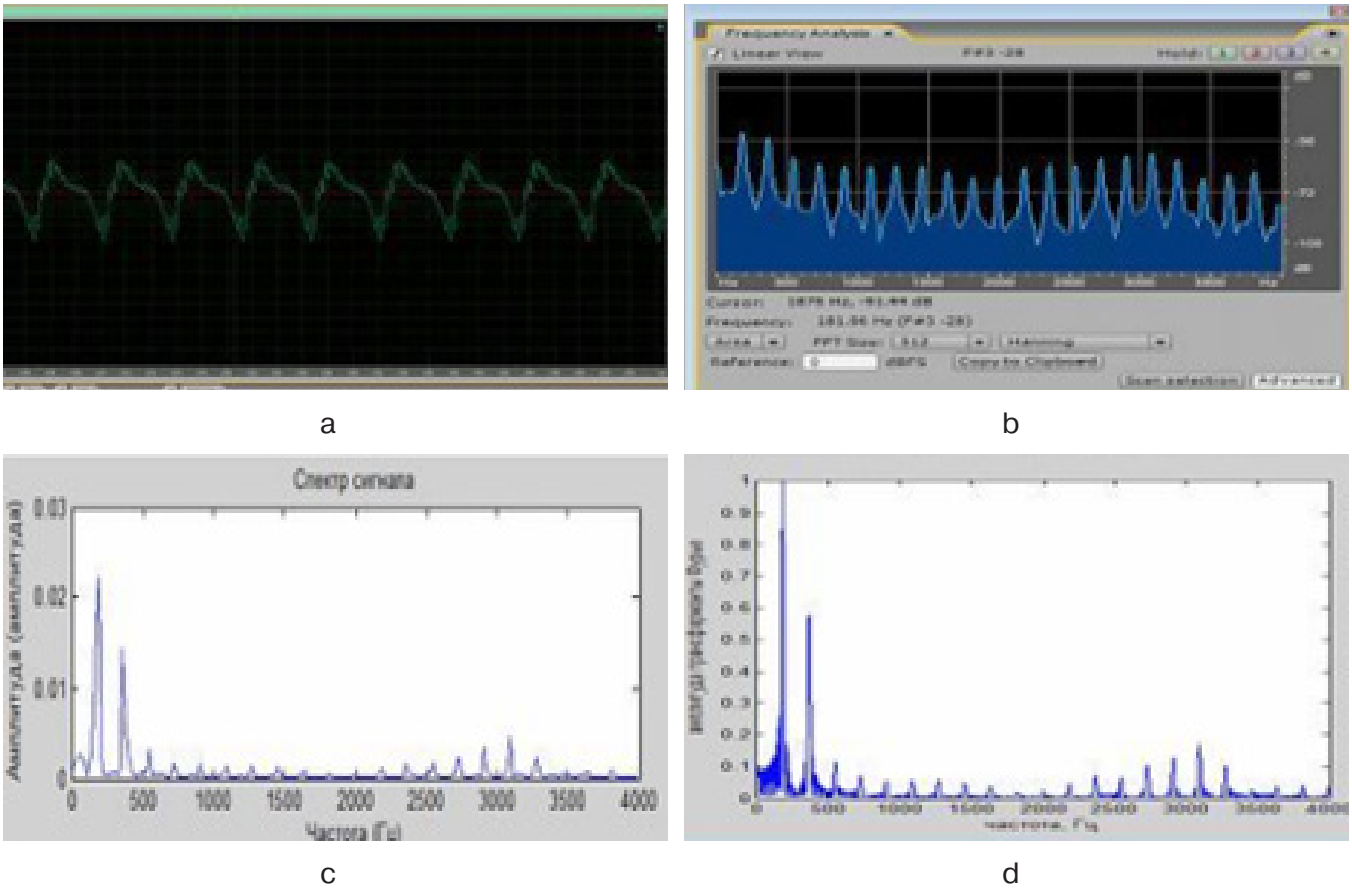
a b c d

Figure 1.

Figure 1 shows the phoneme of the sound "и" selected by the above method with a sampling frequency Fd=8 kHz (a) and the results of its spectral analysis by the FFT method using the Hanning window, N=64 in the Adobe Audition® editor (b), calculated in MATLAB® program using the built-in FFT function, N=64 (c) and using the full DFT formula (d).

Comparison of the spectra in Figure 1, a, b, c shows their significant difference. In Figure 1b, the spectrum looks like a fluctuating function with approximately the same, uniform energy distribution over the entire signal frequency band. The spectra calculated in the MATLAB® program give a completely different picture of the energy distribution – the region around 250 Hz stands out strongly, and local formant regions at frequencies of 2000 Hz, 2500 Hz and 3400 Hz are also visible, which have a clearly lower energy concentration. For the correct interpretation of these spectra, an envelope line should be drawn that smoothly connects the peak values of the spectral components. Obviously, the use of the Adobe Audition® sound editor does not give a satisfactory result and may cause an incorrect assessment of the phoneme energy distribution during the educational process. A similar pattern was observed when calculating the spectrum of phonemes of other speech sounds.

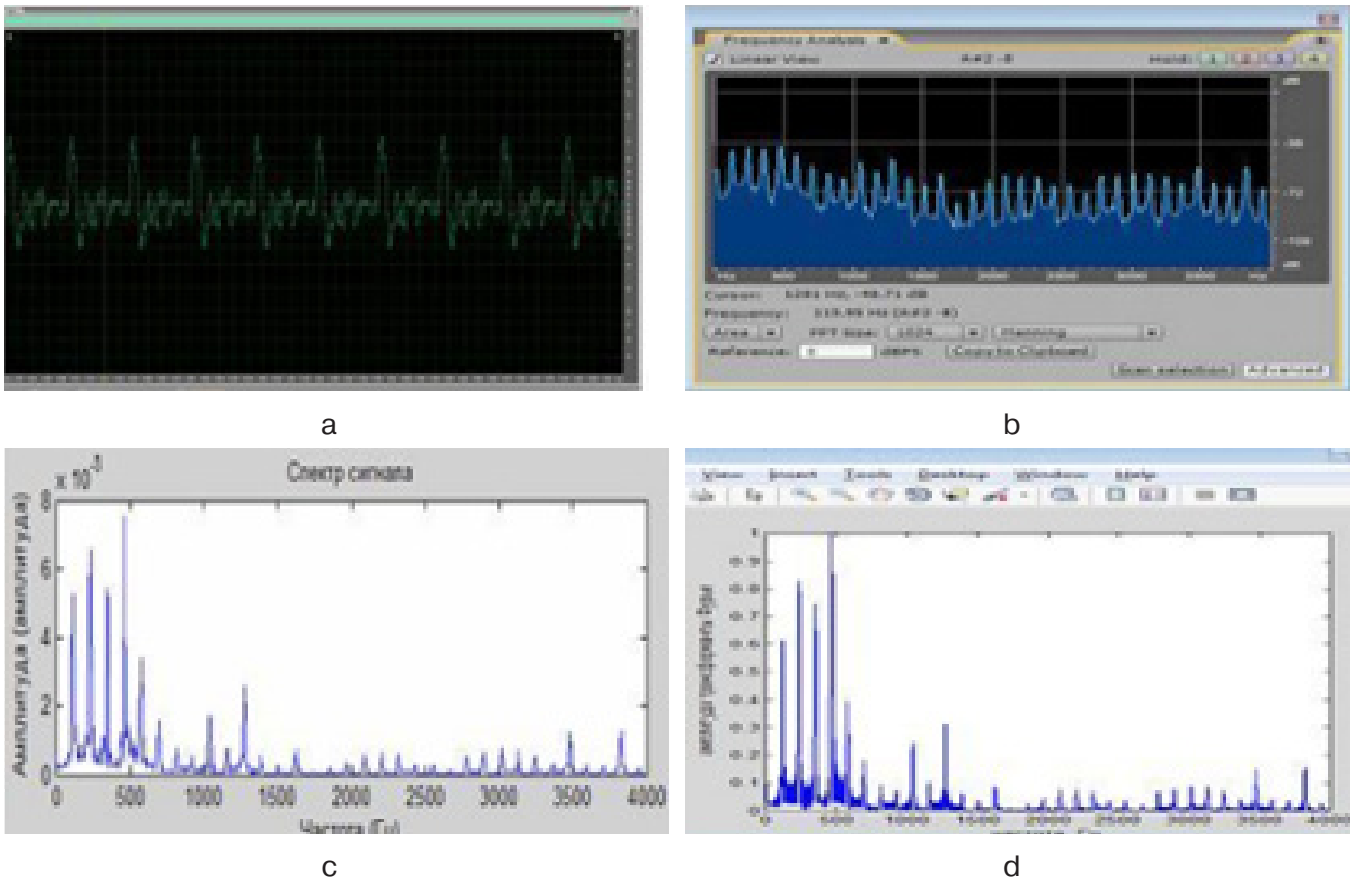
At the next stage of research, it was assumed that in order to improve the accuracy of spectral analysis with the help of sound editors, it is possible to synthesize an "ideal" sound for analysis, formed by repeated copying of one phoneme sample that does not have break points (voltage surges) at the beginning and end. Such an operation is easily implemented using the "insert" option available in all sound editors. Figure 2 shows the levelgram and calculated spectra of 10 phonemes of the sound "и"



a b c d

Figure 2.

On Figure 2 shows the results of calculating the spectrum of an audio signal synthesized from 10 periods of the phoneme of the sound "и". The total duration of the received signal was 440 counts. To analyze the spectrum using the FFT method, in both cases, the closest of the large window sizes N = 512 > 440 was chosen. Accordingly, the DFT was calculated exactly for 440 samples. Comparison of the corresponding results of calculating the spectra in Figs. 1 and 2 shows that the synthesized sound gives a clearer picture of the spectrum, which acquires a pronounced periodic structure and facilitates the localization of formant regions. At the same time, the results of calculations for the FFT and DFT performed in the MATLAB® program for the synthesized "ideal" phoneme are very close, which indicates an increase in the accuracy of calculating the spectrum with the FFT, despite the difference in the signal sample size and analysis window size. The appearance of the spectrum in the Adobe Audition® program has also significantly improved – the spectrum envelope has become more expressive and generally repeats the behavior of the spectrum envelope obtained in the MATLAB® program. For greater expressiveness of the energy distribution, one should use not a logarithmic amplitude scale, but a linear one, as in the MATLAB® program. Levelgram and calculated spectra of 10 phonemes of the sound "з" shown below.



a b c d

Figure 3.

In Figure 3 the results of calculating the spectrum for the "ideal" phoneme of the sound "з", consisting of 10 periods of the phoneme, with a total volume of 690 samples, are given. The window size for the FFT was chosen to be 1024 samples. As in the previous case, a significant improvement in the localization of formant regions is noticeable.

Conclusion

The proposed method for calculating formant regions, which provides for the formation of an "ideal"

phoneme by repeatedly copying one period of the studied phoneme, makes it possible to increase the accuracy of spectral analysis when using the standard FFT procedure in the general case and when using sound editors in particular. It is also necessary to note the universality of the proposed approach for the spectral analysis of any non-stationary or short-duration signals, if the subject of study is their instantaneous spectrum. In fact, the proposed approach partially eliminates the most important drawback of the Fourier transform – its inherent time-frequency uncertainty.

References:

1. Sidorenko I. A., Kuskova P. A. O spektral'nom analize fonem s ispol'zovaniem zvukovyh re-daktorov // Nauchnye vedomosti Belgorodskogo gosudarstvennogo universiteta, No. 1(144). 2013. vypusk 25/1, serija Informatika, – Belgorod, 2013.– P. 246–250.
2. Zhilyakov E. G., Prohorenko E. I. Chastotnyj analiz rechevyh signalov // Nauchnye vedomosti Belgorodskogo gosudarstvennogo universiteta. – No. 2(31). 2006. vypusk 3, serija Informatika i prikladnaja matematika.– Belgorod, 2006.– P. 201–208.
3. Zhilyakov E. G., Firsova A. A. Ocenivanie perioda osnovnogo tona zvukov russkoj rechi // Nauch-nye vedomosti Belgorodskogo gosudarstvennogo universiteta, No. 1(144). 2013. vypusk 25/1, serija Informa-tika, – Belgorod, 2013.– P. 173–181.
4. Babarinov S. L., Budnikova M. A. O raspoznavanii rechi // Nauchnye vedomosti Belgorodskogo gosudarst-vennogo universiteta, No. 21(192). 2014. vypusk 32/1, serija Informatika, – Belgorod, 2014.– P. 182–185.
5. Savchenko V. V., Vasil'ev R. V. Analiz jemocional'nogo sostojanija diktora po golosu na osnove fo-neticheskogo detektora lzhi // Nauchnye vedomosti Belgorodskogo gosudarstvennogo universiteta No. 21(192). 2014. vypusk 32/1, serija Informatika, – Belgorod, 2014.– P. 186–195.
6. Prihod'ko A. I. Determinirovannye signaly. Ucheb. posob. Dlja vuzov.– M: Gorjachaja linija-Telekom, 2013.– 326 p.: il.

Section 7. Science of law

https://doi.org/10.29013/ESR-21-9.10-50-54

Arnaudova-Otouzbirova Anna,
Trakia University,
PhD in Education, Faculty of Education

CITES AND THE INTERNATIONAL LAW ON THE PROTECTION OF WILD ANIMALS

Abstract. Learning about wild animals, their protection and welfare is an important issue for researchers, students and those interested in environmental science and animal welfare. The following article focuses on the role of CITES for the protection of wild animals within the framework of international wildlife law and in light of EU accession to the Convention. The article briefly addresses the question of animal welfare in relation to wild animal protection and emphasises the need for future actions to bridge the gap between wildlife conservation and animal welfare.

Keywords: CITES, protection of wild animals, animal welfare.

Introduction

Throughout human history perceptions about animals have changed significantly and our understanding of other-than-human beings has evolved to embrace the idea that some, including many wild animals, are sentient and are hence capable of experiencing pain, pleasure and suffering. A lot of people value non-human animals for their awareness and cognitive abilities and are prone to believe that we have certain obligations towards them, especially towards sentient creatures whose welfare is important and whom we are more likely to want to protect [1, 46]. Nonetheless, conservation measures have paid little attention to animal sentience [2, 465] and animal cruelty has increased despite animal protection laws [3, 2]. Unsustainable wildlife exploitation threatens the very existence of many endangered species with irreversible biodiversity loss, whereas wildlife trafficking has become "one of the most profitable international crimes" [4, 4]. The above phenomena require a closer look at international law on the protection of wild animals and the regulation of wildlife trade in particular by taking into account the question of wild animal welfare.

International wildlife law

Early legislation for the protection of wildlife on national level can be traced back thousands of years ago to ancient Babylon and Egypt but the use of international instruments is a more recent phenomenon originating in the last quarter of the 19th century [5].

Today's international instruments for wildlife conservation vary in terms of their scope, the geographical area and the species they cover, as well as the number of parties involved. They include global conventions, regional legal instruments with general scope, instruments with specific scope, treaties, memoranda of understanding, special species initiatives and bilateral instruments [6, 785–786]. The most significant of these are the conventions of global scale known as the "Big 5": The Ramsar Convention on Wetlands of International Importance Es-

pecially as Waterfowl Habitat (1971), the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (1972), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973), the Convention on the Conservation of Migratory Species of Wild Animals (1979) and the Convention on Biological Diversity (1992). Individually and collectively these international legal instruments have contributed to the conservation of wildlife and wild animals in particular. Among their positive outcomes are the designation of protected areas, the regulation of wildlife exploitation, increased cooperation between government and non-government stakeholders, conservation of species and development of national legislation regulating wildlife exploitation, to name but a few [6, 787].

Among the "Big 5", the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [7], which entered into force in 1975, stands out as the most successful and effective international agreement [8, 32] with straightforward basic principles ensuring that it is better enforced than other treaties [5, 484].

CITES and its role for the protection of wild animals

Following the dramatic increase of international trade in wildlife during the 1960 s and 1970 s [5, 483] the General Assembly of the International Union for Conservation of Nature and Natural Resources (IUCN) called for a convention to regulate the trade in wildlife species. Today, CITES success lies within the control it exercises over the import, export, re-export and introduction from the sea of specimens of species through the implementation of a licensing system. CITES prohibits the international trade in specimens of species included in its appendices without the prior grant of a permit by the national Management and Scientific Authorities. Thus, CITES becomes the first international wildlife treaty to require the establishment of national authorities to administer its provisions [5]. Currently, there are more than 38.700 species included in the appendices, covering 5.950 wild animal species protected by CITES against over-exploitation through international trade.

Appendix I includes "all species threatened with extinction which are or may be affected by trade" [7, Article II (1)].

Appendix II contains "all species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation" [7, Article II (2)].

Appendix III includes "all species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the co-operation of other Parties in the control of trade" [7, Article II (3)].

While any type of wild animal may be included in the list of species protected by CITES, specific amendments to Appendices I and II must be submitted in the form of proposals by the parties to the Convention and are then voted at the Conference of the Parties, the decision-making authority of CITES. The Secretariat is responsible for organising meetings, drafting resolutions and preparing annual reports. Other structural bodies include the Standing Committee, in charge of monitoring compliance, implementation and enforcement, and the Plants and Animal Committees. The latter is the authority providing specialized knowledge on wild animal species covered by the Convention.

In recent years CITES has contributed significantly to the conservation of species affected by trade [6, 787] and thus, to the protection of wild animals in particular. A major impediment, however, remains the problem of enforcement due to ideological differences and economic interests resulting in various and sometimes insufficient penalties and punishments inflicted, problems with confiscation, inadequate training of officials and ineffective control mechanisms, especially in developing countries [5; 6].

Nonetheless, the Gaborone amendment to the Convention [9], in force since 2013, allowing for the

accession of regional economic organizations, such as the EU, holds great potential for more successful implementation and the acquisition of higher standards in terms of enforcement.

EU implementation and enforcement beyond CITES

The EU accession to CITES took place on 8 July 2015 following Council Decision 2015/451, though the EU had implemented the Convention since 1984 through a number of regulations directly applicable to Member States but requiring enforcement by means of national legislation transference.

The most significant of these regulations is Council Regulation (EC) No 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein [10], amended by Commission Regulation (EU) No 1320/2014. It exercises control over the import, export, re-export, and internal EU trade of specimens through a licensing system of permits. The Regulation has four annexes indicative of how provisions regulating wildlife trade go beyond CITES in including species not covered by the Convention [11].

Annex A to Council Regulation (EC) No 338/97, for example, includes: all CITES Appendix I species, some CITES Appendix II and III species, for which the EU has adopted stricter domestic measures, as well as some non-CITES species.

Annex B covers all other CITES Appendix II species, some CITES Appendix III species and some non-CITES species.

Annex C refers to all other CITES Appendix III species, whereas Annex D is concerned with some CITES Appendix III species for which the EU holds a reservation and with some non-CITES species.

The EU imposes stricter import restrictions for species included in Annexes A and B and prohibits the purchase, sale and any commercial use of Annex A species. Wild animals included in Annexes A and B are further protected and import permits can be issued only provided that the intended accommodation for a live specimen at the place of destination is adequately equipped to conserve and care for it properly. In addition, Article 4 (1f) of the Regulation, in compliance with CITES Guidelines for Transport and IATA Live Animals Regulations for air transport, protects all animals introduced from the sea from "risk of injury, damage to health and cruel treatment" during transport.

Furthermore, the adoption of EU Action Plan against Wildlife Trafficking [12] in 2016 is of paramount importance for the enhancement of cooperation and the fight against illegal wildlife trade.

Animal welfare implications

Both wild animal conservation and animal welfare reflect our social concerns about animals but the two are often in conflict [2, 468] and wild animal conservation law seldom focuses on welfare issues [2, 463; 13, 935; 14, 1]. A good example is the culling of wildlife for conservation purposes, which raises serious welfare concerns. As an international trade agreement CITES contains provisions related to animal welfare, particularly in articles III, IV and V, but the parties to CITES disregard such concerns in preference of conservation measures and the only welfare policies adopted by the Convention are those of the International Air Transport Association [13, 935].

International conventions on wild animal protection focus predominantly on sustainable use [14, 17] and CITES Strategic Vision: 2021–2030 states that by 2030 "all international trade in wild fauna and flora is legal and sustainable" [15, 3]. That may prove beneficial in reducing trade in endangered species but remains, nonetheless, ineffective in addressing the welfare of individual animals, a phenomenon that will require a more "welfare-centric ethic" [2, 471].

The EU has proven that trade restrictions can be grounded in animal welfare concerns [1]. It successfully banned trade in seal products because of the use of inhumane killing methods and the subsequent ruling of the World Trade Organization in 2014 in favour of EU was a move in the right direction.

Furthermore, Article 13 of the Treaty on the Functioning of the European Union [16] which rec-

ognizes animal sentience and welfare requirements, as well as the proposed Universal Declaration on Animal Welfare and its potential adoption as a resolution by the United Nations may raise awareness and trigger legal action to protect wild animals on welfare grounds [2, 482].

Therefore, acknowledgement and acceptance of a broader definition of "animal protection", one that includes concerns about individual welfare and not simply about species conservation, may be warranted [2, 482].

Conclusion

Among the many important wildlife international laws, CITES has the capacity to act as a powerful tool in the protection of wild animals, despite some difficulties with implementation and enforcement. It provides an opportunity for the imposition of stricter conditions on international wildlife trade in view of EU accession and its regulation policy. Arguably, wild animal protection legal instruments and actions may benefit from bringing animal welfare to the forefront of both international and national agendas.

References:

1. Broom D. Chapter 3: International animal welfare perspectives, including whaling and inhumane seal killing as a W.T.O. public morality issue. In: Cao, D. and White, S. (eds.) Animal Law and Welfare – International Perspectives. Springer, 2016.– P. 45–62.
2. Scholtz W. Injecting compassion into international wildlife law: From conservation to protection? // Transnational Environmental Law, 2017.– Vol. 6.– No 3.– P. 463–483. Available at: URL: https://doi.org/10.1017/S2047102517000103/ (Accessed 13 October 2022).
3. White S. and Cao D. Introduction. In: Cao D. and White S. (eds.) Animal Law and Welfare – International Perspectives. Springer, 2016.– P. 1–7.
4. Fajardo del Castillo T. The European Union's approach in the fight against wildlife trafficking: Challenges ahead // Journal of International Wildlife Law & Policy, 2016.– Vol. 19.– No. 1 – P. 1–21.
5. Bowman M., Davies P., Redgwell C. Lyster's International Wildlife Law, 2nd Edn., Cambridge University Press, 2010.– 755p.
6. Trauwborst et al. International wildlife law: Understanding and enhancing its role in conservation // BioScience,– Vol. 67.– No. 9. 2017.– P. 784–790. Available at: URL: https://academic.oup.com/bioscience/article/67/9/784/4077046 (Accessed 18 September 2022).
7. Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973. Available at: URL: https://www.cites.org/eng/disc/text.php/ (Accessed 13 October 20220.
8. Calhoun Y. (ed.). Wildlife Protection, Environmental Issues Series, USA: Chelsea House Publishers., 2005.– 122p.
9. Gaborone amendment to CITES, 1983. Available at: URL: https://stag.cites.org/eng/disc/gaborone.php/ (Accessed 13 October 2022).
10. Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein, 1996. Available at: URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:31997R0338/ (Accessed 13 October 2022).
11. Species included in the annexes of Council Regulation (EC) No 338/97. Available at: URL: https://ec.europa.eu/environment/cites/species_en.htm/ (Accessed 24 September 2022).
12. EU Action Plan against Wildlife Trafficking, 2016. Available at: URL: https://ec.europa.eu/environment/cites/pdf/WAP_EN_WEB.PDF/ (Accessed 13 October 2022).

13. Baker S. et al. Rough trade: Animal welfare in the global wildlife trade // BioScience,– Vol. 63.– No. 12. 2013.– P. 928–938.
14. Adam R., Shaffner J. (2017) International law and wildlife well-being: Moving from theory to action // Journal of International Wildlife Law & Policy,– Vol. 20.– No. 1. 2017.– P. 1–17.
15. CITES Strategic Vision: 2021–2030, 2019. Available at: URL: https://cites.org/sites/default/files/eng/cop/18/Com_II/E-CoP18-Com-II-07.pdf/ (Accessed 13 October 2022).
16. Treaty on the Functioning of the European Union. Available at: EUR-Lex – 12012E/TXT – EN – EUR-Lex (europa.eu)/ (Accessed 10 October 2022).

Contents