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OF THE KARAGANDA
UNIVERSITY

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Status of soil cover on the degree of accumulation of heavy metals in the soil of the industrial region (Karaganda city)

In article the condition of a soil cover of the city of Karaganda is studied. To this end, there have been ranked according to the highest degree of pollution. It was revealed that the dynamics of hygienic indices for 3 years is unfavorable with respect to the soil in the residential area. Against the background of the general tendency to reduce the level of soil pollution in the zone of influence of enterprises, the soil in the industrial area of the city is heavily polluted. The most intensive soils are contaminated with substances belonging to the first and second hazard classes: lead, zinc, copper and nickel. The content of zinc exceeds the MPC by approximately 3 times, lead by 1.5 times, copper by 1.6 times, nickel by 1.3 times. Such differences in the formation of zones of high and low soil polluted cities, to some extent, may be associated with age, the industrial development of the city, which was formed in the past 50–60 years, and much younger.

Keywords: residential area, the soil, lead, method of stripping voltammetry, industrial district, environment, chemical pollution.

In conditions of modern anthropogenic pressure on the environment, the main type of industrial pollution of soils is contamination with heavy metals, the sources of which are industrial enterprises, vehicles, housing and communal services. The most large-scale types of pollution in recent decades include environmental pollution by heavy metals, which are extremely difficult to remove from soil ecosystems.

In addition to direct toxic effects, many heavy metals are characterized by so-called long-term toxicity effects that affect such vital functions of living organisms as reproduction and bioproductivity. Thus, pollution of the environment with heavy metals poses a threat not only to individual organisms, but also to whole generations and populations. Unlike many other pollutants, they are not destroyed and not converted. In nature, in the processes of migration, only the forms of their location and concentration change. For many heavy metals, a cumulative effect is characteristic — the summation of harmful effects from individual pollutants. Monitoring the quality of the urban environment with full coverage of the residential area and taking into account all significant anthropogenic factors in modern conditions will not be implemented to the necessary extent due to the high cost of research. It is necessary to allocate observation zones that reliably reflect the diversity of living conditions of the urban population [1, 2]. From the existing methodological approaches to the ranking of territories according to the level of environmental problems, the most appropriate is the mapping of the territory according to the degree of environmental pollution [3, 4].

In this regard, the state laboratory control soil was held in Karaganda, which allows him to ascertain the environmental status.

Materials and methods

To this end, there have been ranked according to the highest degree of pollution. To this end, we selected soil samples from the various functional areas of the city. The first zone consisted of soil sampling point from the territory located near the industrial plants at a distance of 1000–1500 m. The second zone is the center of the city, where there is not industry, is the big pollution from road transport. Third point selection is «sleeping» area of the city, where there is an extensive highway network and industrial and service enterpris-

es. The metal content in the 750 soil samples was determined by stripping voltammetry. The method is based on the accumulation of ions of analytes on the surface of the working electrode over time, with a yield of ions from the working electrode in a solution under the influence of changes in the working electrode potential. Since each type of ion has a certain output potential, and the movement of ions causes a change in the current in the working electrode circuit, this allows us to detect the current dependence on the voltage applied to the working electrode, to identify the type of ions, proportional to the current to determine the number of ions of the type [5, 6].

The mineralization of samples was carried out in an automated complex sample preparation «TEMOS EXPRESS» TE-1. The automated complex sample preparation «TEMOS EXPRESS» TE-1 is designed for the complete destruction of interfering organic substances, thermal treatment with oxidants (HNO₃, H₂O₂, H₂SO₄ et al.) in the temperature from 50 °C to 650 °C by determining the concentration of toxic elements (Cd, Pb, Zn, Cu, As et al.) in samples of various environmental objects by conducting quantitative chemical analysis by direct and inverse voltammetry, atomic absorption, photometry, etc. Total index of soil contamination (SDRs), calculated using the formula recommended by the F.F. Erisman Moscow Research Institute of Hygiene in 1996.

$$\text{the soil } K = C_1 / \text{MPC}_1 + C_2 / \text{MPC}_2 + C_3 / \text{MPC}_3 + \dots C_n / \text{MPC}_n,$$

where $\text{the soil } K$ — total index of soil pollution; $C_1, C_2, C_3 \dots C_n$ — actual concentration of chemicals in the soil; $\text{MPC}_1, \text{MPC}_2, \text{MPC}_3, \text{MPC}_n$ — the maximum permissible concentration of these substances.

Research results

Dynamics of hygienic indicators for 3 years is unfavorable with respect to soil in the residential area. Against the background of the general tendency to reduce the level of soil pollution in the zone of influence of enterprises, the soil remains heavily polluted in the industrial area of the city. In the Oktyabrsky district recorded 66.6 % of non-standard samples in the zone of influence of industrial enterprises. Within a radius of industrial exposure, there are significant excess of MPC in a number of heavy metals. For example, in the area of influence of the foundry «Kazakhmys» corporation, CHP-3 content of salts of heavy metals — copper, zinc, lead, nickel — ranging from 1.8 to 7.5 MPC. In the central area of the city (Kazybek bi), 100 % of the samples taken in the area of influence of transport highways registered concentrations exceeding the standards for heavy metals (lead — from 2 to 10, MPC, nickel — from 4.6 to 6.3 MPC). In the South-Eastern area of influence of highway industrial enterprises in 100 % of cases, the sampling of lead content exceeds the norm of up to 3 MPC; zinc — 1.7 MPC; nickel — to 1.8 MPC.

During the period 2012–2015 in the city a special eco-hygienic survey of soils was carried out by soil Center of Sanitary Inspection. Evaluation of soil contamination level was carried out by 17 indicators, including heavy metals.

It may be noted that the most heavily contaminated soil substances belonging to the first and second classes of hazards: lead, zinc, copper and nickel.

The most unfavorable is the situation on pollution by lead and zinc soil. The proportion of unsatisfactory samples for these indicators amounted respectively to 19.3 % and 15.5 %, and the frequency of the MPC for copper and nickel, respectively, 7.3 % and 7.6 %.

One of the most contaminated areas is — Kazybek bi, where 40 % of the samples revealed lead in quantities exceeding maximum concentration limit in 46 % of samples — zinc, 26.7 % — nickel. The share of non-standard analyzes for copper was the highest in 2007 in the Oktyabrsky district, but in 2005 the Kazybek bi district was in the lead.

The long-standing industrial pollution of the soil cover of the city, represents the city of Karaganda in a single biogeochemical province. In studying the table we observe that the subject areas on the total figure is almost aligned with each other.

The lead content of the soil cover ranges from 22 mg/kg to 53 mg/kg (Table 1, Fig. 1).

Table 1

Heavy metals in soils of Karaganda (mg/kg)

№	Cu	Pb	Zn	V	Cr	Co	Ni	Mn	Be	SDRs
1	53	22	115	71	98	17	27	607	2,1	6,7
2	26	24	150	50	51	23	14	280	1,8	4,7
3	21	53	60	67	68	22	22	1447	1,6	5,54

Note. 1 — area with high anthropogenic load; 2 — average anthropogenic impact; 3 — relatively clean area.

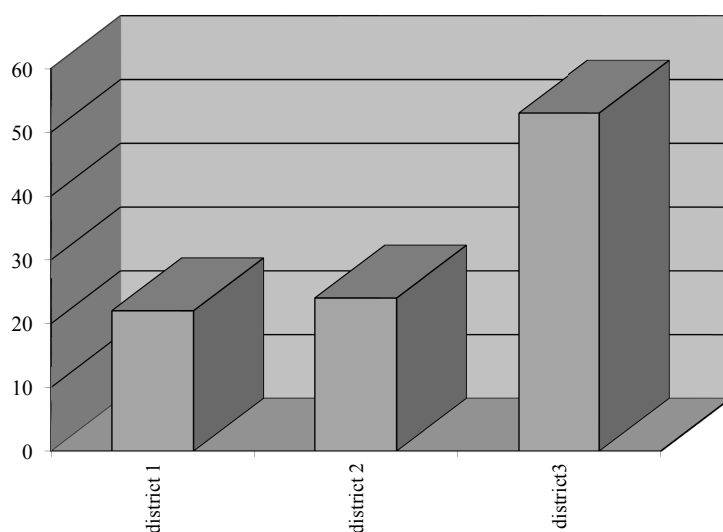


Figure 1. The content of Pb in the soils of Karagandy (mg/kg)

Lead contaminated territories of all areas of the city, most content from leading motorways (Fig. 2). For copper characterized by localization in the upper layer of soil (10–15 cm from the surface) which reflects its bioaccumulation and modern anthropogenic influence. Contamination of soil copper compounds is the result of contributions from industrial sources. Possible occurrence of local copper anomalies in soils as a result of corrosion of structural materials containing copper alloys (electrical wires, pipes).

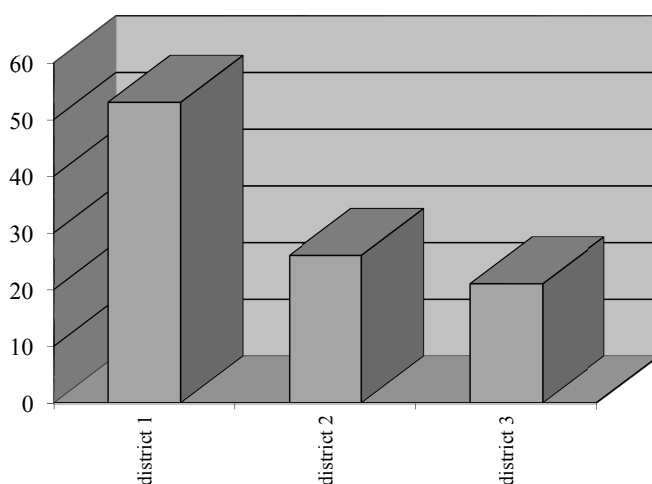


Figure 2. The content of Cu in the soils of Karagandy (mg/kg)

The variability of copper concentration in the city was 21 mg/kg — 53 mg/kg (Fig. 2). Manganese accumulation usually occurs in the subsoil, and 60–90 % of the manganese is found in sandy soil fractions. In soils of the city there is a wide distribution of manganese in concentrations from 607 to 1447 mg/kg (Table 1). This is due to the fact that emissions of many enterprises of the city contain manganese oxide. The reason for the low manganese content in the upper layers of the soil can be a large radius of its dispersion and exceeding the solubility in the presence of pH-lowering humic acids.

Nickel is found in the town soil cover in concentrations of 22 mg/kg to 27 mg/kg (Fig. 3). The high concentrations are determined in the territories of all districts of the city. Accumulation of nickel in soil is due to the ability of the cell adsorbed manganese oxides and organic forms of iron.

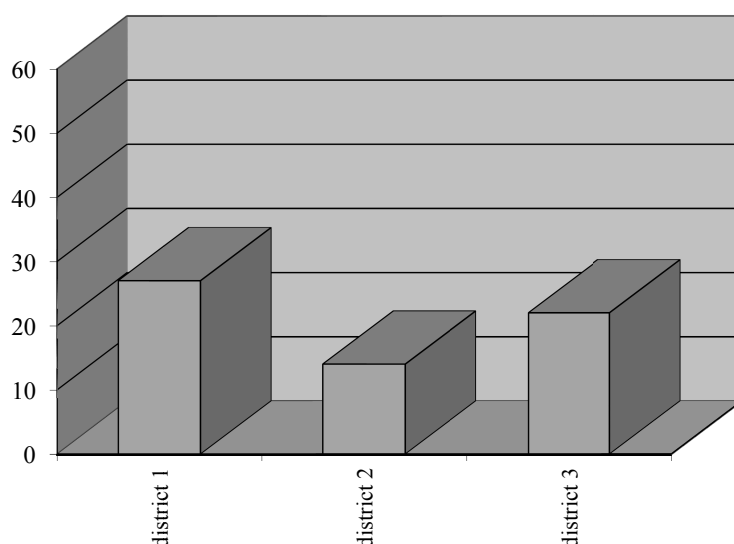


Figure 3. The content of Ni in the soils of Karagandy (mg/kg)

The range of concentration of beryllium in the city of 1.6 mg/kg — 2.1 mg/kg, which contributes to shift the pH toward alkaline sides. The chromium coming from technogenic sources usually accumulates in a thin surface layer of soils. The range of oscillations is 68–98 mg/kg (Table 1). Chromium is from 68 to 98 mg/kg. Increased chromium content is registered in the individual samples. The presence of chromium in soils indicates its technogenic nature. Chromium accumulation in soil associated with the pH of the medium and large amounts of organic complexes [7, 8].

Revealed several territorial areas of the city (district № 2 — the average man-caused load), where there is extensive contamination of soil, including: Avenue Bukhar-Zhyrau (lead — 2.3 MPC, copper — 5.5 MPC); Prospect Builders (lead MPC — 2.5); Bus South-East (lead — 2,9 MPC); area CHP-3 (copper — 7.5 MPC; nickel — 6 MPC); zone of «Kazakhmys» in the October district (lead — 2 MPC, copper — 3,7 MPC, zinc — 1,7 MPC).

High lead contamination of soil from the exhaust gases of vehicles registered in the quarter of 45, str. Yazev, str. Gogol, Avenue N.Abdirova reaching 2 to 10 MPC (Table 2).

Table 2

Excess of heavy metals in the soil relative to the MPC residential areas

Zone	2013 y.				2014 y.				2015 y.			
	Cu	Zn	Pb	Ni	Cu	Zn	Pb	Ni	Cu	Zn	Pb	Ni
1	1.8	2	3.2	4	2	3.4	5	7	2.3	5	6	7.5
2	2	2	4	4	3	3.4	6	6.5	7.5	4.2	7.2	6
3	5.4	—	2	4.6	—	—	6	5.4	—	—	8	6
4	5.5	—	3	4.2	—	—	8	5.7	—	—	10	6.3
5	2.5	—	2.5	1.3	—	—	1.6	1.2	—	1.2	1.7	1.2
6	—	—	2.9	1.2	—	—	1.7	1.2	—	—	1.5	1.2

Note. 1, 2 — Oktyabrsky district; 3, 4 — Kazybek bi; 5, 6 — South-East.

In terms of oil pollution, the most polluted are Kazybek bi and southeastern regions, where the average annual concentration of 735–737 mg/kg. These laboratory monitoring of soil pollution by pesticides indicate their absence in the soil.

Monitoring of territories clinics residential areas on the total level of soil contamination has revealed that similar to the total index of air pollution the highest soil pollution with heavy metals is observed in the service area of a polyclinic № 2 (Kazybek bi). Soil pollution is noted on the territory of the polyclinic № 3 (South-East). Pollution 13 and 15 districts (Maikuduk) territory clinic № 4 and 7 Oktyabrsky district (an average SDRs of the city — 2.08).

By calculating the average levels of soil contamination with heavy metals in the service areas of polyclinics, some sharply differing values of the indicators (abnormal values) characterizing analyzes of soil

samples either on motorways or in the immediate vicinity of industrial facilities were excluded from treatment. Of course, by sampling soil samples, the zones of influence of enterprises and highways were not completely avoided, residential areas were affected selectively, however, the main regularities of the differences in soil pollution of the city were fixed quite objectively.

Thus, the highest level of pollution and accumulation of elements of I and II classes of danger, such as lead, zinc, copper, nickel, based on the share of non-standard samples is Kazybek bi area and the area of the foundry «Kazakhmys» corporation.

City Karaganda receives heat and hot water mainly from CHP-3, which also contributes to the pollution of the regional center [3, 9]. The table shows that the accumulation of the studied elements in the soil adjacent to the territory of CHP-3 at doses exceeding the maximum permissible concentration in a few times (Table 3).

Since the zinc content exceeds the MPC is about 3 times in all sampling points. The lead content exceeds MPC by 1.5 times in all sampling points. The copper content exceeds MPC by 1.6 times. The nickel content exceeds MPC by 1.3 times. MPC cobalt content exceeds 0.6 times at a distance of 500–1000 m, in other points of the content selection is within the MPC, but greater than the background by more than 10 times. We also spread the soil pollution of heavy metal salts was determined (in terms of the SDR). Effects observed in the radius of the motorway on the territory of 45 quarters (Kazybek bi district) and the main part of the prospectus of Builders of South-Eastern District. Similarly, atmospheric pollution regularly highlighted «conditionally clean» zone — Gulder community-1 and Mikhailovka area (Kazybek bi district).

Table 3

The distribution of heavy elements in the soils of the area CHP-3 Karaganda (mg/kg)

Chemical element	Background	MPC	Subject distance		
			500–1000 m	1500–3000 m	3000–10000 m
Zinc	41.5±2.33	100	328.6±18.26	299.1±34.88	285.46±21.0
Lead	15.6±0.89	60	85.5±4.22	82.3±5.85	84.87±10.34
Copper	18.2±2.21	100	168.4±7.11	162.3±12.75	161.5±8.12
Cobalt	3.8±0.56	50	56.5±11.50	46.9±6.33	43.2±7.14
Nickel	12.2±1.54	70	95.5±23.96	89.6±9.74	88.3±11.25

Such differences in the formation of zones of high and low soil polluted cities, to some extent, may be associated with age, the industrial development of the city, which was formed in the past 50–60 years, and much younger.

Thus, to increase the effectiveness of the monitoring of chemical elements in samples of natural environments that require surveillance organization dynamics.

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Өндіріс аумағы топырағында ауыр металдардың жинақталу деңгейі бойынша топырақ жамылғысының жағдайы (Қарағанды қаласы)

Мақалада Қарағанды қаласының әртүрлі функционалды аумақтарының топырақ жамылғысының жағдайы зерттелді. Топырақтың ауыр металдармен ластануына байланысты экологиялық жағдайдың деңгейі бойынша қала аумағының жіктелуі жүргізілді. Селитебі аумақтағы топырағының 3 жылдық гигиеналық көрсеткіштердің жағымсыз динамикасы анықталды. Өндіріс аумағы топырағының жоғары мөлшерде ластануы дәлелденді. Топырақ қарқынды түрде қауіптіліктің бірінші және екінші класына жататын мырыш, мыс, никель және тағы басқа заттармен ластанған. Мырыш мөлшері ШРК мөлшерінен 3 есе, мыс 1,6 есе, никель 1,3 есе жоғары. Қала топырағының жоғары және төмен деңгейде ауыр металдармен ластануы соңғы 50–60 жылдар бойы қалыптасқан өндіріс құрылыспен байланысты болуы мүмкін.

Кілт сөздер: селитебі аумақ, топырақ, мырыш, мыс, инверсиялық вольтаперометрия тәсілі, өндіріс аумағы, қоршаған орта, химиялық ластану.

М.А. Мукашева, Ш.М. Нугуманова

Состояние почвенного покрова по степени накопления тяжелых металлов в почве промышленного региона (город Караганда)

В статье изучено состояние почвенного покрова города Караганды с различных функциональных зон. Проведено ранжирование территорий города по степени направленности экологической ситуации, связанной с загрязнением почвы тяжелыми металлами. Выявлено, что динамика гигиенических показателей за 3 года неблагоприятна по отношению к почве в селитебной зоне. На фоне общей тенденции к снижению уровня загрязнения почвы в зоне влияния предприятий в промышленном районе города почва сильно загрязнена. Наиболее интенсивно почвы загрязнены веществами, относящимися к первому и второму классам опасности: свинцом, цинком, медью и никелем. Содержание цинка превышает ПДК примерно в 3 раза, свинца — в 1,5 раза, меди — в 1,6 раза, никеля — в 1,3 раза. Подобные различия в формировании зон высокой и низкой загрязненности почв города в определенной мере могут быть связаны с возрастом промышленной застройки города, которая сформировалась в последние 50–60 лет (и значительно моложе).

Ключевые слова: селитебные территории, почва, свинец, цинк, медь, никель, метод инверсионной вольтаперометрии, промышленный район, окружающая среда, химическое загрязнение.

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Toxicity of antibiotics mixture to the aquatic biota

Nowadays, the occurrence of pharmaceuticals in various concentrations in surface waters and effluents were reported in many papers worldwide. The studies of developed countries showed that many pharmaceutical ingredients can have the negative effect on the growth and reproduction of environmental species. Nevertheless, pharmaceutical pollution has not been considered as environmental issue in Kazakhstan. Previous studies on pharmaceuticals were focused on the effect of single pharmaceutical ingredient exposure to living organisms. Nevertheless, in most cases pharmaceuticals occur in the environment in mixture forms. Therefore, the aim of the following paper was to perform ecotoxicological test for the effect of the mixture antibiotics to the growth of *Lemna minor*. The combination of five antibiotics as amoxicillin, clarithromycin, azithromycin, sulfamethoxazole and oxytetracycline was used as objects for assessment study. Two measurement variables were used for the evaluation: growth rate and growth inhibition. The results of the experiment showed that the mixture of studied compounds is highly toxic to macrophyte, as the half-maximal effect concentration was below 1 mg/L (0.13 mg/L).

Keywords: amoxicillin, clarithromycin, azithromycin, sulfamethoxazole, oxytetracycline, *Lemna minor*, ecotoxicology, environment, pharmaceuticals, pharmaceutical pollution.

Introduction

In the last three decades of the studies, pharmaceuticals were classified as environmental pollutants and it was concluded that they can lead to environmental contamination and even cause risk to human health. Likely, the production and usage of drugs will grow in the future, as people live longer and consume more pharmaceutical products when they become older. Moreover, the living standards are becoming higher and the number of budget friendly drugs are increasing. As a result, it can lead to the increase of pharmaceutical pollution worldwide [1].

Currently, above 3000 active pharmaceutical compounds as antibiotics, beta-blockers, painkillers, contraceptives, lipid regulators, tranquilizers and impotence drugs are consumed in the world. After usage pharmaceuticals released as parent or metabolized form. The majority of drugs are well soluble in water and therefore they easily enter to the aquatic system. The consequences of such releases and effect of pharmaceuticals to the environment and human are not well studied. Medical substances do not release only in specific location, they are spread worldwide everywhere. Furthermore, drugs do not meet individually, they occur in mixtures [2]. Thus, pharmaceutical products can be included to the uncontrolled chemical stressors that enter to the environment [3].

According to research by scientists at the University of Gothenburg in Sweden, clotrimazole pollutes the ecosystem of the ocean. The community of natural microalgae *Periphyton* were used for their study. The species were exposed to different concentrations of clotrimazole during 4 days. The results demonstrated that clotrimazole violates algae metabolism. The fact that single-celled microalgae are the fundamental basis of the food chain in the ocean, and the use of clotrimazole could affect the whole ecosystem of the ocean [4].

The well-known case of the negative impact of pharmaceuticals has been registered in South Asia. In these countries, the population of vulture species as *Gyps bengalensis*, *Gyps indicus*, *Gyps tenuirostris* and *Sarcogyps bald* declined sharply in 2000–2007. The reason for the extinction of this population became a pharmaceutical formulation of diclofenac. This compound was used for the treatment of tumors and injuries of cattle. After the introduction of the pharmaceutical compound, 0.3 mg of diclofenac were found in cattle liver. Birds fed on the carcasses of those cattle and accumulated in their body in concentration up to 0.1 mg/kg. As a result, there was decline of more than 90 % of vulture population and this led to the increase of wild dog population and consequently spread rabies [5–7].

Photoautotrophs as algae and macrophytes play an important role in total biomass in the aquatic system. Moreover, algae and higher aquatic plants are the major carbon sources for the aquatic environment. However, there have not been performed many toxicity test of antibiotics on macrophytes and algae. It can be noted, that risk assessment results pay a big attention representatives of aquatic organisms [8].

The aim of the following research was to assess the effect of mixture five antibiotics as amoxicillin, clarithromycin, azithromycin, sulfamethoxazole and oxytetracycline to the growth of duckweed. *Lemna minor* was selected as object of the study. Overall, duckweeds occur in the majority of surface waters worldwide. The most well-known duckweed is *Lemna minor*. This macrophyte is very convenient for ecotoxicity study, as it is budget friendly and time saving. Moreover, there have not been conducted many studies on effects of pharmaceuticals to duckweeds. Mostly, ecotoxicity studies are focused on impacts of drugs to fish and algae [9].

Materials and methods

Antibiotics were supplied from Sigma Aldrich UK. *Lemna minor* were collected from Food and Environment Research Agency. Table represents data about the study substances used for the ecotoxicity test.

Table

Physico-chemical properties of study compounds

Antibiotic	Molecular formula	Molecular weight, g/mol	Solubility in water, mg/L
Amoxicillin	C ₁₆ H ₁₉ N ₃ O ₅ S [10]	365.40416 [11]	3430 [10]
Clarithromycin	C ₃₈ H ₆₉ NO ₁₃ [10]	747.953 [11]	1.693 [11]
Azithromycin	C ₃₈ H ₇₂ N ₂ O ₁₂ [10]	748.98448 [11]	2.37 [11]
Sulfamethoxazole	C ₁₀ H ₁₁ N ₃ O ₃ S [10]	253.27764 [11]	610 [10]
Oxytetracycline	C ₂₂ H ₂₅ ClN ₂ O ₉ [11]	496.897 [11]	1000 [11]

Lemna minor growth inhibition test was performed according to OECD Guideline for the testing of chemicals 221 [12]. In order to conduct *Lemna minor* ecotoxicity study, 15 mL petri dishes were used and filled with 10 mL of Swedish SIS medium nutrition solution. Due to low solubility of macrolides in deionized water, the stock solution of was made in ethanol. The mixture of antibiotics was made in ratio 2:1:1:6:5 (amoxicillin, clarithromycin, azithromycin, sulfamethoxazole, oxytetracycline respectively). The following ratio was selected due to their exposure indices in surface waters of Kazakhstan [13]. Each petri dish included 2–4 frond colonies with total 6–8 fronds. Ecotoxicological experiment was set up with three replicates test compounds and six replicates of controls. The toxicity of antibiotics was assessed in concentrations from 0.2 to 1 mg/L. Fronds of *Lemna minor* were calculated at the beginning of the test, then on day 3 and day 7. The area of the colonies in each test sample was detected using the image analysis software Image J. The effect of test samples on growth of *Lemna minor* was assessed using response endpoints: growth inhibition and mean specific growth rate of frond numbers [12].

Results and discussion

According to results of half maximal effect concentrations (EC₅₀) of five compounds to *Lemna minor* was 0.13±0.02 mg/L. Figure demonstrates the growth inhibition and growth rate of tested duckweed to the mixture of the compounds. Initially, tested concentrations ranged from 0.2 mg/L to 1 mg/L. However, at the end of the test, the fronds in the samples with concentration 0.8 mg/L and 1 mg/L died and in concentration 0.6 mg/L almost total growth inhibition was recorded. The concentration value 0.6 mg/L led growth rate till 0.01 d⁻¹, while the value of controls in growth rate was 0.17 d⁻¹.

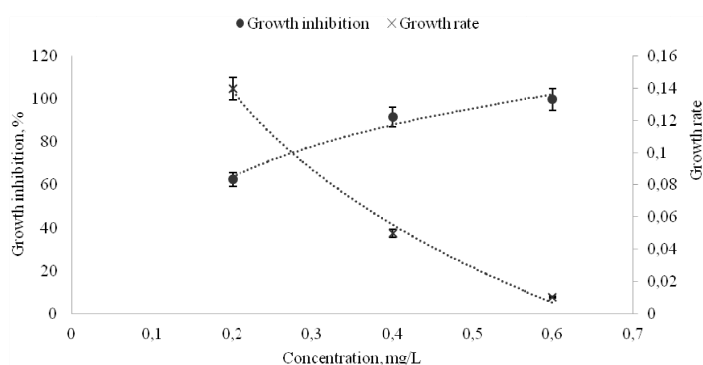


Figure. The growth inhibition and growth rate of the mixture five antibiotics: amoxicillin, clarithromycin, azithromycin, sulfamethoxazole and oxytetracycline

The value of EC_{50} of combined compounds to duckweed is lower than 1 mg/L. According to EU-Directive 93/67/EEC classification, this mixture is very toxic to aquatic life [14].

Overall, the results of the performed ecotoxicological test are persistent with previous with results of previous research. In 2002, Cleuvers carried out investigation on ecotoxicological potential of prescription drugs to aquatic organisms. For the research, he used pharmaceuticals as clofibrac acid, carbamazepine, ibuprofen, diclofenac, naproxen, captopril, metformin, metoprolol and propranolol and aquatic organisms as crustacean *Daphnia magna*, green algae *Desmodesmus subspicatus* and macrophytes *Lemna minor*. The results showed immobilization in 24 and 48 hours. During the test, it was found that *Desmodesmus subspicatus* and *Lemna minor* are sensitive to the most of drugs as they showed a high growth inhibition percentage. In addition, in analysis of effect of drugs to aquatic organisms, Cleuvers identified that the mixture of medications had a stronger effect to tested organisms rather than individual exposure of substances. In view of this study it may suppose that in most cases pharmaceutical compounds affect in combination to environmental species [15].

A recent study by Aubakirova et al. found that amoxicillin, clarithromycin, azithromycin, sulfamethoxazole and oxytetracycline individually also have a toxic effect to *Lemna minor*. Aubakirova et al. highlighted EC_{50} of sulfamethoxazole below 10 mg/L and concluded that this antibiotic is highly toxic to aquatic species [9].

In the same vein, in 2017 Bialk-Bielinska et al. have performed investigation on effects of the combination six antimicrobial sulfonamides and their degradation compounds sulfanic acid and sulfanilamides to green algae *Scenedesmus vacuolatus* and macrophyte *Lemna minor*. The study also included the assessment of toxicity of individual substances as sulfanic acid and sulfanilamides to selected species. According to the results, sulfanilamides are toxic to the species in the aquatic biota, whereas sulfanic acid does not cause risk to aquatic organisms. However, the mixtures of sulfonamides and sulfanilamides showed a high risk, as their effect concentration (EC_{50}) value to *Lemna minor* was lower than 1 mg/L and to *Scenedesmus vacuolatus* was around 1–1,5 mg/L. These outcomes demonstrate that single pharmaceutical compound can be not toxic, but their combination is harmful to environmental species [16].

Conclusion

To sum up, over the last 20 years, there has been increasing interest in the occurrence, fate, effects and risk of pharmaceuticals in the natural environment. However, we still have only limited or no data on ecotoxicological risks of many of the pharmaceutical ingredients currently in use. Consequently, it is essential to conduct ecotoxicity studies of pharmaceutical substances on various environmental species. Nowadays, the most studies are focusing on individual impact of drug to aquatic biota. However, pharmaceuticals occur on surface waters in the combination. Therefore, we believe it is significant to carry on research on the effect of mixture pharmaceutical compounds to living organisms.

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Су биотасына антибиотиктер қоспасының улылығы

Қазіргі уақытта дүниежүзі бойынша фармацевтикалық препараттардың алуан түрлі концентрацияда беткей және ағын суларда таралуы туралы көптеген мақалаларда ақпарат бар. Дамыған елдердің зерттеулеріне сәйкес, фармацевтикалық ингредиенттер экологиялық тірі ағзалардың өсуіне және көбеюіне жағымсыз әсер етеді. Дегенмен, Қазақстанда фармацевтикалық ластану экологиялық мәселе ретінде қарастырылмаған. Дәрілік препараттар бойынша алдыңғы зерттеулер жалғыз фармацевтикалық ингредиенттің тірі ағзаға әсерін қарастырған. Алайда қоршаған ортада көп жағдайда фармацевтикалық препараттар қоспа түрінде кездеседі. Сол себепті берілген мақаланың мақсаты антибиотиктер қоспасының *Lemna minor* өсуіне әсерін зерттеуде экотоксикологиялық тест жүргізу болды. Балдыршөптің өсуін бағалау үшін зерттеу нысана ретінде амоксициллин, кларитромицин, азитромицин, сульфаметоксазол және окситетрацилин антибиотиктер қоспасы қолданылды. Бағалауда екі өлшем пайдаланылды: өсу жылдамдығы мен өсу тежелуі. Зерттеу нәтижелеріне сәйкес зерттелген ингредиенттер қоспасы макрофит үшін аса улы болып табылады, себебі оның жартылай максималды әсер ету концентрациясы 1 мг/л-ден төмен (0,13 мг/л).

Кілт сөздер: амоксициллин, кларитромицин, азитромицин, сульфаметоксазол, окситетрацилин, *Lemna minor*, эокулану, қоршаған орта, фармацевтикалық препараттар, фармацевтикалық ластану.

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Токсичность смесей антибиотиков к водной биоте

На сегодняшний день имеются данные о распространении фармацевтических препаратов в различных концентрациях в поверхностных и сточных водах по всему миру. Исследования развитых стран показали, что многие фармацевтические ингредиенты могут оказывать негативное влияние на рост и размножение живых существ. Однако фармацевтическое загрязнение не рассматривается в качестве экологической проблемы в Казахстане. Предыдущие исследования по загрязнению фармацевтическими препаратами были сосредоточены на влиянии одного фармацевтического ингредиента на живые организмы. Тем не менее в большинстве случаев фармацевтические препараты встречаются в окружающей среде в виде смесей. Таким образом, целью данной работы было проведение экотоксикологического теста на воздействие смесей антибиотиков на рост *Lemna minor*. В качестве объектов для оценки использовалась комбинация из пяти антибиотиков: амоксициллин, кларитромицин, азитромицин, сульфаметоксазол и окситетрацилин. Для оценки использовались две переменные измерения: скорость роста и ингибирование роста. Результаты эксперимента показали, что смесь исследуемых соединений высоко токсична для макрофита, так как его полумаксимальная эффективная концентрация была ниже 1 мг/л (0,13 мг/л).

Ключевые слова: амоксициллин, кларитромицин, азитромицин, сульфаметоксазол, окситетрацилин, *Lemna minor*, экотоксикология, окружающая среда, фармацевтические препараты, фармацевтическое загрязнение.

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Ақтау таулы өңірінің кең таралған кейбір дәрілік және эфир майлық өсімдіктерінің жер беті мүшелерінің шикізат қоры

Мақалада Ақтау тауына қарасты төрт өңірдің (Райыс, Дарат, Қорған, Ақсай) әр түрлі өсімдіктер бірлестігінде кездесетін кең таралған әрі дәрілік, әрі эфир майлық 10 түрлі өсімдіктің (кәдімгі түймешетен — пижма обыкновенная — *Tanacetum vulgare*, кәдімгі мыңжапырақ — тысячелистник обыкновенный — *Achillea millefolium*, дәрілік қандышөп — кровохлёбка лекарственная — *Sanguisorba officinalis*, дала жалбызы — мята полевая — *Mentha arvensis*, ащы жусан — полынь горькая — *Artemisia absinthium*, сұр жусан — полынь серая — *Artemisia glauca*, биік жусан — полынь высокая — *Artemisia abrotanum*, далалық сәлбен — шалфей степной — *Salvia stepposa*, иісті киікоты — зизифора пахучковидная — *Ziziphora clinopodioides*, кәдімгі жебіршөп — тимьян обыкновенный — *Thymus vulgaris*) шикізатының эксплуатациялық және жыл сайынғы мүмкіндік қоры анықталды. Тіркелген өсімдіктердің ішінде ғылыми медицинаға енгізілген, қазіргі таңда сұранысы жоғары үш түрлі (кәдімгі түймешетен — пижма обыкновенная — *Tanacetum vulgare*, кәдімгі мыңжапырақ — тысячелистник обыкновенный — *Achillea millefolium*, ащы жусан — полынь горькая — *Artemisia absinthium*) дәрілік өсімдіктердің жер беті өркен мүшелері эксплуатациялық шикізат қоры мен жыл сайынғы мүмкіндік қоры барлық зерттелген өңірлер бойынша жоғары сандық көрсеткіш көрсеткендігі туралы айтылған. Әр аудан бойынша 10 түрлі дәрілік, эфир майлық өсімдіктердің қорын салыстырмалы түрде анықтау барысында таралу жағынан да, шикізат қорының тығыздығымен мен эксплуатациялық, жыл сайынғы мүмкіндік қорының сандық көрсеткіштері — Райыс көңі мен Дарат тоғанының маңында анықталған өсімдіктерде жоғары көрсеткіштер бергендігі туралы айтылды.

Кілт сөздер: дәрілік, эфир майлық, фитоценологиялық сипаттама, ареал (таралуы), қор, эксплуатациялық шикізат қоры, өмір сүру формасы, қауымдастық, біржылдық және көпжылдық өсімдіктер, ксерофит, мезофит, ксеромезофит, мезоксерофит, гиетрофит.

Соңғы жылдары Қазақстанның көптеген аудандарында кең таралған пайдалы өсімдіктер адамзаттың табиғатқа тигізген әр түрлі жағымсыз әсерінен зардап шегуде. Әсіресе дәрілік, эфир майлық өсімдіктердің шикізатын ретсіз жинаудан көптеген өсімдіктердің ареалы тарылып, кейбір түрлері сирек кездесетін және жойылып бара жатқан өсімдіктер қатарына кірді [1, 2]. Әдеби деректер бойынша, дәрілік және эфир майлық өсімдіктер жан-жақты зерттелген аудандарға Қазақстанның оңтүстік және шығыс өңірінің таулы аудандары жатады. Ал, Орталық Қазақстанның кейбір таулы аймақтарының пайдалы өсімдіктері, солардың ішінде Ақтау таулы өңірінде кездесетін дәрілік, эфир майлық және тағы басқа пайдалы өсімдіктері туралы деректер жоқтың қасы [3, 4]. Осыған байланысты Қарағанды облысының Жаңаарқа ауданына қарасты, алшақ орналасқан Ақтау таулы өңірінің өсімдіктер бірлестігінің типін анықтап, оларда кездесетін қазіргі таңда сұранысы жоғары дәрілік және эфир майлық өсімдіктердің түрлерінің тізімін жасап, олардың ішінен кең таралған түрлерінің шикізат қорын анықтаудың үлкен теориялық және практикалық маңызы бар. Сондықтан Ақтау таулы өңіріне қарасты Дарат, Қорған, Ақсай бөлімшелерінде, әр түрлі өсімдіктер бірлестігінде кең таралған 10 түрлі әрі дәрілік, әрі эфир майлық өсімдіктерінің қорын анықтау біздің алдымызға мақсат етіп қойылды. Осы мақсатқа жету үшін 3 өңірдің (Дарат, Қорған, Ақсай) өсімдіктер бірлестігінің типі анықталып, осы бірлестіктерде кездесетін дәрілік және эфир майлық өсімдіктердің тізімін жасап, қазіргі кезде медицинада сұранысы жоғары, кейбір кең таралған дәрілік, эфир майлық өсімдіктердің жер беті мүшелерінің шикізат қорының тығыздығын салыстырмалы түрде анықтау алдымызға міндет етіліп қойылды. Тіркелген өсімдіктердің тығыздығын анықтау үшін И.Л. Крылова, А.И. Шпретердің [5], И.Л. Крылованың [6] әдістері пайдаланылды. Өсімдіктердің қорларын анықтауда пайдаланылатын негізгі екі әдістеме бар, олар кең таралған өсімдіктердің қопаларының нақты шоғырланған жерлері немесе белгілі бір есептеу телімінде, модельдік даналар әдістемесін қолдану.

Өсімдіктердің қорларын анықтауда зерттеуге алынған өсімдіктердің нақты шоғырланған жерлерін көрсету ең анық мәлімет береді, бірақ зерттеу аймағы үшін толық мәлімет бере алмайды. Осы әдіспен анықталған өсімдік қорларының шикізатын жинау ұзақ уақытқа болжау бере алмайды,

себебі сол жерлерде егін егіліп немесе құрылыс салынуы, өрт, тағы да басқа өзгерістер болуы мүмкін.

Екінші әдіс — ол өсімдіктердің қорларын белгілі бір есептеу телімінде анықтау, бұл онша нақты емес, алайда толық мәлімет береді. Бұл әдісті өсімдік қорларын алдын ала болжау үшін және шикізат жинауды жоспарлау үшін пайдаланады. Өндірістік шикізат қорларын және бір жылда жинауға болатын мүмкіндік қорын анықтау үшін шикізатын жинауға ұсынылған дәрілік немесе эфир майлық өсімдіктердің өмір сүру формаларының ерекшелігін, яғни, ол өсімдіктер көпжылдық шөптектес өсімдіктерге жатқызылғанымен, ол түрлердің шикізат көзі болып есептелетін жер беті мүшесін жиналғаннан кейін, сол бірлестікте ол өсімдіктердің қайта қалпына келу мүмкіндігі неше жылға созылатындығын ескерген жөн. Бір рет жиналған жерді демалдырып, өсімдіктің қайта қалпына келу мерзімін ескеріп отырса, сонда ғана біз өсімдіктерді құрып кетуден қорғай аламыз. Мысалы, шөптектес өсімдіктердің шикізат қорын анықтауда мынандай түрлер үшін, егер шикізат көзі ол өсімдіктің гүлшоғырлары және жер үсті бөлігі (шөптері) болса, жиналатын біржылдық өсімдіктерді ол жерден 2 жылда бір рет жинауға болады, жерүсті бөлігі (шөптері) жиналатын көпжылдық өсімдіктерді 4–6 жылда бір рет жинауға болатындығын ескеру қажет.

Зерттеуге алынған Ақтау таулы өңірінің 4 бөлімшесі бойынша (Райыс, Дарат, Қорған, Ақсай) кейбір кең таралған, медицинада сұранысы жоғары, әрі дәрілік, әрі эфир майлық өсімдіктердің жер беті мүшелерінің шикізат қоры туралы алынған далалық эксперименттік жұмыстың нәтижелері төмендегі кестеде көрсетілген.

К е с т е

Ақтау таулы өңіріне қарасты Райыс, Дарат, Қорған, Ақсай бөлімшелерінде кездесетін кейбір дәрілік, эфир майлық өсімдіктердің таралуы мен қоры

Р/с №	Өсімдіктің аты	Табылған жері	Шикізат ретінде жиналатын мүшесі	Қопаның жалпы ауданы, га	Қордың орташа шикізатының тығыздығы, ц/га	Шикізаттың құрғақ қоры, т		Жыл сайын дайындалатын мүмкіндік қоры, т
						биологиялық	эксплуатациялық	
1	2	3	4	5	6	7	8	9
1	Кәдімгі түймешетен — пижма обыкновенная — <i>Tanacetum vulgare</i>	Қорған бөлімшесінің жайлымдық жерінде	Гүлі	44	217,7±17,4	41±3,5	20,5±1,75	6,8
		Райыс көңі шабындық жерлерінде		20	89,4±5,3	8,98±2,6	4,49±1,3	1,4
		Дарат тоғанының маңында		10	73,8±3,5	4,45±2,7	2,2±1,4	0,74
		Ақсай бөлімшесінің шабындық жерлерінде		7,0	65±2,0	8,4±1,0	4,2±0,25	1,4
2	Кәдімгі мыңжапырақ — тысячелистник обыкновенный — <i>Achillea millefolium</i>	Райыс көңі жазық жерлерінде	Жер беті мүшесі	50	190,8±0,57	61,9±4,3	31,0±2,15	10,3
		Дарат тоғанының маңындағы шабындық жерлерде		32	9,4±0,9	51,6±3,8	25,8±1,9	8,6
		Қорған бөлімшесінің жазық жерлерінде		25	8,4±0,7	42,8±3,4	21,4±1,7	7,1
		Ақсай бөлімшесінің шабындық жерлерінде		19	6,8±0,5	25,8±1,4	12,9±0,7	4,3
3	Дәрілік қандышөп — кровохлёбка лекарственная — <i>Sanguisorba officinalis L.</i>	Қорған бөлімшесінің ылғалды жерлерінде	Тамыр-сабағы мен тамыры	50	101±21	5,05±1,0	2,5±0,5	0,83
		Райыс көңі жазық, далалы жерлерінде		35	126±10,15	6,75±1,35	3,4±0,7	1,13
		Дарат тоғанының маңында		25	140±24	3,5±0,6	1,75±0,3	0,58
		Ақсай бөлімшесінің шабындық жерлерінде		10	100±44	5,75±1,1	2,9±0,55	0,97

1	2	3	4	5	6	7	8	9
4	Дала жалбызы — мята полевая — <i>Mentha arvensis</i>	Дарат тоғанының жағасында	Жапырағы	20	9,0±1,5	7,2±1,2	3,6±0,6	1,2
		Райыс көңінің ылғалды жерлерінде		15	6,8±1,3	4,9±0,9	2,45±0,45	0,82
		Қорған бөлімшесінің ылғалды жерлерінде		10	5,7±1,4	4,4±0,7	2,2±0,35	0,73
		Ақсай бөлімшесінің жазық, далалы жерлерінде		7,0	2,2±0,1	3,0±0,2	1,5±0,1	0,5
5	Ащы жусан — полынь горькая — <i>Artemisia absinthium</i>	Ақсай бөлімшесінің жайлымдық жерлерінде	Жер беті мүшесі	50,7	4,8±0,2	24,3±1,8	12,15±0,9	4,05
		Қорған бөлімшесінің жол жиектерінде		47,5	5,2±0,3	24,7±1,9	12,35±0,95	4,11
		Райыс көңінің жазық, далалы жерлерінде		39,7	4,5±0,2	17,8±1,2	8,9±0,6	2,97
		Дарат тоғанының маңындағы шабындық жерлерде		27,3	5,2±0,2	14,1±0,8	7,05±0,4	2,35
6	Сұр жусан — полынь серая — <i>Artemisia glauca</i>	Ақсай бөлімшесінің шабындық жерлерінде	Жер беті мүшесі	44,8	3,4±0,2	15,2±0,9	7,6±0,45	2,53
		Қорған бөлімшесінің жазық, далалы жерлерінде		42,3	3,1±0,2	13,1±0,8	6,6±0,4	2,2
		Райыс көңінің сортаң жерлерінде		33,2	4,3±0,2	14,2±0,8	7,1±0,4	2,36
		Дарат тоғанының маңындағы шалғындық жерлерінде		24,8	3,2±0,3	7,9±0,4	3,95±0,2	1,3
7	Биік жусан — полынь высокая — <i>Artemisia abrotanum</i>	Райыс көңінің жазық, далалы жерлерінде	Жер беті мүшесі	37,1	5,3±0,3	19,6±1,0	9,8±0,5	3,26
		Дарат тоғанының маңындағы шалғындық жерлерінде		33,7	5,1±0,4	17,1±1,0	8,55±0,5	2,85
		Ақсай бөлімшесінің жайлымдық жерлерінде		27,9	5,6±0,3	15,6±1,1	7,8±0,55	2,6
		Қорған бөлімшесінің шалғындық жерлерінде		19,5	4,6±0,3	8,9±0,5	4,45±0,25	1,48
8	Далалық сәлбен — шалфей степной — <i>Salvia stepposa</i>	Дарат тоғанының ылғалды жерлерінде	Жер беті мүшесі	36,5	4,3±0,2	15,6±0,9	7,8±0,45	2,6
		Райыс көңінің жазық, далалы жерлерінде		26,8	4,1±0,3	11,5±0,7	5,75±0,35	1,92
		Қорған бөлімшесінің ылғалды жерлерінде		16,1	3,3±0,2	5,3±0,3	2,65±0,15	0,88
		Ақсай бөлімшесінің шалғындық жерлерінде		10	2,5±0,5	3,4±0,2	1,7±0,1	0,6
9	Иісті кикоты — зизифора пахучковидная — <i>Ziziphora clinopodioides</i>	Қорған бөлімшесінің қиыршық-тасты-шоқылы төбелердің етектерінде	Жер беті мүшесі	28,3	2,8±0,3	15,8±1,2	7,9±0,6	2,63
		Райыс көңінің жазық жерлерінде		27,9	2,7±0,2	15,0±1,0	7,5±0,5	2,5
		Дарат тоғанының шалғындық жерлерінде		21,2	2,2±0,2	9,2±0,4	4,6±0,2	1,53
		Ақсай бөлімшесінің жайлымдық жерлерінде		14,1	2,3±0,2	6,4±0,6	3,2±0,3	1,07

1	2	3	4	5	6	7	8	9
10	Кәдімгі жебір-шөп — тимьян обыкновенный — <i>Thymus vulgaris</i>	Райыс көңінің жайлымдық жерлерінде	Жер беті мүшесі	25	24,8±8,7	1,8±0,16	0,9±0,08	0,3
		Қорған бөлімшесінің жазық жерлерінде		20	19,5±0,4	4,1±0,1	2,05±0,05	0,69
		Дарат тоғанының тастақты жерлерінде		15	17,8±0,2	2,6±0,08	1,3±0,04	0,43
		Ақсай бөлімшесінің шабындық жерлерінде		10	20,7±0,5	5,0±0,1	2,5±0,05	0,83

Кестеде көрсетілгендей, төрт бөлімше (Райыс, Дарат, Қорған, Ақсай) бойынша, бұтатектес — көпжылдық шөптектес, астық тұқымдас-көп жылдық шөптектес, жусанды-көпжылдық шөптектес өсімдіктер бірлестігінде кездесетін әрі дәрілік, әрі эфир майлық өсімдіктердің жер беті өркен мүшелерінің орташа шикізат қорының тығыздығы мен жалпы қоры анықталды. Әр аудан бойынша 10 түрлі дәрілік және эфир майлық өсімдіктердің қорын салыстырмалы түрде талдау барысында ең көп шикізат қоры кәдімгі мынжапырақтан анықталды, мысалы, Райыс көңінің жазық, далалы жерлерінде бұтатектес-көпжылдық шөп тектес өсімдіктер бірлестігінде, оның эксплуатациялық шикізат қоры 31,0±2,15 т, шикізат дайындау мүмкіндік көлемі 10,3 т құрады, ал осы түрдің ең аз таралған жері Ақсай бөлімшесінің шағындық жерлері ондағы оның шикізат көзінің эксплуатациялық қоры не бары 12,9±0,7 т, шикізат дайындау мүмкіндік көлемі 4,3 т, осы түр жалпы зерттелген төрт өңірде де кездеседі. Төрт өңір бойынша кәдімгі мынжапырақтың жалпы эксплуатациялық шикізат қоры 91,1±6,45 т, ал, шикізат дайындау мүмкіндік көлемі 30,3 т құрады.

Ащы жусанның (*Artemisia absinthium*) ең көп шикізат қоры Ақсай бөлімшесінің жайлымдық жерлерінде, көпжылдық шөптектес-жусанды өсімдіктер бірлестігінде анықталды және оның эксплуатациялық шикізат қоры 12,15±0,9 т, дайындау мүмкіндік көлемі 4,05 т құрады. Ескертетін жағдай, ащы жусан зерттелген төрт өңірде де кең таралған. Осы зерттелген аудандардағы ащы жусанның жалпы эксплуатациялық шикізат қоры 40,45±2,85 т көрсетті, шикізат дайындау мүмкіндік көлемі 13,49 т құрады.

Кәдімгі түймешетеннің (*Tanacetum vulgare*) ең көп шикізат қоры Қорған бөлімшесінің жайлымдық жерінде, астық тұқымдас-көпжылдық шөптектес өсімдіктер бірлестігінде анықталды және оның эксплуатациялық шикізат қоры 20,5±1,75 т, дайындау мүмкіндік көлемі 6,8 т құрады. Кәдімгі түймешетеннің зерттелген төрт өңірдегі жалпы эксплуатациялық шикізат қоры 31,39±4,9 т болды, ал шикізат дайындау мүмкіндік көлемі 10,34 т құрады.

Келесі кең таралған эфир майлы өсімдік биік жусан (*Artemisia abrotanum*) Райыс көңінің жазық, далалы жерлерінде бұтатектес-көпжылдық шөптектес өсімдіктер қауымдастығында анықталды, оның эксплуатациялық шикізат қоры 9,8±0,5 т, дайындау мүмкіндік көлемі 3,26 т құрады. Барлық зерттелген бөлімшелер бойынша биік жусанның эксплуатациялық шикізат қоры 30,6±1,8 т, ал шикізатын дайындау мүмкіндік көлемі 10,2 т көрсетті. Одан кейінгі орында сұр жусан (*Artemisia glauca*) бұл түрдің барлық зерттелген төрт өңірдегі эксплуатациялық шикізат қорының жалпы сандық көрсеткіші 25,2±1,45 т, ал, шикізат дайындау мүмкіндік көлемі 8,4 т құрады.

Далалық сәлбеннің (*Salvia stepposa*) төрт өңірдегі жалпы эксплуатациялық шикізат қоры 17,9±1,05 т, ал шикізат дайындау мүмкіндік көлемі 5,97 т көрсетті.

Келесі әрі дәрілік, әрі эфир майлы өсімдік иісті киікоты (*Ziziphora clinopodioides*) төрт бөлімше бойынша оның жалпы эксплуатациялық шикізат қоры 23,2±1,6 т және шикізат дайындау мүмкіндік көлемі 7,73 т көрсетті.

Дәрілік өсімдік — дәрілік кандышөп (*Sanguisorba officinalis*) барлық зерттелген өңірлер бойынша оның шикізат қоры, басқа зерттелген өсімдіктермен салыстырғанда, біршама азырақ және эксплуатациялық шикізат қоры 10,5±2,05 т көрсетті, ал шикізат дайындау мүмкіндік көлемі 3,51 т құрады.

Келесі әрі дәрілік, әрі эфир майлы өсімдік — дала жалбызы (*Mentha arvensis*), оның шикізат көзі тек жапырағы болып есептелетіндіктен, барлық зерттелген бөлімшелерде эксплуатациялық шикізат қоры 9,75±1,5 т, ал шикізат дайындау мүмкіндік көлемі 3,25 т құрады.

Әрі дәрілік, әрі эфир майлы өсімдік — кәдімгі жебіршөптің (*Thymus vulgaris*) зерттелген төрт өңір бойынша эксплуатациялық шикізат қоры $6,75 \pm 0,22$ т болды, ал шикізат дайындау мүмкіндік көлемі 2,25 т көрсетті.

Сонымен, далалық зерттеу жұмысы нәтижесінде, жалпы Ақтау таулы өңірі (Райыс, Дарат, Қорған, Ақсай) бойынша тіркелген әрі дәрілік, әрі эфир майлық өсімдіктердің таралуы жағынан да, қоры жағынан да, сандық көрсеткішітері бойынша ерекшеленетін өңірге — Райыс көңі мен Дарат тоғаны жататындығы анықталды. Зерттелген өсімдіктердің ішінде қазіргі таңда медицинада сұранысы жоғары және Мемлекеттік фармакопеяға енгізілген үш түрлі (кәдімгі түймешетен — *Tanacetum vulgare*, кәдімгі мыңжапырақ — *Achillea millefolium*, ащы жусан — *Artemisia absinthium*) дәрілік өсімдіктердің шикізат қоры, басқа анықталған өсімдіктерге қарағанда, әлдеқайда жоғары болды. Мысалы, шикізаты гүл шоғы болып есептелетін кәдімгі түймешетеннің барлық зерттелген өңірлер бойынша эксплуатациялық қоры $31,39 \pm 4,7$ т тең болды, ал жыл сайынғы мүмкіндік қоры 10,34 т құрады. Сол сияқты шикізат көзі жер беті мүшесі болып есептелетін кәдімгі мыңжапырақтың эксплуатациялық қоры $91,1 \pm 4,45$ т көрсетті, ал жыл сайынғы мүмкіндік қоры 30,3 т құрады. Одан кейінгі орында ащы жусан, оның жер беті мүшесінің құрғақ шикізатының қоры өңірлер (Ақсай, Қорған, Райыс, Дарат) бойынша $40,45 \pm 2,85$ т тең болды, ал жыл сайынғы мүмкіндік қоры 13,41 т көрсетті.

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А.И. Ахметжанова, А.Н. Наурызбаева

Запасы надземных масс наиболее распространенных лекарственных, эфиромасличных растений горной системы Ақтау

В статье рассматриваются эксплуатационные и возможно допустимые ежегодные запасы десяти лекарственных и эфиромасличных растений (пижма обыкновенная — *Tanacetum vulgare*, тысячелистник обыкновенный — *Achillea millefolium*, кровохлёбка лекарственная — *Sanguisorba officinalis*, мята полевая — *Mentha arvensis*, полынь горькая — *Artemisia absinthium*, полынь серая — *Artemisia glauca*, полынь высокая — *Artemisia abrotanum*, шалфей степной — *Salvia stepposa*, зизифора пахучковидная — *Ziziphora clinopodioides*, тимьян обыкновенный — *Thymus vulgaris*), расположенных в горной среде Ақтау. Среди изученных растений выделено 3 вида лекарственных растений (пижма обыкновенная — *Tanacetum vulgare*, тысячелистник обыкновенный — *Achillea millefolium*, полынь горькая — *Artemisia absinthium*), которые введены в Гос. фармакопею, а также отмечено, что в настоящее время в медицине увеличивается спрос на эти растения. Следует отметить, что по горной системе Ақтау наибольшее распространение запасов сырья лекарственных и эфиромасличных растений находится в отделе Райыс и в окрестностях пруда Дарат.

Ключевые слова: лекарственные, эфиромасличные растения, фитоценологическая характеристика, ареал, ресурсы, эксплуатационный запас сырья, жизненная форма, ассоциация, однолетние и многолетние растения, ксерофит, мезофит, ксеромезофит, мезоксерофит, гигрофит.

A.I. Akhmetzhanova, A.N. Nauryzbaeva

Stocks of overground masses of the most common medicinal, essential oil plants of the Aktau mountain system

The article discusses the operational and permissible annual reserves of ten medicinal and odoriferous plants (*Tanacetum vulgare*, *Achillea millefolium*, *Sanguisorba officinalis*, *Mentha arvensis*, *Artemisia absinthium*, *Artemisia glauca*, *Artemisia abrotanum*, *Salvia stepposa*, *Ziziphora clinopodioides*, *Thymus vulgaris*) located in the mountainous environment of Aktau. Among the plants studied, the authors marked 3 species of medicinal plants (*Tanacetum vulgare*, *Achillea millefolium*, *Artemisia absinthium*) imposed in the State Pharmacopoeia, and the authors noted that there is currently increasing demand for these plants in medicine. It should be noted that on the mountain system of Aktau, the greatest distribution of raw material inventories medicinal and the efirmomaslenichnykh of plants to be in office of Raiys and vicinities of a pond Darat.

Keywords: medicinal, aromatic plants, the fitocoenotic characteristics, habitat, resources, operating stock of raw materials, life form, association, annuals and perennials, xerophytic, mesophyte, xeromesophyte, mesoxerophyte, hygrophyte.

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Adaptive features of some species of Lumbricidae

The few-bristled worms is an extremely important taxonomic group in terrestrial ecosystems. These worms did not receive earlier the attention they deserve and now we have some deficiencies in the knowledge about their taxonomy, distribution, biology and ecology. Experiments with species of different morphoecological groups of Lumbricidae were spent. We considered that the differences in amplitude and frequency of gizzard smooth muscles contractions between species of Lumbricidae have adaptive character. The contractive activity of the muscles was studied according to the method of isolated preparations. The greatest amplitude and the least frequency of contractions of visceral muscles was recorded in detritophages worms of mineral soils. The near-surface species showed the smaller amplitude of muscles contractions, and more greater frequencies of contractions. These physiological distinctions support ideas of the ecological heterogeneity of earthworms. The parameters of contractive activity of smooth muscles of gizzard are the specific physiological variable integrated with the morpho-ecological differentiation of earthworms in natural habitats.

Keywords: earthworms, gizzard, isolated smooth muscles, contractive activity, spontaneous activity, induced contractive activity, acetylcholine, atropine.

The best known oligochaete group are earthworms that were one of the first animal group colonizing humus soils. The important role of earthworms has been recognized from the dawn of human history till present. They were known as important factors of soil fertility. Earthworms have been also used in medicine. They have also been used as a model of scientific explanation of our world. In spite of the importance of oligochaetes, there are presently some serious deficiencies in the knowledge about their taxonomy, distribution, biology and ecology, in comparison with other organismal groups.

The process of adaptation to locally-specific habitat conditions often leads to the formation of various life forms exhibited intraspecifically by geographically distant populations [1]. Ecological distinctions between life forms of earthworms can be seen at other organizational levels, for example as adaptive anatomical-morphological and physiological differences. In soil animals, the examination of adaptations to the natural environment through the prism of specificity of soil-forming properties revealed adaptive development trends in digestive, nervous and other organ systems [2, 3].

Ecological distinctions between species and forms of earthworms can be compared to some obviously adaptive anatomical-morphological and physiological distinctions. There are two main morpho-ecological groups of Lumbricidae: the humus formers feeding coarse particulate organic matter near the ground surface and the humus feeders eating soil humus or the actual soil [4]. The features of the digestive systems of different ecological groups of earthworms are connected with their living conditions [5]. The intestine or midgut is investigated in more details since the pharynx, oesophagus, and muscular gizzard are morphologically similar in most species of Lumbricidae.

Two different types of the intestine correspond to two groups of earthworms with different characteristics of feeding. The first group (soil-eaters) is characterized by the cylindrical form of the intestine with a powerful typhlosole. The second group (inhabitants of the uppermost soil horizons) is characterized by the bead-form intestine with a small typhlosole.

However, differences in adaptive characters between two groups of Lumbricidae are not exhausted by the anatomical features of the digestive system. Feeding near the surface is accompanied by loss of some characteristics inherent for soil-dwelling forms. The cuticular cover becomes thinner; the body length decreases; the ability to diapause disappears. At the same time, emersion to the surface is accompanied with many new characteristics: differentiation of the prostomium, a more perfect form of the tail end, plumose type of the longitudinal muscles in the body wall providing greater mobility, more intensive metabolism, and more perfect nervous system regulation.

The ecological groups of Lumbricidae also differ in size of their daily ration and at the time of assimilation of the food. The degree of decomposition and humification of the vegetative remains in their digestive tract differs significantly [6].

The impellent function of the digestive tract is still insufficiently studied in ecologo-physiological relation. It is known that the isolated crop and gizzard of an earthworm are spontaneously active when stretched. However, the contractive activity of the visceral muscles in different earthworm species has not been studied and its parameters have not been established, particularly in a comparative aspect.

The aim of our research was to determine specific features of the contractive activity of smooth muscles of the digestive tract of earthworms, as a specific physiological variable integrated with the morpho-ecological differentiation of species.

In our research, we identified characteristic physiological features of the contractive activity of smooth muscles in the digestive tract of earthworms *Aporrectodea caliginosa* and *Eisenia nordenskioldi* integrated them with morpho-ecological differentiation of species. Then we hypothesized that the different reaction properties of this biologically active substance will be different between distinct life forms of *A. caliginosa* and *E. nordenskioldi*. We determined the spontaneous and induced contractive activity of crop-gizzard visceral muscles of two life forms of *A. caliginosa* and *E. nordenskioldi*. The acetylcholine, is numbered among the main mediators of neuro-muscular transmission in earthworms [7, 8].

Materials and methods

Two representatives of the genus *Aporrectodea* Örley, 1885, were studied: *Aporrectodea caliginosa trapezoides* (Dugés, 1828), and *Ap. caliginosa caliginosa* (Savigny, 1826). Worms were taken from a natural site in the Kazakh Uplands. The ranges are rough with numerous granite intrusions. The floor of every valley or gully is filled with woody or shrub growth.

The genus *Eisenia* Malm, 1877 is represented in the Kazakh upland by the species *Eisenia nordenskioldi*, which is widespread in Asia and might be a complex of diploid and polyploid lineages. Earthworm specimens tested and compared in the project were collected in black alder forests of the Kazakh Uplands and belong to the following two subspecies:

Eisenia nordenskioldi nordenskioldi (Eisen, 1873). Length 60–150 mm, width 4–8 mm. Number of segments 80–130. Prostomium epilobous. The visible dark-purple pigmentation of the body (the pigment cells are localized in the subcuticular muscle layers) is not, in this subspecies, expressed laterally on the 9–11th segments. The dark-purple body with white lateral spots distinguishes this subspecies from other subspecies. However, several polyploid lineages are known in *E. n. nordenskioldi*. In Kazakhstan, *E. n. nordenskioldi* of anthropochoric origin has been recorded in soils of forest nurseries, flower beds and lawns. Apart of Kazakhstan, this nominal subspecies is known from the adjacent areas of the Asian part of Russia and from the Urals. This is a surface-living worm feeding on coarse particulate organic matter near the ground surface.

Eisenia nordenskioldi pallida Malevic, 1956. Length 55–116 mm, width 4–6 mm. Number of segments 80–140. The body pigmentation is scarcely noticeable on several anterior segments, the rest of segments are whitish. *E. n. pallida* is dwelling in the soil mineral layer and feeding on soil humus. This species is autochthonous in the moist pine and deciduous forests in the Kazakh upland. Apart of colour and ecology, no other features are known to differentiate between the pair *E. n. Nordenskioldi* and *E. n. pallida*. The different morpho-ecological properties of both subspecies allow them to share the same biotop [9].

In our physiological experiments, contractive activity of the muscles was studied according to the method of muscles isolated preparations [10]. The longitudinal tension of isolated muscular crop-gizzard and gut walls preparations from earthworms stimulated spontaneous rhythmic contractions. The common regime of tension of muscle preparations 380–450 mg was adopted as the optimum mode of registration of spontaneous contractions in the two different earthworm taxa.

Acetylcholine-hydrochloride (ACh) ($1 \cdot 10^{-11}$ – $1 \cdot 10^{-4}$ M), that stimulates tonic contractions, was used as biologically active substance to study particular features of induced contractile activity of smooth muscles. During the experiment the muscle preparations were superfused with a saline water solution containing: 103 mM NaCl, 3 mM KCl, 1.8 mM CaCl₂ and 1 mM NaHCO₃. We selected amplitude and frequency of spontaneous and induced contractions of the smooth muscles and constructed dose-response curves of muscle reactions to acetylcholine concentrations in the range from $1 \cdot 10^{-11}$ up to $1 \cdot 10^{-4}$ M. Atropine, known as the antagonist of M-holinoreceptors, was applied in concentrations ranging from $1 \cdot 10^{-6}$ up to $1 \cdot 10^{-4}$ M in order to identify the nature of receptors.

Reactions of the muscle tissue to the stretching: amplitude of fluctuations of the contraction in percentage of maximal, and their frequency per minute were measured. Presence or absence of spontaneous rhythmic activity was considered. Statistical analysis was performed by using Statistica v. 6.0 (SPSS Inc.). Values

are presented as mean \pm SE if the data were normally distributed (normality of data distribution was tested by Kolmogorov-Smirnov test with Lilliefors' correction).

Results and discussion

Force of tension determines expression of spontaneous rhythmic contractions of smooth muscles in the higher and lower vertebrates [11]. The features of longitudinal tension of isolated smooth muscle preparations of two different earthworm taxa were used to establish the common optimum of tension. From the data received a scheme of dependence of frequency and amplitude of spontaneous rhythmic contractions on tension in the visceral muscles of earthworms was constructed.

Upon the increase in background tension of smooth muscles' preparation from 150 mg up to 250 mg, the amplitude of spontaneous contractions increased to 54 ± 2.03 %, and their frequency to 3 ± 0.4 %. Tensions 360–430 mg revealed the maximum amplitude of spontaneous contractions ($85\text{--}100 \pm 4.05$ %) and were accompanied by acceleration of the rhythm to 39 ± 0.4 %. The even greater tension of an isolated smooth muscles' preparation led to a fast increase in frequency and reduction of amplitude of contractions.

The fast-dosed outstretching of a preparation at loadings 360–420 mg did not change the contractive reaction authentically. At the reduction of background loading down to 260 mg the tone of a preparation diminished, the amplitude of spontaneous contractions decreased for 20 % and the frequency for 25 % ($p < 0.01$).

Thus, at a tension of 360–430 mg the most expressed rhythmic contractions of smooth muscles were noted. The maximal amplitudes of rhythmic contractions in this regime were registered in 92.8 % of experiments ($p < 0.01$) for individuals of both subspecies. Such loading allows keeping rhythmic activity of the isolated smooth muscle tissue preparations for soil-dwelling *Ap. c. caliginosa* up to 30 hours. The other litter-dwelling subspecies of earthworms is characterized by a shorter time of activity of the similar preparations (up to 4–5 hours). On the results we accept the force of tension of smooth muscles preparation 380–450 mg as the common and optimum mode of registration of spontaneous contractions for two subspecies of *Ap. caliginosa*.

The rhythmic contractions with subspecies-specific frequencies and amplitudes (phase) were the basic form of spontaneous contractive activity of the gizzard muscles. In the 10 % of experiments ($p < 0.01$), spontaneous contractive activity was expressed as slow tonic (phase-tonic) waves. Harmonious (transitive) fluctuations of varying amplitude were observed also in 10 % of experiments ($p < 0.01$).

The more elaborated definition of parameters of spontaneous contractive activity of visceral muscles revealed an essential difference of average amplitude and frequency of contractions in two life forms of *Ap. caliginosa*. The biggest amplitude of contractions was registered for the soil-dwelling subspecies *Ap. c. caliginosa* (86.71 ± 3.66 mg). The frequency of contractions of visceral muscles was 2.46 ± 0.58 a minute.

Gizzard muscles of the litter-dwelling subspecies *Ap. c. trapezoides* contracted with less force, but faster. The average amplitude of force was 49.58 ± 2.56 mg and the frequency 4.89 ± 0.37 contractions/min.

The rhythmic contractions with specific frequencies and amplitudes (phase) constituted the basis for determining the spontaneous contractive activity of isolated crop-gizzard and gut walls in *E. n. nordenskioldi* and *E. n. pallida*. A thorough analysis of spontaneous contractive activity in muscle preparations revealed essential differences in average amplitude and frequency of contractions between *E. n. nordenskioldi* and *E. n. pallida*. The biggest amplitude of contractions was registered in the soil-dwelling subspecies *E. n. pallida* (68.23 ± 3.25 mg). The frequency of contractions of smooth muscles was 3.23 ± 0.53 /minute. Visceral muscles of the digestive tract of the litter-dwelling subspecies *E. n. nordenskioldi* contracted with less force, but faster. The average amplitude of force was 46.06 ± 4.05 mg and the frequency 4.21 ± 0.44 contractions/min.

We found that the Ach application to several regions of the earthworm gut causes a rapid increase in tension, accompanied by an abolition of rhythmic movements. In our experiment, ACh induced the contractions of gut and isolated smooth muscles crop-gizzard preparations in a dose-dependent amplitude and frequency (tonic induced contractile activity). The induced contractions were persistent for several minutes after Ach application and were accompanied by an increase in the amplitude. We observed that if the spontaneous contractions of smooth muscles were absent the application of Ach caused also contractive activity of smooth muscles.

We estimated the sensitivity of the earthworm smooth muscles at different concentrations of ACh from the established concentration-response curves. The minimum concentration inducing the changes in the

spontaneous contraction activity in the visceral muscles is approximately $1 \cdot 10^{-10}$ M ACh. The maximum effective doses of acetylcholine in the studied subspecies are: $1 \cdot 10^{-5}$ M in *E. n. nordenskioldi* and *Ap. c. trapezoides* and $1 \cdot 10^{-4}$ M in *E. n. pallida* and *Ap. c. caliginosa*.

The concentrations of ACh (pD_2) inducing a half-maximal contractive response were estimated from the logistic curve. For *E. n. nordenskioldi* $pD_2 = 1 \cdot 10^{-7}$ M, for *Ap. c. trapezoides* $pD_2 = 3 \cdot 10^{-7}$ while the half-maximal response for the soil-dwelling form *E. n. pallida* and *Ap. c. caliginosa* is higher ($pD_2 = 6 \cdot 10^{-7}$ M and $pD_2 = 1,2 \cdot 10^{-6}$ M). The isolated smooth crop-gizzard and gut muscles in the surface-living form are of higher reactivity and affinity to acetylcholine. In general, there is a similarity of the half-maximal response on acetylcholine in smooth muscles of earthworms and primitive vertebrates [12].

We examined the role of the cholinergic antagonist atropine on the ACh-induced response of muscles. Atropine has an excitatory effect on crop-gizzard of some species of genera *Lumbricus* and *Allolobophora*, but not on the crop-gizzard of *Eisenia fetida*. Other researchers have shown that the effect of ACh on somatic and visceral muscles is partially blocked by atropine.

We have not found an expressed contractile effect of atropine on isolated crop-gizzard and gut preparations of *E. nordenskioldi* and *Ap. caliginosa*. Atropine in concentrations $1 \cdot 10^{-6} - 1 \cdot 10^{-5}$ M acted on earthworm muscles within 10 minutes. Three ACh applications ($1 \cdot 10^{-9} - 1 \cdot 10^{-8}$ M) on the background of atropine were used for determining the degree of receptors blockade of muscles. Blockade was complete if the phasic contractions of muscles had not changed. The ACh ($1 \cdot 10^{-7} - 1 \cdot 10^{-5}$ M) induced response (in the presence of atropine) consisted of series of suppressive phasic contractions. Thus atropine moved concentration-response curves on acetylcholine for about 70 % of experiments. But atropine reversibly reduced the ACh-induced response. We observed an increase in spontaneous contractions and a significant increase in ACh-induced contractions after a 10 min. washout time, between the termination of atropine treatment and the last exposure to ACh. Atropine in a concentration of $1 \cdot 10^{-4}$ M completely eliminated ACh-induced responses. Receptors of smooth muscles of earthworm might be similar to muscarinic receptors of vertebrates. However, atropine is a muscarinic antagonist in vertebrates. It is therefore difficult to extrapolate the obtained results to invertebrates [13].

We assume that the occurrence of the observed rhythmic contractions with subspecies-specific frequencies and amplitudes are the basic form of spontaneous contractive activity of earthworms smooth muscles of the digestive system. A higher amplitude of contractions was registered in the soil-dwelling subspecies *E. n. pallida* and *A. c. caliginosa* than in the surface dwelling subspecies. This is consistent with our results, obtained earlier for different life forms of earthworms. This means that the life forms of species differs not only in spontaneous but also in induced contractive activity of crop-gizzard and gut-visceral muscles, mediated by muscarinic acetylcholine receptors. Furthermore, the smooth muscles of the surface-living form are characterized by a high sensitivity to small doses ($1 \cdot 10^{-10} - 1 \cdot 10^{-8}$ M) of acetylcholine and by a more pronounced reactivity. We can suppose that the distinctions between parameters of induced contractive activity of smooth muscles in life forms are related to the metabolic features and particular nervous regulation.

According to histological researches, the gizzard of earthworms has very powerful muscular walls [14] consisting of three layers: two external longitudinal muscle layers from which the inner one has huge cells, and a thick internal layer of circular muscles with very large cells. The circular muscle layer has species-specific characters. For example, muscular rings of *Ap. c. caliginosa* are very thin and numerous.

The food mass taken from the intestine of *Ap. c. caliginosa* and studied under a preparation microscope was composed of fine mineral grains mixed with very fine vegetative rests. No large particles were observed in the intestine. This species feeds on much decayed vegetative material, which apparently does not grind in the stomach [15]. Besides, the intestine of *Ap. c. caliginosa* is represented by an almost regular cylindrical tube with a round typhlosole bearing deep folds. The intestine can be stretched no more than 1.2–1.5 times. Such a structure of the intestine has much adaptive value for feeding by organic particles dispersed in the soil. The large absorbing surface of the intestine allows using soils poor in organic substances. According to our experiments, the gizzard of this detritophage vigorously pushes the dense food mass, but its contractions occur not more often than 2–3 times a minute, therefore, the food mass passes to the intestine pretty passively. Subsoil species of earthworms processing large amounts of soil promote preservation of water, air permeability of soil, enrichment of the bottom horizons and formation of the soil's particulate structure.

The circular muscular layer of gizzard in the litter-dwelling subspecies *Ap. c. trapezoides* is thick and precisely distinguishable. This subspecies basically consumes decaying vegetative remains entering the intestine as a loose mass completely accessible for digestion. The amount of mineral particles is small. There is no special crushing and grating of this food in the gizzard, even as large particles of plants come across to the

hindmost part of the intestine. The bead-like form is providing an extension of the intestine during the passage of more viscous food mass containing less mineral particles. The food is more easily forced along the intestine. More frequent contractions provide faster promotion of food in the intestine.

We assume that the parameters of contractions of visceral muscles are connected with morpho-functional features of the digestive system of different ecological groups of Lumbricidae. The higher amplitude of contractions of the gizzard in the actual soil-dwellers is probably connected with large volume and dense structure of the ingested food. These worms swallow vegetative fragments together with mineral soil particles, and slow contractions of the digestive tract promote slow passage of food along the typhlosole, assisting the more complete assimilation of organic substances from soil.

We consider the observed parameters of the activity of digestive tract in *Ap. caliginosa* as stable characteristics of the forms adapted to consumption of certain types of food resources. These physiological distinctions support ideas of the ecological heterogeneity of Lumbricidae and validity of distinguishing the life forms in this group according to characteristics of feeding.

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В.С. Абуkenова

Люмбрицидтердің кейбір түрлерінің адаптивтік ерекшеліктері

Азқылтанақты құрттар — жер беті экожүйесінің өте маңызды таксономиялық тобы әлі күнге дейін жеткілікті зерттелмеген. Қазіргі таңда олардың таксономиясы, биоценозда таралуы, биология және экологиясы жайлы деректер аз. Бұл эксперименттік зерттеулер Lumbricidae тұқымдасының әртүрлі морфоэкологиялық топтарына жүргізілді. Lumbricidae туысының түрлері мен түрше аралығында асқазан бұлшық етінің жиырылғыш жиілігінің белсенділігі мен амплитуда айырмашылығы бейімделеу сипат алады деп топшыладық. Бұлшық еттің жиырылғыш белсенділігі оқшауланған препарат әдісіне сүйеніп жасалды. Жоғарғы амплитуда мен асқазан бұлшық етінің ең төменгі

жиырылу жиілігі детритофагтарда — топырақтың минералды қабатындағы құрттарда байқалды. Жер бетіне таяу түрлер мен түршелерде бұлшықет жиырылу белсенділігінің аз амплитудасы мен жиырылу жиілігінің жоғары көрсеткіші анықталды. Түрлердің биоценоздағы экологиялық дифференциациясы, Lumbricidae висцеральді бұлшық еттерінің өзіндік жиырылу белсенділігінің ерекшеліктері зерттелген. Бұл физиологиялық өзгерістер Lumbricidae экологиялық әртүрлілігін береді. Люмбрицидтер әр түрлері мен формаларының морфоэкологиялық дифференциациясы үйреншікті сипат алатын асқазан бұлшық етінің функционалды белсенділігі өзгерістерімен сипатталды.

Кілт сөздер: жауын құрты, асқазан, оқшауланған бұлшықет препараты, жиырылғыш белсенділігі, қауырт белсенділік, индуцирленген жиырылғыш белсенділігі, ацетилхолин, атропин.

В.С. Абуkenова

Адаптивные особенности некоторых видов люмбрицид

Малоштитинковые черви — это чрезвычайно важная таксономическая группа в наземных экосистемах, которая до сих пор остается недостаточно изученной. В настоящее время получено еще мало данных об их таксономии, распределении в биоценозах, биологии и экологии. Были проведены эксперименты с видами семейства Lumbricidae различных морфо-экологических групп. Мы предположили, что различия в амплитуде и частоте сократительной активности гладких мышц кишечника между видами и подвидами Lumbricidae носят адаптивный характер. Сократительная активность гладких мышц была изучена согласно методу изолированных препаратов. Наибольшая амплитуда и наименьшая частота сокращений мышц кишечника были зарегистрированы у детритофагов, червей минеральных слоев почв. Для поверхностнообитающих видов и подвигов определена меньшая амплитуда сократительной активности мышц и большая частота сокращений. Эти физиологические различия подтверждают существование экологической разнородности Lumbricidae. Параметры сократительной активности гладких мышц кишечника — определенная физиологическая переменная, связанная с морфо-экологической дифференциацией дождевых червей в природных местообитаниях.

Ключевые слова: дождевые черви, кишечник, изолированный мышечный препарат, сократительная активность, спонтанная активность, вызванная сократительная активность, ацетилхолин, атропин.

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Physiological assessment of adaptive reactions of organism among gifted schoolchildren

The article gives a physiological assessment of adaptive reactions of organism among gifted schoolchildren. An increase in growth was observed both among boys and girls. Simultaneously with the increase, the body weight of adolescents also increases. Muscle strength intensively increases in adolescence. The schoolchildren had significant differences in the level of functional state of the central nervous system. Differences in the level of functional tension of the central nervous system and mental performance are noted among gifted schoolchildren, depending on age and sex. Education of the schoolboys changed organisms' functional condition and nervous — emotional activity, appreciable exhaustion of the pupils, progressive decrease of serviceability, cordial — vessel system and central nervous system, energy provisional system in the intensification educational process conditions. The badly ecological situation has a negative effect for physiological parameters and «quality» of health of the living children's population, that in a consequence will be reflected in his serviceability and illness.

Keywords: adolescent, age, reaction, organism, process, central nervous system, cardiovascular system, Ruffier index, muscle strength, working capacity, adaptation.

Adolescence is a natural stage in the development of organism, but at the same time, it sharply differs from all other stages of a person's lifewith its uniqueness and pace. During this period, rapid restructuring takes place in the activity of all the physiological systems of the body. From the physiological point of view, the adolescent period is characterized by an increase in the intensity of growth, increased metabolism, increased oxygen consumption, a sharp increase in the activity of the endocrine glands, active assimilatory processes, pronounced endocrine shifts, processes of morphological and functional differentiation of the brain and internal organs. A person never grows as intensely as during adolescence, except for the first two years of his life [1, 2].

In functional terms, the body is extremely unstable and prone to diseases and frustrations. The cardiovascular system undergoes significant changes. The stimulating effect on heart growth is exerted by endocrine glands whose activity is sharply activated [3].

Respiratory organs intensively develop during adolescence. The vital capacity of the lungs significantly increases [4]. Breathing becomes less frequent and deeper. The chest and respiratory muscles develop intensively; along with this the rate of their development is most intense during puberty. The type of breathing is finally formed in adolescence.

Thus, the body of adolescents on a number of parameters is approaching the level of adults, but the peculiarity of this age, consisting in the relative weakness of the cerebral cortex, the imperfections of the nervous and humoral regulation, the mobility and instability of the regulation of the autonomic nervous system, disharmony in the rate of growth of the heart, blood vessels and the body determines the increased sensitivity of their organism to various influences [4].

The introduction of innovative methods into the process should promote the development of children, training their body and adapting it to mental and physical stress [4, 5]. The improvement of education must follow the path that fosters the formation of child's personality, capable of effective adaptation in changing conditions.

Materials and methods of research

The research was carried out on the basis of the school for gifted children «Daryn» affiliated with the Karaganda State University named after Ye.A. Buketov. The object of the study is pupils of grades 8–11. All schoolchildren were also divided into age periods: 14–15 years (pubertal) and 16–17 years (post-pubertal).

Anthropometric studies included: measuring the main indicators of the physical development of schoolchildren: length, body weight, chest circumference, their centile evaluation were determined; the study of individual psychological traits of personality according to the method of G.D. Eysenck, definition of personal anxiety; pulse rate measurement before and after the dosed load, calculation of the Ruffier index, sys-

toloc (SBP) and diastolic (DBP) blood pressure; mathematical analysis of the heart rhythm according to R.M. Baevskiy. Physiological studies included: measurement of the indices of functional state of the central nervous system (simple and complex AMR, VMR, Anfimov table), subjective assessment of state of health, activity and mood (SAM). To characterize the degree of tension of individual links of the system of neuro-humoral regulation in the whole organism, the method of mathematical analysis of the heart rhythm (SR) for RM Baevsky was used. Analysis of vegetovascular reaction is a method to assess the state of regulation mechanisms of physiological functions in the human and animal organism, in particular, the overall activity of regulatory mechanisms, neurohumoral regulation of the heart, the relationship between sympathetic and parasympathetic parts of the autonomic nervous system.

Research results

As the results of the comparative analysis showed, the schoolchildren had significant differences in the level of functional state of central nervous system in the studied age periods.

Pronounced sexual and age features were noted from the point of view of sensorimotor reactions (Fig. 1). Thus, the boys in the first age period (14–15 years) showed higher values of VMR and AMR in comparison with the second age period (16–17 years). In the first age period VMR and AMR among boys were averaged 254.8 ± 12.5 and 231.0 ± 10.6 msec, and in the second period there was a significant decrease of 227.0 ± 4.4 and 210.3 ± 3.9 msec, respectively ($p < 0.05$). Significant differences among girls were noted only in the time of AMR (in the first age group of AMR — 248.9 ± 7.7 msec, in the second — 229.9 ± 6.6 msec, $p < 0.05$), significant difference in VMR was noted.

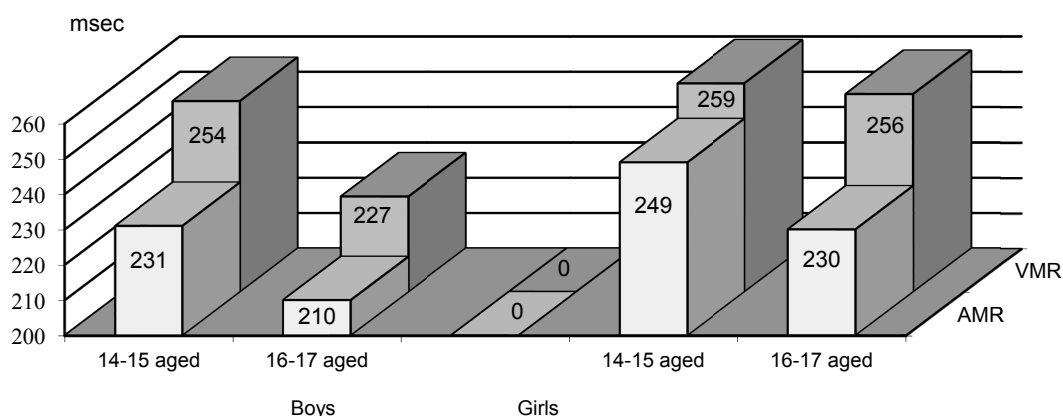


Figure 1. Level of sensorimotor reactions of schoolchildren depending on age periods

If we take into account the fact that the reaction time depends on many external and internal causes and reflects the course of many processes in the central nervous system, the observed changes in the magnitude of the reaction time correspond to the overall effect of interaction of the main processes in the central nervous system, namely, the inhibitory processes were dominated over excitation among the schoolchildren of the first age group. The direction of the general equilibrium shift between these processes, as well as the ability to focus attention to a certain extent, depends on the workload and the degree of fatigue. Consequently, the mental load in the first age group is higher than in the second, and these processes were more pronounced among boys than among the girls.

Evaluation of the effectiveness of attention process with the help of correcting tables of Anfimov showed the presence of significant differences in mental performance among girls (Fig. 2).

Its lower values were noted in the first age period — the number of scanned and found figures (in the first group, 374.7 ± 10.4 and 36.9 ± 1.06 figures, respectively, in the second group — 429.4 ± 16.5 and 42.0 ± 1.69 figures, ($p < 0.05$, Fig. 2.). An additional confirmation is the attention index, in the first age group this indicator had also reliably low values (23.4 ± 0.65 units) in comparison with the second (26.8 ± 0.73 units, Table 1, $p < 0.05$).

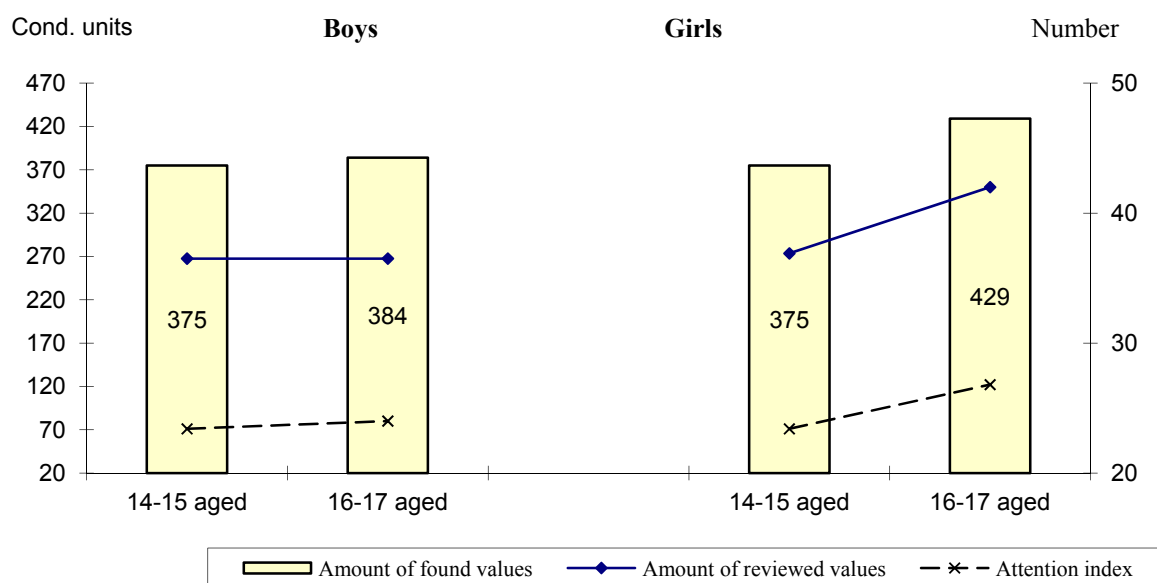


Figure 2. The level of indicators of mental performance among schoolchildren, depending on age

Table 1

The level of functional status of the central nervous system among gifted schoolchildren in different age periods

Indices	Boys		Girls	
	14–15 aged n=145	16–17 aged n=144	14–15 aged n=143	16–17 aged n=141
Amount of reviewed values	374.8 ± 28.2	384.5 ± 12.4	374.7 ± 10.4	429.4 ± 16.5*
Amount of found values	36.5 ± 2.59	36.5 ± 1.12	36.9 ± 1.06	42.0 ± 1.69*
Amount of mistakes	2.60 ± 0.91	2.84 ± 0.49	1.45 ± 0.30	1.91 ± 0.32
Index of attention	23.4 ± 1.76	24.0 ± 0.78	23.4 ± 0.65	26.8 ± 0.73*

Note. * — Differences are significant ($p < 0.05$).

Thus, the obtained results indicate that the gifted students have differences in the level of functional tension of the central nervous system and mental capacity for work, depending on age and sex. Moreover, boys in the 14–15 age group had a higher level of functional tension of the central nervous system, while girls of the same age period had low values of mental capacity for work.

The level of state of health, activity and mood among gifted schoolchildren did not have significant differences depending on age (Table 2).

Table 2

Level of reactive anxiety and SAM indicators among gifted schoolchildren in different age periods

Indices	Boys		Girls	
	14–15 aged n=145	16–17 aged n=144	14–15 aged n=143	16–17 aged n=141
State of health	5.22 ± 0.36	5.46 ± 0.14	5.20 ± 0.18	5.32 ± 0.14
Activity	4.75 ± 0.30	4.91 ± 0.15	4.40 ± 0.22	4.75 ± 0.16
Mood	5.72 ± 0.21	5.74 ± 0.12	5.55 ± 0.17	5.64 ± 0.15

Low mental performance was accompanied by the high values of reactive anxiety level — 39.8 ± 2.32 units among girls of the first age group, while in the second age group — 34.8 ± 1.73 units ($p < 0.05$, Fig. 3). There were no significant differences in the level of reactive anxiety among the boys.

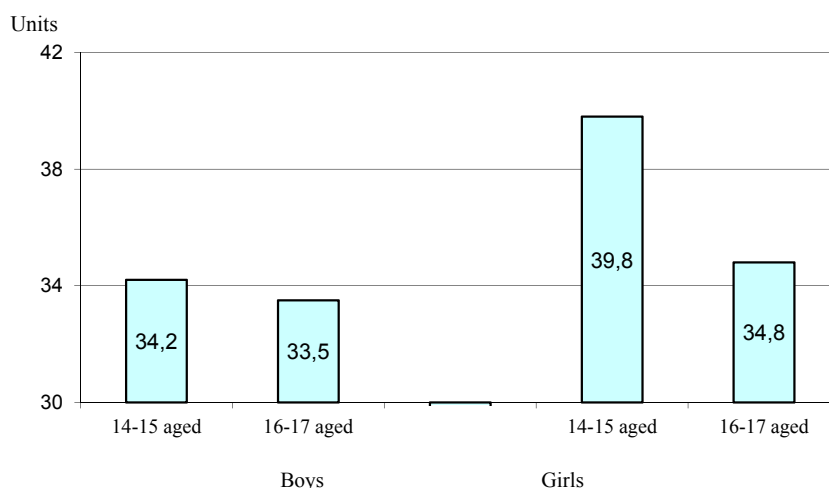


Figure 3. Level of reactive anxiety among gifted schoolchildren in different age periods

On the part of indicators that characterize the level of functional state of the cardiovascular system, there are no significant differences depending on age, except for the pulse rate among girls (Table 3). For example, in the first age group, the heart rate averaged 84.6 ± 1.74 beats per minute, while in the second, 80.2 ± 1.66 beats/min ($p < 0.05$).

Table 3

The level of functional state of the cardiovascular system among gifted schoolchildren in different age periods

Indices	Boys		Girls	
	14–15 aged n=145	16–17 aged n=144	14–15 aged n=143	16–17 aged n=141
SBP	109.6 ± 2.2	111.9 ± 1.5	105.7 ± 1.8	109.1 ± 2.1
DBP	71.2 ± 2.05	72.4 ± 1.15	67.3 ± 1.52	68.1 ± 1.35
Pulse rate	82.5 ± 4.09	79.2 ± 1.70	84.6 ± 1.74	$80.2 \pm 1.66^*$
Ruffier index	6.75 ± 0.61	6.59 ± 0.26	8.63 ± 0.39	$7.52 \pm 0.35^*$

Note. * — Differences are significant ($p < 0.05$).

An evaluation of the intensity of labor according to the pulse rate among schoolgirls of the first age group showed that it corresponded to the level of «satisfactory», while among schoolgirls of the second age group the tension corresponded to the level of «good». Among boys, the intensity of labor according to the pulse rate, according to the quantitative gradation, corresponded to the levels as among the girls, although the quantitative values of the state of emergency did not have such pronounced differences.

This is also confirmed by the results of assessment of the functional capabilities of organism among schoolchildren, depending on the age boundaries. As can be seen from Figure 4, the response to the measured physical load among girls of the first age group is higher than in the second group. The values of the pulse rate here were higher at all stages of the sample. So, if the initial pulse rate among girls of the first age group is averaged 84.6 ± 1.74 beats per minute, in the second group — 80.2 ± 1.66 beats/min ($p < 0.05$), after the emergency load in the first group it increased to 137.7 ± 2.4 bpm, while in the second group it increased to 129.3 ± 2.6 bpm ($p < 0.05$).

Comparison of the average values of the Ruffier index for boys of both age groups, the range of its variability are in the range of satisfactory performance (with the criteria for satisfactory performance of 6–8 standard units, the Ruffier index was in the range of 6.59 ± 6.75 units) [6]. The level of working capacity among the girls of the first age group was inadequate (i.e., more than 8 standard units), among girls of the second age group — satisfactory (Table 3).

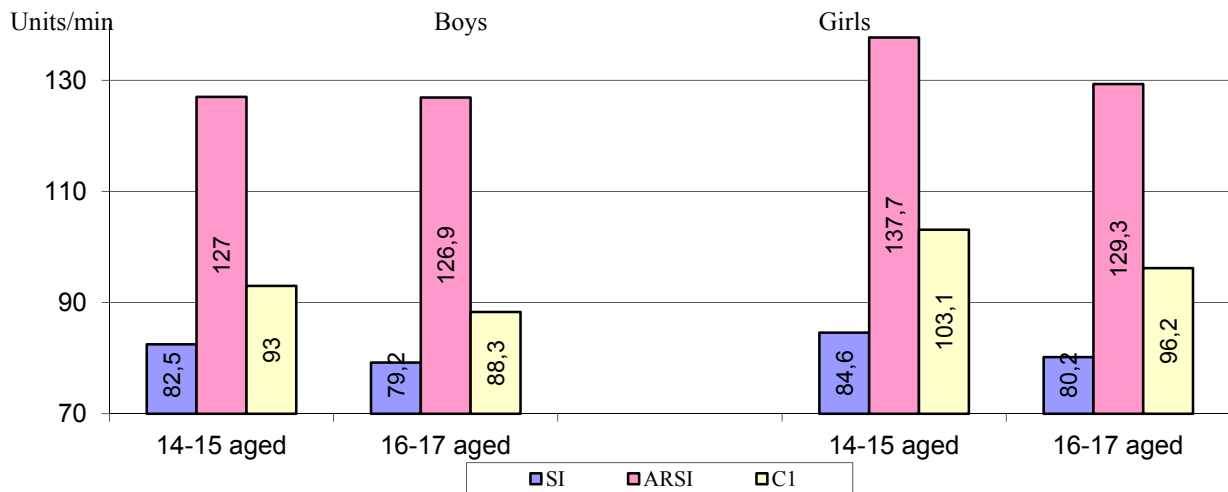


Figure 4. Dynamics of the pulse rate during the exercise test

As the analysis of the regulatory mechanisms of cardiac activity on the basis of mathematical parameters of heart rhythm showed, girls of the first age group have higher reaction intensity, and as a result, the «physiological value» of the work is higher (Table 4). The boys did not have significant differences. The higher tension of regulating systems of organism is shown by higher values of A Moreflecting the mobilizing effect of centralization of cardiac rhythm control, the conditional index of the activity of sympathetic link of regulation. The average AMO among girls of the first age group was $49.6 \pm 3.40\%$, while in the second group it was $41.7 \pm 2.81\%$ ($p < 0.05$, Table 4).

Table 4

Level of heart rate variability among gifted schoolchildren in different age periods

Indices	Boys		Girls	
	14–15 aged n=145	16–17 aged n=144	14–15 aged n=143	16–17 aged n=141
M_{R-R}	764.8 ± 21.3	776.2 ± 15.8	739.3 ± 15.2	$780.5 \pm 17.7^*$
CV	7.23 ± 0.91	7.05 ± 0.35	7.61 ± 0.67	7.11 ± 0.47
Mo	772.6 ± 27.4	782.2 ± 19.4	733.7 ± 24.7	779.1 ± 21.1
Amo	43.8 ± 6.33	40.1 ± 2.02	49.6 ± 3.40	$41.7 \pm 2.81^*$
ΔX	286.2 ± 50.4	302.5 ± 14.6	252.6 ± 27.0	290.5 ± 21.1
TP — S_0	3.82 ± 1.19	4.16 ± 0.46	4.20 ± 0.76	3.63 ± 0.46
HF (HFav) — ΔB	6.15 ± 2.51	5.41 ± 0.71	7.12 ± 1.86	5.37 ± 0.80
LF (LFav) — MB1	11.3 ± 3.64	12.8 ± 1.53	12.4 ± 2.28	11.0 ± 1.48
VLF (VLFav) MB2	18.3 ± 4.31	17.9 ± 2.09	16.2 ± 1.66	$12.3 \pm 1.73^*$
LF/HF	1.06 ± 0.19	1.37 ± 0.21	1.05 ± 0.20	0.96 ± 0.13

Note. * — The differences are significant ($p < 0.05$).

Thus, there is a predominance of the sympathetic part of the autonomic nervous system over the parasympathetic department.

A high degree of tension of regulatory systems is indicated by high values of the stress index, which characterizes the degree of predominance of activity of the central regulatory mechanisms over autonomous ones. An average value of stress index among girls was 167.2 ± 24.3 units for the first age group, 104.1 ± 10.6 units for the second age group ($p < 0.05$).

Analysis of the dynamics of the stress index (Fig. 5) among girls of the first age group showed a sympathetic type of regulation ($SI > 150$ units). Girls of the second age group and boys of both age groups have normotonic type ($SI 60-150$ units).

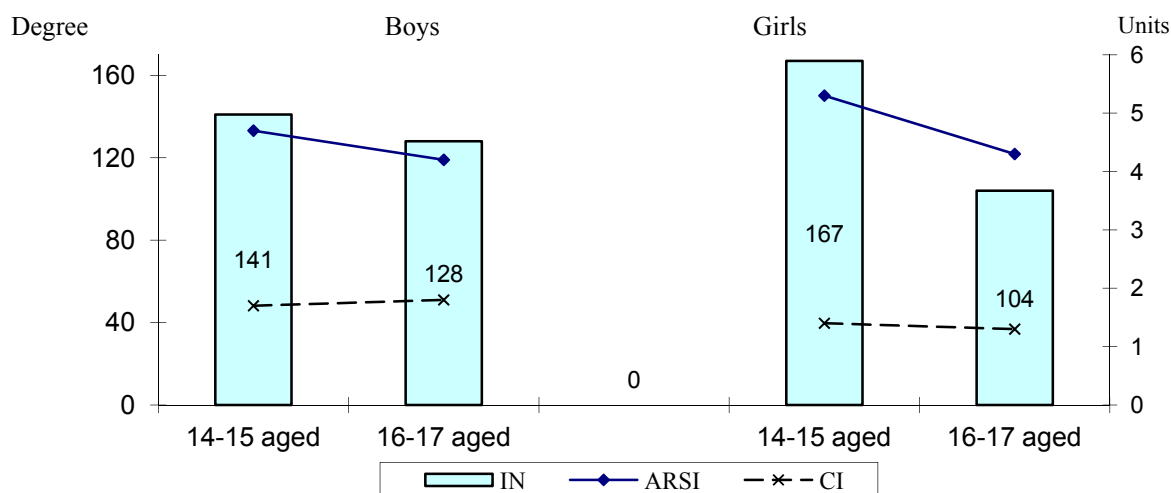


Figure 5. Level of stress and centralization index, index of activity of regulatory system among gifted schoolchildren in different age periods

Thus, the index of activity of the regulatory system, obtained by calculation, made it possible to differentiate different degrees of stress in the school's regulatory systems, depending on the age range, with the exception of 14–15 year old girls with the pronounced level of functional tension of the regulatory systems; this indicator corresponded to the level of the expressed stress in other groups.

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Ш.М. Нугуманова, А.Е. Казимова

Дарынды оқушылар ағзасының бейімделу реакциясына физиологиялық баға беру

Мақалада дарынды оқушылар ағзасының бейімделу реакциясына физиологиялық баға берілді. Қыздар мен ұлдардың бойы мен салмағының ұлғаюы анықталды. Балалардың өтпелі кезеңінде бұлшық ет күшінің жоғары көрсеткіші зерттелді. Оқушыларда орталық жүйке жүйесінің (ОЖЖ) функционалдық жағдайының деңгейінде дәлелденген айырмашылықтар тіркелді. Дарынды оқушыларда ОЖЖ және ойлау қабілетінің функционалдық ширығу көрсеткіштерінің айырмашылықтары жасына және жынысына байланысты болды. Оқу үрдісінің күрделенуіне байланысты оқыту барысында оқушылар ағзасының эрекеттік күйінің өзгерістері, жүйке эмоционалдық белсенділігінің қажуы, жұмыс қабілеттілігінің жылдам төмендеуі, ОЖЖ және жүрек-тамыр жүйесінің жағымсыз өзгерістері пайда болады. Қолайсыз экологиялық жағдайлар осы аудандарда тұратын балалардың физиологиялық көрсеткіштеріне және денсаулық «сапасына», келешекте олардың әр түрлі ауруларға шалдығуына және жұмыс қабілеттілігіне әсер етеді.

Кілт сөздер: жеткеншек, жас, реакция, ағза, орталық жүйке жүйесі, қан-тамыр жүйесі, Руфье индексі, бұлшық ет күші, жұмысқа қабілеттілік, бейімделу.

Ш.М. Нугуманова, А.Е. Казимова

Физиологическая оценка приспособительных реакций организма одаренных школьников

В статье дана физиологическая оценка приспособительных реакций организма одаренных школьников. Выявлено увеличение роста как у мальчиков, так и у девочек. Одновременно с ростом увеличивается и масса тела подростков. Интенсивно растет мышечная сила. У школьников отмечались достоверные различия в уровне функционального состояния центральной нервной системы. У одаренных школьников отмечены различия в уровне функционального напряжения ЦНС и умственной работоспособности в зависимости от возраста и пола. Обучение школьников в условиях интенсифицированного учебного процесса вызывает изменения функционального состояния организма и нервно-эмоциональной активности, заметное утомление учащихся, прогрессивное снижение работоспособности, неблагоприятные изменения в сердечно-сосудистой системе, системе энергообеспечения. Неблагоприятные экологические факторы негативно влияют на физиологические показатели и состояние здоровья, на заболеваемость и работоспособность детей, проживающих в этих районах.

Ключевые слова: подросток, возраст, реакция, организм, процесс, центральная нервная система, сердечно-сосудистая система, индекс Руфье, мышечная сила, работоспособность, адаптация.

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Изучение микрофлоры мяса конины

Проведено изучение микрофлоры конского мяса, собранного в Северо-Казахстанской и Акмолинской областях. Установлено, что на 1 грамм казы из Акмолинской области приходится в среднем $7,8 \cdot 10^5$ КОЕ, а в казы из СКО содержится $1,1 \cdot 10^5$ КОЕ. Уровень контаминированности мяса конины из Акмолинской области был в 7 раз выше, чем образца мяса из СКО. С помощью микробиологических методов выделены и получены чистые культуры девяти бактериальных изолятов. Среди выделенных изолятов отсутствуют бактерии группы кишечных палочек (колиформы), что позволяет говорить о соответствии данных мясных продуктов санитарно-гигиеническим нормам. Однако микроскопический анализ позволил 8 выделенных культур отнести к коккообразным бактериям. Культуральные, морфологические и биохимические тесты позволили 6 кокковых культур отнести к группе условно-патогенных и коагулазо-негативных стафилококков.

Ключевые слова: микрофлора, изоляты, пигментированные бактерии, конское мясо, казы, контаминация, серийное разведение, колониеобразующие единицы, стафилококки, коагулазо-негативные, условно-патогенные микроорганизмы.

Кокки представляют собой широко распространенную в природе группу микроорганизмов, объединяющую в себе наряду с сапрофитными и болезнетворными формами. В последние десятилетия в развитых странах из всех бактериальных инфекций, чаще всего приводящих к смерти, наибольшую опасность представляет золотистый стафилококк *Staphylococcus aureus*. Известно, что многие штаммы золотистого стафилококка продуцируют энтеротоксин. Поэтому наличие в продуктах питания энтеротоксигенных и антибиотико-устойчивых штаммов вида *S. aureus*, а также нарушение производственно-санитарных условий создают угрозу для здоровья потребителей [1].

Естественные популяции стафилококков в основном заселяют кожные и слизистые покровы теплокровных животных и человека, являясь резервуаром инфекции. Некоторые виды стафилококков могут присутствовать в окружающей среде — в воздухе, пыли, сточных водах, воде, почве, в продуктах животного происхождения — в молоке, сыре, мясе, а также на оборудовании пищевых производств. В роду стафилококков, относящихся к семейству *Staphylococcaceae*, выделяют около 37 видов и несколько подвидов [2], среди которых патогенными для человека могут быть не только коагулазо-позитивные стафилококки. Недавние исследования показали, что некоторые коагулазо-негативные стафилококки (КоНС) являются основными возбудителями бактериемии, а также способны продуцировать энтеротоксин [3]. Известны штаммы группы КоНС, имеющие технологическое значение в процессах ферментирования и созревания копченых колбас [4].

Установлено, что преобладание тех или иных видов микрофлоры кишечника связано с их географической привязанностью, т.е. в различных странах доминируют различные виды и штаммы микроорганизмов, поэтому употребление импортных пищевых продуктов может привести к коренному изменению естественной микрофлоры человека [5]. В целом при проведении мониторинга здоровья населения обязательными являются оценка микробно-санитарного качества продуктов питания, а также идентификация микроорганизмов.

Целью данных исследований было изучение микроорганизмов, распространенных в конском мясе, на основе которого изготавливается такой традиционный казахский продукт, как казы.

Результаты исследования

Для определения количества микроорганизмов в конском мясном продукте использован метод серийного разведения образца и высева на плотные среды [6]. Посев полученных суспензий проводили на чашках с питательным агаром СПА (Himedia, India) по 2–3 повторности.

На рисунке 1 представлены результаты подсчета количества выросших колоний на чашках при различном разведении мясного продукта, полученного из образцов казы 1 и 2, собранных в Северо-Казахстанской (СКО) и Акмолинской областях соответственно.

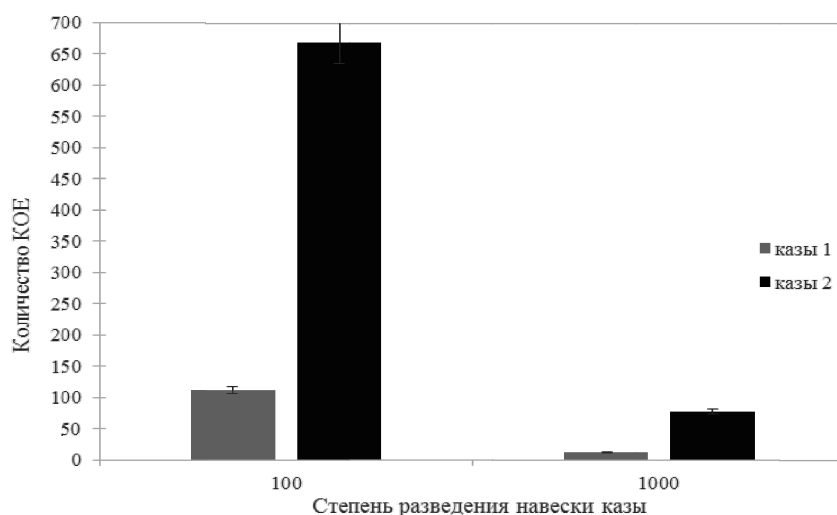


Рисунок 1. Количество бактериальных колоний, полученных из образцов казы

В микробиологической практике лучшим разведением считается то, из которого на чашках со средой вырастает от 50 до 300 колоний бактерий. Поэтому для подсчёта количества микроорганизмов в образце казы 1 взяты данные, полученные при посеве 100-кратно разведенного продукта, что в среднем, исходя из 3-кратной повторности, составило $112 \pm 23,8$ колониеобразующих единиц (КОЕ). Тогда как для определения количества микроорганизмов в образце казы 2 взяты данные, полученные с использованием 1000-кратно разведенной суспензии, что соответствует в среднем $78 \pm 5,6$ КОЕ на одну агаровую чашку.

При перерасчете количества микроорганизмов, находящихся в навеске, установлено, что на 1 грамм пробы казы из Акмолинской области приходится в среднем $7,8 \cdot 10^5$ КОЕ, а в пробе казы из СКО содержится $1,1 \cdot 10^5$ КОЕ. Эти данные указывают, что обсемененность конского мяса из Акмолинской области приблизительно в 7 раз выше, чем в мясе из Северо-Казахстанской области.

Как известно, физиологические и биохимические свойства микроорганизмов исследуют при работе с чистой культурой. Поэтому для получения чистой культуры по методу Р. Коха из агаровых чашек, полученных методом серийного разведения, проведен отбор отдельных колоний с последующим посевом на свежую питательную среду [6].

Культуры микроорганизмов, представленные на рисунке 2, получены из отдельных колоний, полученных из образца казы 1. Исходя из однородности роста колоний по штриху и культурально-морфологических особенностей данные бактериальные изоляты отнесены к чистым культурам, которые обладают различной окраской. Известно, что коккообразные бактерии на питательной среде формируют гладкие, круглые и ровные колонии кремового цвета, а также бывают окрашены каротиноидами в желтый или оранжевый цвета. Однако пигментирование бактерий не является видовым признаком.

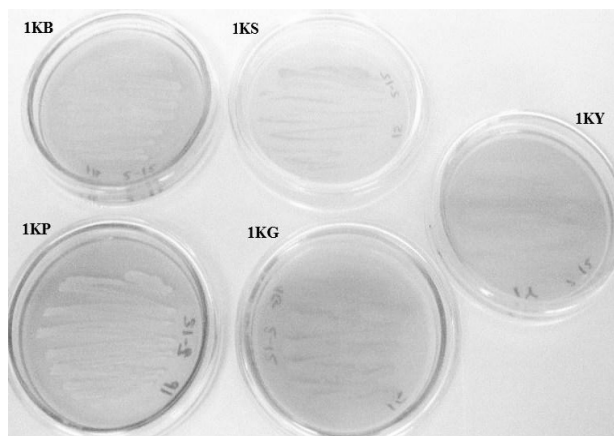


Рисунок 2. Рост изолятов, выделенных из казы 1 на среде СПА

Чистота выделенных культур контролировалась с помощью микроскопии. На рисунке 3 представлен микроскопический анализ кокковых культур, окрашенных по методу Грамма.

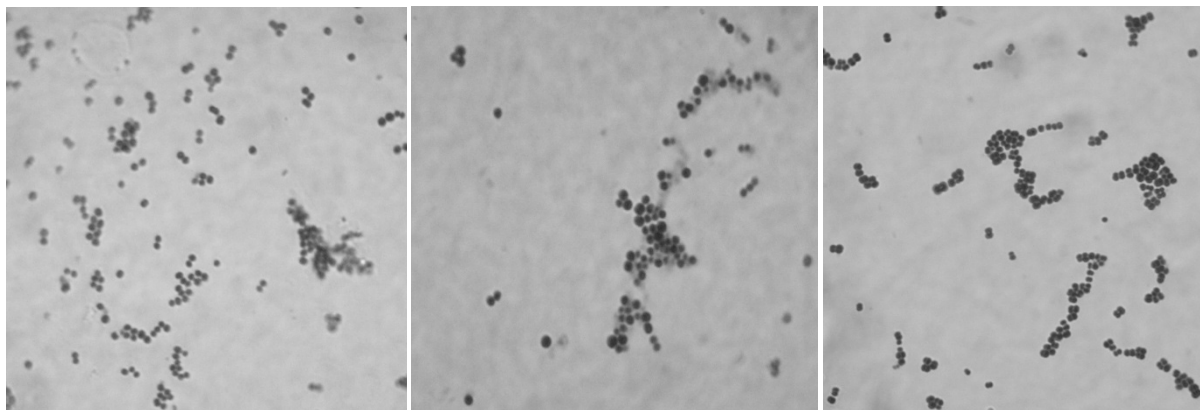


Рисунок 3. Микроскопия изолятов 1КВ, 1КР и 1КУ, выделенных из казы 1

Микроскопия выделенных из образца казы 1 изолятов 1КВ и 1КР подтверждает, что они относятся к грамположительным коккам, клетки которых располагаются одиночно, попарно или в виде тетрад, а также образуют скопления, напоминающие «гроздья» винограда. Клетки изолятов 2КВ1 и 2КВ2, выделенных из казы 2, также образуют «виноградные гроздья», что является одним из признаков, указывающих на их принадлежность к стафилококкам. Культуры 1КУ и 2КР1 имеют клетки идеальной шаровидной формы, которые в большинстве случаев расположены тетрадами. Клетки коккоподобных культур 1КС и 2КУ1 также не образуют четких плотных скоплений в виде «сот». Изолят 1КГ имеет клетки округло-овальной, немного вытянутой формы и отнесены к грамм-положительным палочкам.

Присутствие каталазы является основной отличительной особенностью стафилококков от стрептококков. Поэтому для дифференциации всех 9 исследуемых изолятов проведена постановка теста на каталазу. Результаты определения каталазной активности двух культур 1КВ и 1КР показаны на рисунке 4. Установлено, что все выделенные изоляты относятся к каталазоположительным микроорганизмам.

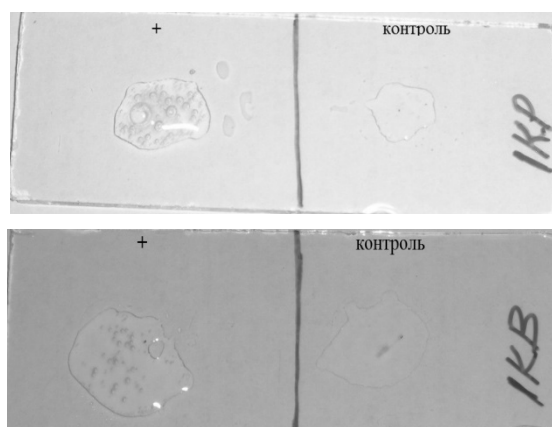
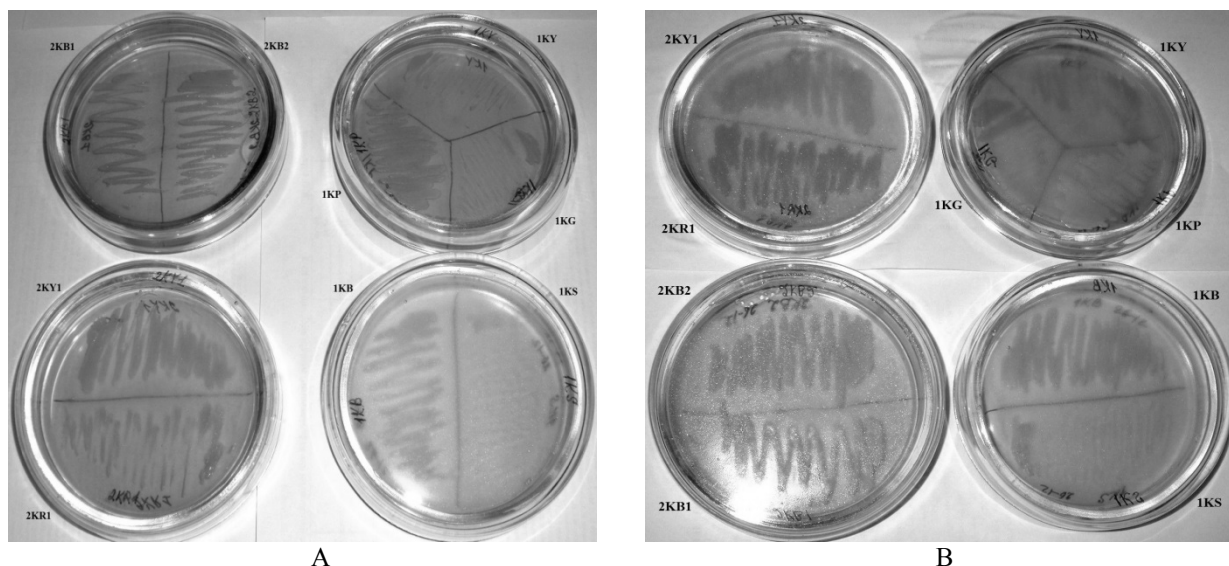


Рисунок 4. Определение каталазной реакции бактериальных изолятов 1КР и 1КВ из казы 1

Для определения характерной пигментации колоний стафилококков проведено их культивирование на селективной питательной среде *Staphylococcus agar* (Fluka, США), содержащей высокую концентрацию NaCl (7,5%), маннит в качестве источника углеводов и желатин. Патогенные стафилококки дают на этой среде колонии с желтой пигментацией. На рисунке 5 показаны чашки с 1- и 2-суточными культурами исследуемых микроорганизмов.



А — чашки с 1-суточными и В — чашки с 2-суточными культурами

Рисунок 5. Рост изолятов, выделенных из казы на среде *Staphylococcus agar*

На первые сутки на стафилококковой среде быстрый и обильный рост был характерен для культур 1KB и 1KP, а также 2KB1 и 2KB2, выделенных из образцов казы 1 и 2 соответственно (рис. 5А). Однако характерной для патогенных стафилококков желтой пигментации у данных бактерий не выявлено, их колонии были кремово-белого или бежевого цвета. На 2-е сутки культивирования изоляты 2KY1 и 2KR1 на этой среде показали средний рост, а 1KY, 1KG, 1KS на данной среде слабо росли (рис. 5В).

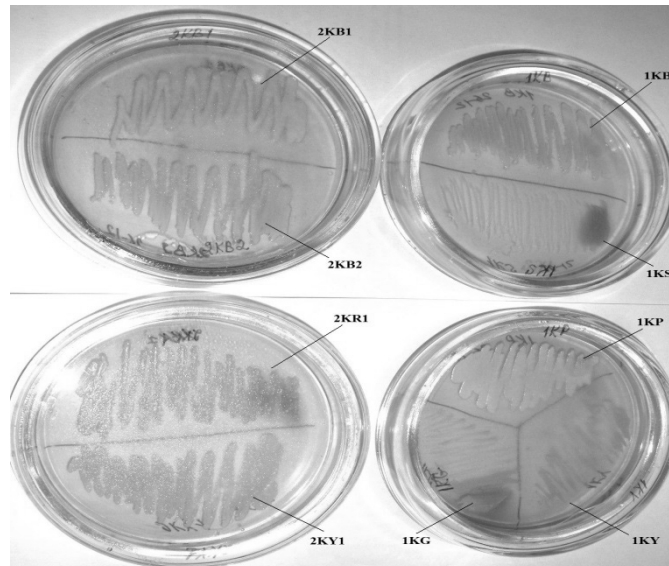


Рисунок 6. Качественная оценка усвояемости маннитола изолятами, выделенными из казы

На представленном рисунке 6 показано, что при нанесении на бактериальные колонии 1KB, 1KP, 2KB1 и 2KB2 капли 0,04 %-ного раствора бромтимолового синего цвет красителя был желтым, тогда как цвет колоний 2KY1 начинал приобретать слабо-зеленоватый оттенок. При этом цвет культур 1KY, 1KG, 1KS и 2KR1 сразу же приобретал слабо-зеленоватую или ярко-зелено-синеватую окраску. Данный показатель свидетельствует о возможной утилизации маннитола данными бактериями в анаэробных условиях.

Согласно определителю Берджи и сведениям, обобщенным в руководствах по клинической микробиологии, большинство штаммов рода *Staphylococcus spp.* на среде с глюкозой в анаэробных усло-

виях образуют ацетонин [2, 7]. На рисунке 7 представлены результаты определения способности бактериальных изолятов 1KB, 1KP, 1KY, 1KS и 1KG усваивать глюкозу в анаэробных условиях.

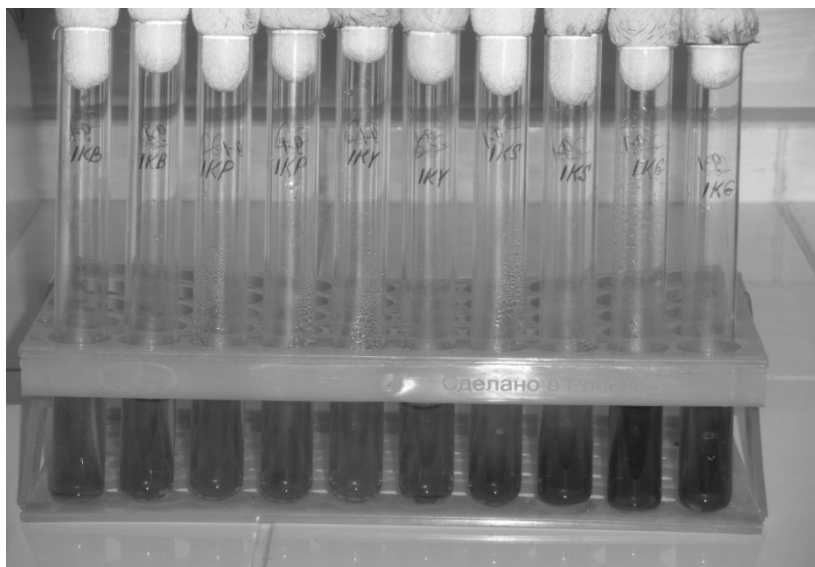


Рисунок 7. Качественная оценка усвояемости глюкозы в анаэробных условиях изолятами, выделенными из казы 1

Изменение окраски индикаторной среды Гисса свидетельствует, что изоляты 1KB, 1KP и 1KY (рис. 7), выделенные из образца казы 1, а также изолят 2KR1 из второго образца казы способны полностью ферментировать глюкозу в анаэробных условиях. В данных условиях из девяти изучаемых культур изоляты 2KB1, 2KB2, 2KY1, а также 1KG и 1KS обладали слабой активностью или совсем не ферментировали глюкозу.

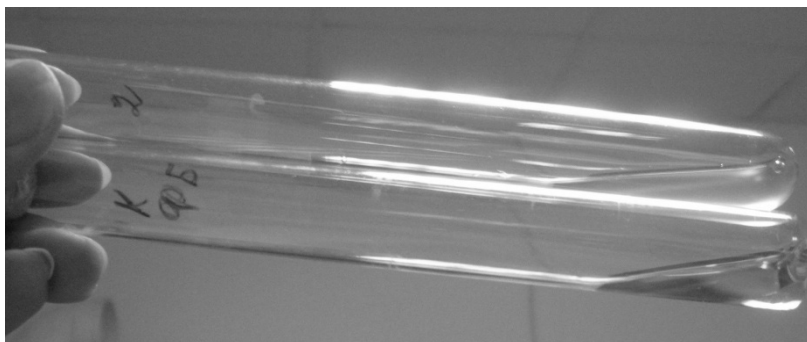


Рисунок 8. Качественная оценка коагулазной активности изолята, выделенного из казы

Для дифференциации патогенных стафилококков от непатогенных проведено определение коагулазной активности (рис. 8). Все 9 исследуемых культур отнесены к коагулазонегативным микроорганизмам, так как не обладали способностью к сворачиванию плазмы кроличьей крови.

Таким образом, на основе проведенных исследований установлено, что уровень обсемененности конского мяса, собранного на территории Северо-Казахстанской и Акмолинской областей, составляет $1,1 \cdot 10^5$ КОЕ и $7,8 \cdot 10^5$ КОЕ соответственно. Из данных мясных продуктов выделены в основном пигментированные коккоподобные бактерии, относящиеся к грамположительным микроорганизмам. Микроскопический анализ 9 выделенных микроорганизмов наряду с результатами биохимических тестов позволяет изоляты 1KB, 1KP и 1KY, а также 2KB1, 2KB2 и 2KR1 отнести к непатогенным бактериям рода *Staphylococcus spp.* Среди выделенных изолятов отсутствуют бактерии группы кишечных палочек (колиформы), что позволяет говорить о соответствии данных мясных продуктов санитарно-гигиеническим нормам. Однако в связи с тем, что некоторые виды КоНС, в частности *S. epidermidis* и *S. haemolyticus*, относятся к условно-патогенным микроорганизмам, вызывающим за-

болевания, возникает необходимость проведения видовой идентификации исследуемых изолятов, выделенных из мяса конины [8].

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М.Ж. Каирова

Жылқы етінің микрофлорасын зерттеу

Солтүстік Қазақстан және Ақмола облыстарының жылқы еті сынамаларының микрофлорасы зерттелді. Нәтижесінде Ақмола облысының 1 г жылқы еті үлгідегі микроағзалардың саны $7,8 \cdot 10^5$ КОЕ және Солтүстік Қазақстан облысының сынамасында $1,1 \cdot 10^5$ КОЕ деп анықталды. Солтүстік Қазақстанға қарағанда, Ақмола облысының жылқы еті сынамаларының микроағзалармен контаминациялану деңгейі жеті есе жоғары болды. Микробиологиялық әдістердің көмегімен тоғыз түрлі бактериялардың таза өсінділері бөліп алынды. Осы изоляттардың арасында ішек таяқшалар тобына жататын бактериялар (колиформалар) жоқтығы, зерттелінген ет сынамаларының санитарлық-гигиеналық талаптарына сәйкес келетінін растады. Алайда бөліп алынған 8 изоляттар кокктарға жататындығы микроскопиялық әдіс арқылы анықталды. Алынған бактерия изоляттарының морфологиялық, өсінділік және биохимиялық қасиеттерін зерттеу барысында олардың алтауының шартты-патогенді және коагулаза-негативті стафилококктар тобына жататындығы айқындалды.

Кілт сөздер: микрофлора, изоляттар, пигментелінген бактериялар, жылқы еті, қазы, контаминация, сериялық ерітінділер, колония қалыптастыратын бірліктер, стафилококктар, коагулаза-негативті, шартты-патогенді микроағзалар.

M.G. Kairova

Studying microflora of horsemeat

Microflora of horsemeat samples that collected in North Kazakhstan and Akmola regions are studied. It was found that Akmolinsky's kazy contains in average of $7.8 \cdot 10^5$ CFU/g and the kazy from North Kazakhstan have $1.1 \cdot 10^5$ CFU/g. The level of contamination of horsemeat from the Akmola region was seven times higher than that of the North Kazakhstan region. Nine bacterial cultures were isolated and obtained their pure cultures by using traditional microbiological methods. The general group of intestine rod-shaped bacteria (coliforms) indicating a lack of adherence to good sanitary hygienic practices did not find among these microorganisms isolated from meat samples. However, microscopic analysis showed that 8 bacterial isolates is assigning to coccoid bacteria. Six of these cultures are belonging to a group of opportunistic and coagulase-negative staphylococci according to cultural-morphological and biochemical tests.

Key words: microflora, isolates, pigmented bacteria, horsemeat, kazy, contamination, serial dilution, colony-forming units, staphylococci, coagulase-negative, opportunistic microorganisms.

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G.K. Turlybekova

*Ye.A. Buketov Karaganda State University, Kazakhstan
(E-mail: gulzhazira_t@mail.ru)***The current ecological state of mountain ram (*Ovis ammon collium*)
of population of GNPP «Buyratau»**

This article in is showed the ecological features of mountain sheep's (*Ovis ammon collium*) population of «Buyratau», a state national nature park. It is belong to rare and endangered category from the Red book. Area of existence of animals is local. It is one of five mountain sheep's subspecies, which exist in Kazakhstan. Argali use winter and summer pastures, with which their seasonal movements. Daily activity changes at seasons of year and depends on factors as: temperature of air, light intensity, air humidity, the frequency of rains and snowfalls, influence of sanguivorous insects and physiological state of animals. Food allowance of argali includes 87 species of plants. Today the number of population of argali in «Buyratau» depend of several complex of factors, anthropogenic and natural factors. The most important natural factor is death from wolves. Strategy creation of biological defence, reproduction and rational use is impossible without detailed knowledge of the animal's ecology and of factors that influence on its population in specific conditions which correspond to objectives of Convention on Biological Diversity, which was approved by the government of Republic of Kazakhstan.

Keywords: GNPP «Buyratau», populations, territory, movement, mountain ram, arkhara, hoofed animals, area, factors, activity, delivery, number.

Today one of the important problems of biology is conservation of biological diversity. Conservation of biodiversity and sustainability problem of biotic communities appears to be the priority direction of modern biology and ecology. Therefore studies of ecological features, lifestyle and changes of population of mountain sheep is one of the current problems of population ecology. President of Kazakhstan noted as important the problem of conservation and rational use of country's biodiversity as one of the main long-term priorities of Kazakhstan's development. Despite of the ecological plasticity, resources and economic importance of argali is decreasing day by day. Against the background of its common decrease in Kazakhstan various reserves and natural parks where breed red deer, for the purpose of increase in their number in Kazakhstan, and also its preservations. Arkhara are included in the Red List, the mountain ram is included, in the list of the most dangerous invasive types according to the International Union of Conservation.

The type from category of «infrequent and disappearing», is included in Red Lists of the USSR, and Republic of Kazakhstan and appears in the Appendix 2 «Convention on international trade in the types of fauna and flora which are under the threat of disappearance». The range of argali is very broad. They inhabit Pamir, Himalayas, Dzhungarian Alatau, Tarbagatai, Saur, Kazakh Highlands, south and south-east Altai, mountains of Mongolia and China.

Now mountain rams are widespread in the Central Kazakhstan very widely and can be met on shallow heights. They live practically in all large mountain as Semizbuga, Karaganda, Zhartas, Zheltau, Dyn, Hankashta, Karkaraly, Koshubai, Kent, Tungatar, Besobinsky, Ulken-Karakus, Narshoky, Kyzyltas, Kyzylaray, Chingiztau, etc. This same time isolation of some groups from the main area is observed.

The Ermentau mountain massif covers the area over 200 thousand hectares. About a half of this territory (88 968 hectares) are belong to the especially protected natural territory (EPNT) — Republican public organization «State national Buyratau natural park» formed in March, 2011. Around the park a security zone created equal territory of the park (88064 hectares) with differentiated mode of protection of the nature works. All these actions are directed to preservation of unique natural complex of Ermentau mountains

The mountain ram — *Ovis ammon collium* — the representative of the Bovidae, Artiodactyla group, the class Mammalia [1–6] lives in Ermentau uplands. The area is focal. It is one of five subspecies of the mountain rams living in Kazakhstan.

Three types of movements are allocated at arkhara: seasonal, daily and compelled. Seasonal movements are most noticeable. First of all they are caused by existence of a forage during particular seasons of year, so our arkhars move in the winter to the southern and east areas where on slopes of mountains and valleys the stern is more. Before a genus of female go to more protected places with the sharp crossed relief. The considerable movements are observed during rutting when adult males pass into habitats of females. But all the-

se movements happen, is routine in the territory of population if arkhar not to disturb. The compelled movements can be caused by natural disasters (the fires, hurricanes) or with emergence of some. Also paths of distant migrations of arkhar within its area are known, they are constant.

The description of the modern distribution of arkhars is rather authentically provided by Berbera (1999) [5–6].

The sizes and body weight of animals, their body height and development are depend not only from a genotype, but also from conditions of life. Growth rates, development and a metabolism are not identical even at the close sibling species. At the North Kazakhstan mountain rams number of chromosomes 56.

Legs at these animals are thin. Hoofs are large, are well adapted for movement on snow, the weak soil and rocks. Horn substance very solid, and in the tail of a hoof acts a finger pulp which does not slide on smooth stones. The area of forward hoofs (38,6 cm²) considerably exceeds the area back (29,3 cm²).

Brown-brown or grayish-brown coloring of an upper of the head and trunk at it to a thicket is sharply separated from a white bottom, and below of the frontal part of hind legs there passes the dark strip [5–10].

Nutrition is one of the most important forms of communication of organisms with environment of dwelling of animals. Searching and eating of forages as not discontinuous acts of activity at mountain rams to a large extent, than at many other hoofed animals, define placement of animals on the area, promoting at the same time development of a special rhythm of daily activity, a way of getting of a forage, the nature of movements, etc. [6].

Daily activity of a mountain ram changes on seasons of year and is defined by many factors: air temperature, illuminating intensity, humidity and amount of precipitation, influence of blood-sicking insects, and also physiological condition of animals.

In the mountains Ermentau, Koshubais, Temirshi apxap eats in the summer, in the fall and winter of 87 species of plants (including 19 species of bushes) and 1–2 types of lichens of the sort *Parmelia* [11–15].

Distribution of arkhars on biotopes has particular regularity: females with lambs prefer territory enriched by food, males — the most protected prefer. Summer and winter pastures to which their seasonal movements are bound clearly are expressed. These hoofed animals make also slight daily movements, and at natural disasters can migrate on long distances.

In the summer daily activity has pronounced recurrence. Arkhars begin to be grazed early in the morning with sunrise (Fig. 1) and late at night.



Figure 1. Arkhara at pasturage

In August activity of arkhar increases. In the evening they begin to be fed with 16–17 ch, and to twilight (from 19 to 22 o'clock) their activity increases. In especially hot days of arkhars at 7 o'clock already lay down or disappear in a shadow under rocks, in a bush or in the wood. During rest some individuals rise, fed on average 9–12 min and again lay down, changing the place, but not moving away from a from place more than on 25–30 m.

The pronounced cyclic mode of daily activity in June-October. In November of the grazed arkhars it is possible to meet at any time. During this period physical activity of males increases. They look for females or rivals and are a little fed.

Winter time arkhars spend for pasturage more time, than in the summer. Intensive feeding is the share of morning hours, and the greatest number of vacationers is noted in December and January from 13 to 16 o'clock and in February from 11 to 13 p [9, 10]. In spring–summer period to arkhara in the Kazakh uplands the great trouble is caused by midges, mosquitoes, gadflies and blood taken flies [11].

Important factor changes of number of arkhars are epidemics and epizodiya. Death caused by necrobatsileis a pyroplasmosis are known [12]. The most significant effect on the number of population of arkhars in Ermentau uplands, as well as in other regions of its habitats, is rendered by wolves (Fig. 2).



Figure 2. Remains of a young female

Population of arkhars in GNPP «Buyratau» (winter route accounting of migration) in 2012–2016 (Fig. 3).

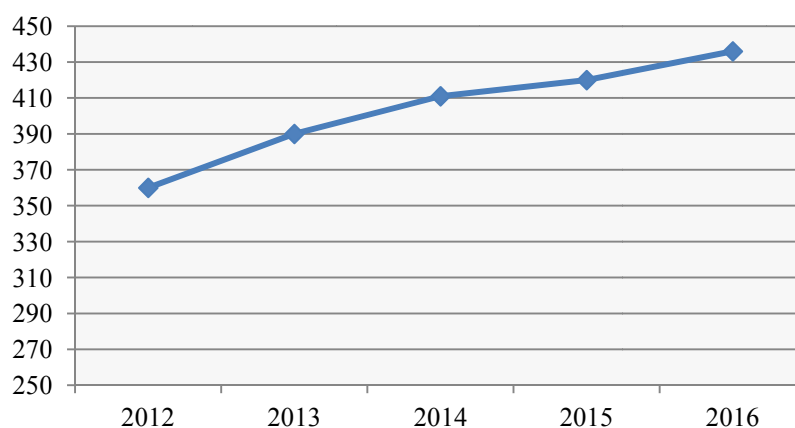


Figure 3. Population of arkhars in GNPP «Buyratau» winter route accounting of migration of animals in winter period 2012–2016

The number of an arkhars was stabilized in compared with 2012 and tends to increase (Fig. 3). The annual increase of a livestock of population is noted, it is promoted by the favorable factors in the territory of GNPP «Buyratau».

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Г.К. Тұрлыбекова

**«Бұйратау» МҰТП арқарының (*Ovis ammon collium*)
қазіргі экологиялық күйі**

Мақалада «Бұйратау» Мемлекеттік ұлттық табиғат паркінің Қызыл кітапқа енген, сирек және жойылып бара жатқан арқар (*Ovis ammon collium*) популяциясының экологиялық ерекшеліктері берілген. Таралуы, негізі, тұрақсыз. Қазақстанда мекендейтін тау арқарының бес түршесінің бірі болып табылады. Арқарлардың жазғы және қыстық жайылымдары олардың маусымдық ауысуына тікелей байланысты. Арқардың тәуліктік белсенділігі ауа температурасы, жарық, ылғалдылық және жауын-шашын мөлшеріне, қансорғыш жәндіктер таралуына және физиологиялық күйі жыл маусымына және көптеген факторларға байланысты. Арқардың рационы 87 өсімдік түрлерінен тұрады. «Бұйратау» МҰТП арқар популяциясының сандық динамикасының азаюы қазіргі таңда антропогенді, табиғи әсерден, оның ішінде қасқырлар шабуы кешенді түрде болуынан екендігі белгілі. Құнды тұяқты жануардың санын көбейту және рационалды пайдалану оның экологиясын, нақты мекендейтін аумағында сандық динамикасына әсер ететін факторларды тікелей зерттеумен байланысты. Бұл заңдылық Қазақстан Республикасы Үкіметінің Биоалуантүрлілікті сақтау конвенциясы мақсаты мен міндетіне сәйкес қорғалады.

Кілт сөздер: «Бұйратау» МҰТП, популяция, аймақ, ареал, арқар, жұптұяқты, экологиялық факторлар, белсенділігі, қоректену тізбегі, сандық динамикасы.

Г.К. Турлыбекова

Современное экологическое состояние горного барана (*Ovis ammon collium*) популяции ГНПП «Буйратау»

В статье показаны экологические особенности горного барана (*Ovis ammon collium*) популяции Государственного национального природного парка «Буйратау», краснокнижного вида из категории редких и исчезающих. Ареал — очаговый, пульсирующий. Это один из пяти подвидов горных баранов, обитающих в Казахстане. У архара отчетливо выражены летние и зимние пастбища, с которыми связаны их сезонные перемещения. Характер суточной активности горного барана меняется по сезонам года и определяется такими факторами, как температура воздуха, освещенность, влажность и количество осадков, воздействие кровососущих насекомых, а также физиологическое состояние животных. Рацион горного барана включает 87 видов растений. Динамика численности популяции горного барана Буйратау в настоящее время зависит от ряда факторов, действующих комплексно: антропогенных и естественных, из которых наиболее значима — гибель от волка. Выработка биологической стратегии охраны, воспроизводства и рационального использования этого ценного копытного невозможна без детального знания его экологии, изучения факторов, влияющих на динамику численности в конкретных местах обитания, что соответствует целям и задачам Конвенции о биологическом разнообразии, одобренной Правительством Республики Казахстан.

Ключевые слова: ГНПП «Буйратау», популяция, территория, перемещение, горный баран, архар, копытные, ареал, факторы, активность, питание, численность.

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Prevention destruction of pancreatic B-cells induced by chelators by reduced form of Glutathione

Authors investigated preventive effect of Reduced form of Glutathione on developing of diabetes caused by diabetogenic zinc binding ligands. It is shown that only Reduced form of Glutathione contains SH-radical in chemical structure possesses ability to protect B-cells of death unlike the Oxidized form of the Glutathione, free of it. It was established that injection of R-Glutathione, 1000 mg/kg completely connects with zinc in B-cells that protect cells of formation of toxic complexes causing destruction of B-cells and development of diabetes. Investigation of chemical aspect of interaction of R-Glutathione with zinc showed that administration of it result a complete blocking of zinc in B-cells therefore zinc does not revealed using of high specific and sensitive histochemical methods. The studying of duration of blocking of zinc in B-cells showed that complex Zn-R-Glutathione begins to dissociate with partial release of zinc approximately about 36 hours after injection and 48 hours later majority of complex is dissociate. Authors suppose that preventive ability of R-Glutathione is caused by ability to formation of not toxic temporary complex with zinc; zinc atom is fixed between atom of sulfur of the SH-radical and atom of oxygen or nitrogen which are contained in a molecule of R-Glutathione as well as after administration of diabetogenic chelators between of sulfur atom — and either oxygen atom, or atoms of nitrogen or carbon on the other hand.

Keywords: B-cells, R-Glutathione, insulin, zinc, experimental diabetes.

Abbreviations

R-Glutathione — Reduced form of Glutathione,
O-Glutathione — Oxidized form of Glutathione,
Zn — zinc,
DZ — Dithizon 8PTSQ — 8-para(toluenesulphonylamino)quinolin

Background

It was found that Diphenylthiocarbazone (Dithizon) and some derivatives of 8-oxyquinolin (8-ox) induced formation of toxic chelat complexes as «Zn-DZ» and «Zn-8-ox» in cytoplasm of B-cells that result selective destruction of B-cells within 15–30 min. and accompanied by developing of 1st type diabetes in animals [1]. Later it was reported preventive injection of some amino acids as Cystein and L-Hystidine contains sulfhydryl SH-radical in structure of molecule, accompanied by protect B-cells of destruction caused by DZ and 8-ox that result prevention of developing of diabetes in majority of animals [2–5]. High durability of the Zn⁺²-Dithizon complex 2:1 (Fig. 1, 2) determined by space elongation of molecule of Dithizon and disposition of two phenolic rings on the ends of a molecule that does not prevent the atoms of sulfur and nitrogen located in the center of a molecule to approach zinc atom. Besides, atom of zinc is located between two

atoms of nitrogen and sulfur, regarding to which affinity of zinc is very high and exceeds affinity to oxygen. [6]. It was supposed that protective activity of Cystein and L-Hystidine may be determined by the presence of SH-radical in the structure of molecule because formation of chelat complexes with DZ and 8-ox is processed by connection of Zn atoms with atom of S, H, O or N [6]. Aim of investigation: to study possible preventive effect of amino acids as Gluthation Reduced form contains SH-group and Gluthation Oxidised form not contains SH group.

Methods

Animals. 16 Rabbits 2400–2850 g.

Group 1. Injection of Dithizon, 48.6–51.2 mg/kg;

Group 2. Injection of Gluthatione-O, 970–1010 mg/kg + 10 min. later Dithizon, 49.8–50.6 mg/kg.

4 animals from each groups (1a and 2a) were killed 10 min. after injection of Dithizon and 4 animals (1b and 2b) — 9 days after injection.

Group 3. Injection of Gluthatione-R and Gluthatione-O: 985–1020 mg/kg. Animals were killed 6h, 12h and 24h after injection. Staining of frozen sections of pancreas for Zn-ions by Dithizon method and by 8PTSQ.

Frozen sections of pancreas of animals 1a and 1b groups were investigated using dark microscopy. Blood glucose level measuring — in animals of 1b, 2a and 2b groups before injection of Dithizon and 1, 3, 6 and 9 days after injection. Aldehyde-fucshine method [7–9] was used for analysis state of histostructure of pancreas tissue and Dithizon method formed red granules of complex «Zn–DZ» visible using dark microscopy. Maximum of absorbance of Zn^{+2} –DZ complex on spectrum of absorbance correspond for 530 nm [3].

8-para(toluenesulphonylamino)quinolin (8PSQ), a high specific fluorescent reagent was used for staining of Zn-ions in B-cells. 8TSQ formed fluorescent green complexes with Zn^{+2} -ions visible using fluorescent microscopy [10–12].

Results

Group 1a. Administration of DZ accompanied by formation of a large amount of red granules of Zn–Dithizon complex in cytoplasm of B-cells (Fig. 1). Maximal concentration of granules located on the pole of B-cells contacted blood capillaries that correspond to concentration of deposited insulin.

Group 1b. Experimental diabetes. Blood glucose concentration increased since 5.2 ± 0.3 mM until 12.6 mM at 6th day and 16.4 ± 1.7 mM at 9th day (Table 1). Histology: necrosis and destruction of 70–90 % of B-cells, marked decreasing of insulin and zinc content in B-cells.

Group 2a. Preliminary injection of Gluthatione-R result almost complete prevention of formation of «Zn–DZ» complex in B-cells (Fig. 1). Simple granules contacted capillaries contain granules of complex only.

Group 2b. Administration of Glutathione Reduced form before Dithizon accompanied by prevention developing of diabetes in 3 animals from 4 (Table 2, Fig. 1). In one rabbit (N3) blood Glucose level increase till 9th day until 7.3. Histologic analysis showed decreasing of insulin content in cells without marked histological changes.

Administration of Glutathione Oxidized form before Dithizon not accompanied by prevention developing of diabetes: diabetes was developed in all animals (Table 3) with marked histological changes. Histologic analysis showed decreasing of insulin content in cells and presence of marked histological changes.

Group 3. It was important to obtain direct experimental confirmation that administration of Glutathione Reduced form to animals accompanied by binding of Zn-ions in B-cells as to investigate: how long time this complex exist in B-cells as we suppose, that 24 hours later after injection of R–Glutathione partial dissociation of complex is observed and 48 hours later there are almost complete dissociation (Fig. 1) with restoring of positive fluorescent reaction for zinc in B-cells.

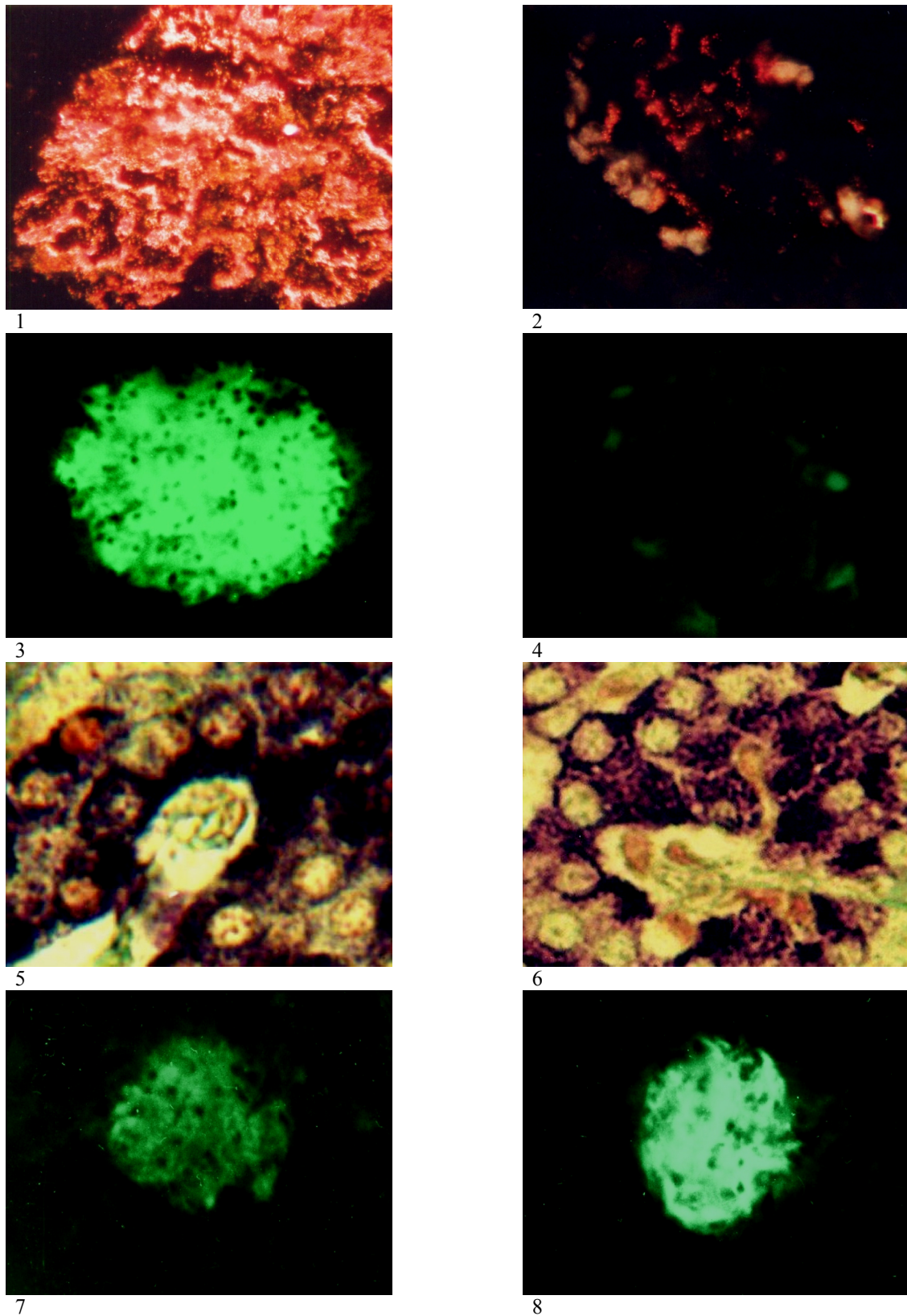


Figure 1

- 1 Pancreatic islet of intact rabbit. Dithizon, 48.9 mg/kg. Large amount of red granules of complex Zn-DZ in B-cells; Dark microscopy; $\times 280$.
- 2 Pancreatic islet. Glutathione Reduced form, 985 mg/kg + Dithizon, 50,2 mg/kg. Almost complete absence of complex Zn-DZ in B-cells; Dark microscopy; $\times 280$.

- 3 Pancreatic islet of intact rabbit. Positive fluorescent reaction for Zn-ions in B-cells; $\times 140$.
- 4 Pancreatic islet. Glutathione Reduced form, 1015 mg/kg. Negative fluorescent reaction for Zn-ions in B-cells; $\times 140$.
- 5 Pancreatic islet of intact rabbit. Histostructure and insulin content in B-cells without changes; Aldehyde-fuchshine; $\times 280$.
- 6 Pancreatic islet of rabbit. Glutathione Reduced form, 1010 mg/kg + Dithizon, 49.4 mg/kg. Histostructure and insulin content in B-cells without changes; Aldehyde-fuchshine; $\times 280$.
- 7 Pancreatic islet of rabbit. Glutathione Reduced form, 975 mg/kg, 36h after injection. Partial dissociation of complex Zn-Glutathione; Fluorescent reaction for Zn-ions; $\times 140$.
- 8 Pancreatic islet of rabbit. Glutathione Reduced form, 1000 mg/kg, 60h after injection. Almost complete dissociation of complex Zn-Glutathione; Positive fluorescent reaction for Zn-ions; $\times 140$.

Table 1

Blood glucose concentration in rabbits after injection of Dithizon

Animals	Dose of Dithizon (mg/kg)	Blood glucose concentration (mM)				
		before	1 st day	3 rd day	6 th day	9 th day
1	48,6	4,7	11,6	18,5	16,4	22,8
2	49,9	5,6	7,7	16,2	24,4	21,5
3	51,8	5,3	12,2	20,6	17,2	18,8
4	48,8	5,9	10,3	14,6	20,5	17,8

Table 2

Blood glucose concentration after injection of Glutathione Reduced form and Dithizon

Animals	Dose of Glutathion Red. (mg/kg)	Dose of Dithizon (mg/kg)	Blood glucose concentration (mM)				
			before	1 st day	3 rd day	6 th day	9 th day
1	985	49,3	5,9	6,7	6,2	4,3	5,8
2	1010	50,6	5,1	7,1	5,3	6,0	5,9
3	1012	52,2	4,3	6,1	5,7	6,2	6,8
4	1020	50,8	5,5	7,2	6,6	5,4	5,7

Table 3

Blood glucose concentration after injection of Glutathione Oxidized form and Dithizon

Animals	Dose of Glutathion Ox. (mg/kg)	Dose of Dithizon (mg/kg)	Blood glucose concentration (mM)				
			before	1 st day	3 rd day	6 th day	9 th day
1	960	47,2	8,9	15,7	12,5	14,3	15,8
2	1000	51,7	5,1	9,1	13,6	11,9	14,8
3	1020	50,1	4,3	12,5	10,6	14,2	21,8
4	1015	52,5	5,5	10,5	15,8	18,8	20,6

Discussion

Obtained results showed that administration of R-Glutathione result binding of almost all amount of Zn-ions in B-cells reversibly as least for 24 hours. Injection of dithizon after R-Glutathione not accompanied by forming in B-cells of chelat complexes Zn-DZ that result prevention of damage and death of majority B-cells and prevention developing of diabetes in 3 animals from 4. It is known that amino acids Cystein and L-Hystidine possess same property: injection of acid result protect B-cells of destruction by Dithizon as of developing of diabetes in animals [6]. However, administration of Oxidized Glutathione not contains in structure of SH-radicals not protect B-cells of formation of Zn-DZ complex and of destruction of B-cells as of developing of diabetes [13]. Binding of Zn-ions of diabetes B-cells by a glutathione is apparently confirmed by existence of negative reaction for Zn for 24 hours. After that the complex gradually dissociated up and 48–72 hours later dithizon is able to form in B-cells toxic complex that accompanied by developing of experimental diabetes in animals.

It is known that in process of formation of the Zn^{+2} -complex with Dithizon and diabetogenic derivatives of 8-oxyquinolin atom of zinc is fixed between S or O atoms in position 8, and N or O atoms — in positions 1 or 2 (Fig. 2) [14]. Diabetogenic derivatives of 8-oxyquinolin have in the 8 position of quinolin ring active OH^- radical or other radicals contains atoms of S, N or O (Fig. 2). Isomers of 8-oxyquinolines not contains in this position such radicals or atoms, or if these radicals extracted from a molecule — not capable to form complex salts with zinc and not possess completely diabetogenic properties. It is necessary to return the active radicals in position 8 for to restore diabetogenic activity of substance [15]. Formation of the chelat complex by atoms of O and N accompanied by forming of pentagonal or hexagonal rings [14].

SH group contains sulfur atom. Meanwhile, as described above, it is known that sulfur atom participates in formation of the chelate complexes with Zn as well as N, O and C atoms. It is known that in process of formation of the Zn^{+2} -complex with Dithizon and diabetogenic derivatives of 8-oxyquinolin atom of zinc is fixed between S or O atoms in position 8, and N or O atoms — in positions 1 or 2 (Fig. 2) [14].

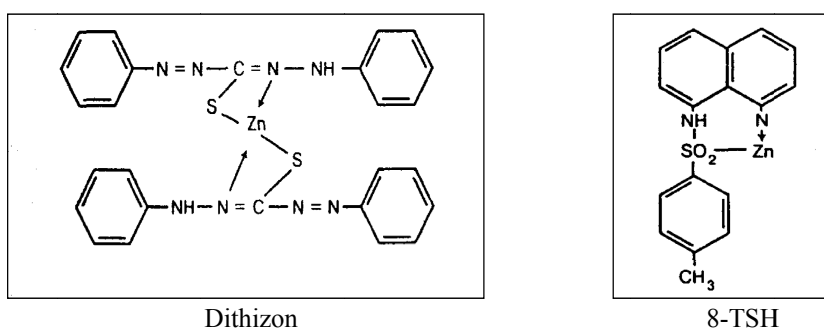


Figure 2. Chelat complexes Zn^{+2} -Dithizon and Zn^{+2} -8TSH

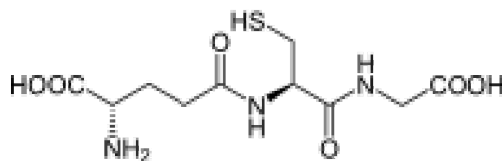


Figure 3. Chemical structure of R-Glutathione

On the base of obtained results we suppose that negative fluorescent reaction for Zn in B-cells after administration of Glutathione Reduced form determined by binding of Zn-ions via atom of sulfur of the SH-group and followed disposition of zinc atom between atom of sulfur and, probably, atom of oxygen or nitrogen (Fig. 3).

Conclusions

1. Amino acid Glutathione Reduced form contain in structure of SH-radical, 1000 mg/kg protect B-cells of formation complexes with diabetogenic zinc binding chelators that result prevention of destruction of cells prevention of developing of diabetes in animals.

2. Amino acid Glutathione Oxidized form not contain in structure of SH-radical, 1000 mg/kg not protect B-cells of formation complexes with diabetogenic zinc binding chelators that result destruction of cells and developing of diabetes in animals.

3. Administration of Glutathione Reduced form to animals result blocking of Zn-ions in B-cells that protect of interaction of metal with diabetogenic chelators.

4. Complex «Zn-Glutathione Oxidized form» in B-cells dissociated over 48 hours after forming.

5. We suppose that preventive effect after administration of Glutathione Reduced form determined by binding of Zn-ions via atom of sulfur of the SH-group and followed disposition of zinc atom between atom of sulfur and atom of oxygen or nitrogen.

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Қалпына келген глутатион көмегімен хелатор арқылы панкреатит В-жасушаларының бұзылуын болдырмаудың алдын алу

Авторлар мырышбайланыстырушы диабетогенді заттар тудыратын диабет дамуына глутатион аминқышқылының алдын алу әсерін зерттеген. Алдын алу әсер қасиетіне глутатионның тотыққан түріндегі формасы емес, құрылымында SH-радикалы бар глутатион қалыпты формасы ие екендігі көрсетілген. Глутатион қалыпты формасын жануарларға 1000 мг/кг дозасында бір ретті енгізу В-жасушаларының мырышпен байланысуына толығымен кедергі келтіріп, В-жасушаларының бұзылуын тудырып, жануарларда диабет тудыратындығы анықталды. Қалыпты глутатионның мырыш аралшығымен әрекеттесу химизмын зерттеу оны енгізгеннен кейін В-жасушаларында мырыштың толық бұғатталуы жоғары ерекше гистохимиялық әдістер көмегімен гистохимиялы түрде көрініс бермейді. В-жасушаларындағы мырыштың бұғатталу уақыты ұзақтығын зерттеу нәтижесі мырыш-глутатион кешені 36 сағ кейін мырыштың біртіндеп босап шығуымен ыдырай бастайды, ал 48 сағ соң кешен көп мөлшерде диссоциацияланады. Авторлар қалыпты глутатионның алдын алу бейімділігі оның аралшық мырыш пен байланысуын көрсетеді; мырыш атомы глутатион молекуласындағы SH-радикалы күкірт атомы мен оттегі не азот атомымен қосылып, диабетогенді хелатор енгізген есебінде танылады.

Кілт сөздер: В-жасушалар, R-глутатион, инсулин, мырыш, эксперименталды диабет.

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Предотвращение деструкции панкреатических В-клеток хелаторами с помощью восстановленной формы глутатиона

Авторами исследовалось предупреждающее влияние аминокислоты глутатиона в отношении развития диабета, вызываемого цинксвязывающими диабетогенными веществами. Показано, что предотвращающим действием обладает восстановленная форма глутатиона, содержащая в своей структуре SH-радикал, в отличие от окисленной формы глутатиона, не содержащей его. Установлено, что однократное введение восстановленного глутатиона животным в дозе около 1000 мг/кг полностью препятствует связыванию цинка В-клеток с формированием токсических комплексов, вызывающих разрушение В-клеток и развитие диабета у животных. Исследование химизма взаимодействия восстановленного глутатиона с островковым цинком показало, что введение его сопровождается полным блокированием цинка в В-клетках, в результате чего он не выявляется гистохимически с помощью высокоспецифичных гистохимических методов. Исследование длительности блокирования цинка в В-клетках показало, что комплекс цинк-глутатион начинает расщепляться с постепенным освобождением цинка через 36 ч, а через 48 ч комплекс в значительной степени диссоциирован. Авторы полагают, что предупреждающая способность восстановленного глутатиона обусловлена его способностью связывать островковый цинк; атом цинка при этом фиксируется между атомом серы SH-радикала и атомом кислорода или азота, содержащимися в молекуле глутатиона как и в случаях введения диабетогенных хелаторов, связывающих островковый цинк с помощью атома серы, с одной стороны, и либо атома кислорода, либо азота, или углерода — с другой.

Ключевые слова: В-клетки, R-глутатион, инсулин, цинк, экспериментальный диабет.

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Pharmacogenetics and the system of biotransformation of drugs

In this article the state and prospects of one of the modern directions of personalized medicine — pharmacogenetics are examined. General ideas about the role of biotransformation and metabolism of medicinal substances in pharmacogenetics were given, namely information on the polymorphism of genes involved in biotransformation of drugs and in the genetic control of their interaction, the description of the enzymes of the I and II phases of biotransformation of drugs. The first phase undergo oxidation, reduction and hydrolysis reactions in order to increase the polarity of the compound is described. In this phase, induction or inhibition by enzymes P450 is the main mechanism of drug interactions. The crystal structure of cytochrome P450 is studied. The main processes of the second phase of biotransformation are described: glucuronation, sulfation, conjugation with glycine, conjugation with glutathione, acetylation, methylation. Pathways of metabolism, enzymes involved in them, biotransformation phases are considered. The role of UDF-glucuronyltransferases in the transformation of drugs in the human body is shown. The classification of the superfamily of the UGT gene is described, the products of the members of this superfamily are described. The possibilities of genotyping using real-time PCR for the detection of individual single nucleotide polymorphisms, determination of the number of copies of the gene, pyrosequencing, mass spectrometry, matrix-activated laser desorption / ionization, and the use of microchips. The problems of drug use, such as drug toxicity, side effects, etc. are considered. Examples are given of the study of the effect of drugs on organisms in different countries. Such problems of genomic testing in our country as lack of funding, lack of clear cooperation between industrial and scientific circles, lack of specialists, creation of concrete and comprehensive.

Keywords: pharmacogenetics, cytochrome P450 isoenzymes, allele, UDF-glucuronyltransferase, polymorphic genes, genotypes, real-time PCR, LC marker, ferments of metabolism, gene expression.

A significant part of patients spend a large amount of money on drug treatment, and pharmacotherapy often does not justify the invested money. Most drugs do not satisfy all patients with their individual characteristics of susceptibility and tolerability of certain drugs. Patients face such problems as selecting the most suitable drugs for themselves, which will be more effective and less toxic. In the price plan, the analogues of medicines purchased are very expensive, and the free generics of well-known brands issued by the state do not bring the desired result. For realization of the state program on public health, 30 billion tenge was allocated from the state budget in 1995. By 2005, this amount increased by 185.5 billion, that is, by 155.5 billion tenge in absolute terms and 518.3 % in relative terms [1]. In 2010, budget purchases of medicines in Kazakhstan exceeded 77 billion KZT, this is already 44 % of the total domestic pharma market [2]. Also should be noted the fact that the state spends huge expenses on medicines and the fact that pharmapreparations do not justify the funds allocated for them, there is a question of getting out of this situation.

One of the ways to solve this problem is personalized medicine. Personalized medicine is a new direction in health care, which is characterized by an integrated, coordinated and individual approach to the treatment of the patient [3]. There is not only a difference in the sex or age characteristics among patients, it is also necessary to take into account the individual genetic characteristics of each patient [4, 5], so the approach to the use of medicines should be individual, and the use of technologies that allow personalizing pharmacotherapy will contribute its optimization, making it as efficient and safe as possible. Moreover, it is economically advantageous, since it allows to minimize the acquisition of ineffective drugs and drugs with high toxicity and NLR.

The use of such technologies in clinical practice is the basis of personalized medicine. Based on the fact that the genetic characteristics of the patient more than 50 % can determine an inadequate pharmacological response, i.e. what we do not expect from drugs (ineffectiveness or development of NLR), personalization of drug use based on genetic research is the most promising direction.

Pharmacogenetic (Pgx) testing provides information on the therapeutic response to drug treatment or the patient's likelihood of having adverse drug reactions, which can potentially reveal the effectiveness or ineffectiveness of medications and find an individual approach to drug therapy [6]. The genetic differences of patients are estimated to be 20–95 % of the variation in individual responses to medications [7]. At present, the problem of improving the safety of the use of pharmacological drugs is very relevant. The effec-

tiveness of treatment, the presence or absence of side effects makes it possible to determine the extent of drug use by a particular population group [6].

Genetic features are polymorphic regions of genes, whose products, one way or another, participate in the realization of various pharmacokinetic and pharmacodynamic processes [8, 9].

At the present time, the role of genes that control the synthesis and operation of biotransformation enzymes is studied. These are cytochrome P-450 isozymes (CYP2D6, CYP2C9, CYP2C19, etc.), phase II biotransformation enzymes (N-acetyltransferase, glutathione-S-transferase) and Transporters of drugs (P-glycoprotein, carriers of organic anions and cations). Genes that encode the «target molecules» of the drug or, called the other way, functionally associated with these proteins (receptors, enzymes, ion channels). Also included are genes whose products are involved in various pathological processes (blood clotting factors, apolipoproteins, genes of the HLA system, etc.) against which appropriate pharmacotherapy is directed [8].

There are numerous reliable methods of genotyping, such as real-time PCR for individual single nucleotide polymorphisms (SNP) or for determining the number of copies of a gene, pyrosequencing, mass spectrometry, matrix-activated laser desorption/ionization (MALDI-TOF), as possibility of using microchips as well [10]. However, these studies underscore the complexities that arise at the level of the underlying mechanisms (zero alleles, partially functional alleles, substrate-dependent effects, bonded disequilibrium, etc.), as well as pharmacological and clinical levels (PD versus PK, adverse reactions, prodrugs, etc.). Drug toxicity and the result of treatment depends on the number of additional genetic and non-genetic factors, and not just on one genotype. Only in a few cases, with specific drugs and treatment regimens, can it be determined whether the patient will have a clearly predictable benefit from genotyping.

The need to implement the introduction of pharmacogenetic testing in clinical practice is due to its practical importance in the appointment and determination of drug dosing. However, the high expectations of the clinical use of pharmacogenetic testing remain largely unmet, and only a limited number of applications have actually entered the market and into clinical practice [11].

In this period there are a number of problems for the widespread clinical introduction of genomic medicine and pharmacogenetics [11, 12]. Thus, its potential impact on health and its socio-economic status remains uncertain.

There are such problems as lack of funding, lack of clear cooperation between industry and academia, lack of specialists, as well as the creation of a concrete and comprehensive regulatory and legal framework, lack of necessary technical equipment.

In addition, there are a number of other points that need to be considered when planning a pharmacogenetic test. So, to perform the test, the patient should take a single dose of LS_marker once, in addition, there is a chance of occurrence of unwanted reactions of the body. Difficulties and inconvenience for patients, risks with multiple blood sampling. The need to identify the concentration of LS_marker, as well as its metabolites in certain time intervals. When assessing the dynamics of biotransformation enzymes, one should take into account the fact that patients not only differ in genetic characteristics, but also have differences in age, sex and lifestyle (eating patterns, smoking, drinking alcohol, etc.). In addition, testing on large populations and sensitivity analysis for individual ethnic groups is difficult to achieve [13].

There is an alternative testing option, such as the identification of allelic variants of the biotransformation system genes and LS transports, in this case it is possible to predict the pharmacological response before taking the drug, since it is not required to receive LS_markers. Also, in this case, only a single intake of blood or other biological material (scraping from the inner surface of the cheek, hair) is required. In terms of the execution line, it is optimal, because, does not require a definition in in certain periods of time. For testing, equipment is required only for performing PCR, the cost of testing is minimal. Tests evaluate only the «genetic» component that affects the pharmacological response, and its results can be used to create the so-called pharmacogenetic passport of the patient. In addition, this test is acceptable for conducting large population studies [13].

First of all, it is necessary to study the peculiarities of the metabolism of drugs, whether it is an inducer or an inhibitor. The substrate of which isoenzyme of the cytochrome P450 system it is, the features of the I-II phases of biotransformation

Phase I of the biotransformation reaction. System of cytochromes P450 participating in biotransformation of drugs. In the phase I of the biotransformation reaction, the functional groups of the preparation undergo oxidation, reduction and hydrolysis reactions in order to increase the polarity of the compound (Table 1). In the process of non-synthetic reactions, LSs turn into more polar and better water-soluble (hydro-

philic) compounds than the original substance. Although the first stage of the metabolism of drugs is carried out in most cases in tissues, the primary phase of metabolism occurs during hepatic circulation. Additional metabolism occurs in the gastrointestinal epithelium, kidneys, skin and lung tissue [8, 13].

Metabolism of most drugs in the first phase of biotransformation in the primary occurs in the liver with the participation of microsomal enzyme systems, the main one of which is the system of cytochromes P-450.

Cytochrome P450 (CYP) is a group of enzymes synthesized in the endoplasmic hepatic tissue network of heme-containing monooxygenases, which play a key role in xenobiotic detoxification, cellular metabolism and homeostasis. Isozymes of cytochrome P450 and its enzyme subfamily carry out oxidative reactions of xenobiotics and metabolism of intermediate products of drugs in the body. So, for example, isoenzymes of families CYP1, CYP2 and CYP3 bear joint responsibility for most of the phase I biotransformation reaction [13]. At present, 57 cytochrome P450 (CYP) genes and approximately the same number of pseudogenes that are grouped according to their sequence similarity into 18 families and 44 subfamilies have been identified in humans [14]. Eight human cytochrome P450 enzymes from five subfamilies (1A, 2B, 2C, 2D, 3A) are responsible for the vast majority of oxidative metabolism of drugs from the most important clinical drugs. Among the 200 drugs sold in the largest amount in the US, about 80 % is metabolized primarily by cytochrome P450 enzymes [10].

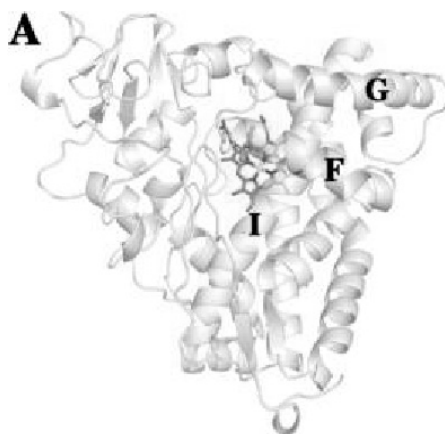


Figure 1. Crystal structure of cytochrome P450cam. A long spiral I permeates cytochrome through and helps to interact with the substrate and oxygen. Spirals F and G cause the mobility of cytochrome

The study of the crystal structures of cytochrome P450 isoenzymes (CYP) (Fig. 1) has opened the possibility of interpreting structural and functional features and other biologically important differences between cytochrome P450 (CYP) isoenzymes [15]. Prior to this time, there were significant inaccuracies in predicting amino acid sets that define substrate specificity for various cytochromes P450 (CYP) whose three-dimensional structures were not determined. However, now it has become easier to develop specific inhibitors or agonists related to cytochrome P450 isoenzymes (CYP).

The enzymes of cytochrome P450 are extremely versatile, they can catalyze numerous types of reaction. Oxygenations include the introduction of an O atom (from O₂) into a C–H bond, forming a hydroxylated metabolite, or a C=C double bond forming an epoxide. The hydroxylated metabolite may be stable or unstable. From the unstable hydroxylated metabolite of the group, spontaneously: an alkyl group, ammonia, a halogen atom, or a sulfur atom; such reactions are called oxidative dealkylation, oxidative deamination, oxidative dehalogenation, and oxidative desulfurization, respectively.

Changes in the initial physico-chemical properties of drugs are due to the addition or release of active functional groups: for example, hydroxyl (–OH), sulfhydryl (–SH), amino groups (–NH₂) [8].

These reactions have been characterized as mixed-functional oxidation, in which the enzymatic system catalyzes the consumption of one oxygen molecule / substrate molecule (RH); one atom of this oxygen molecule is inserted into the product (ROH), and the other is subjected to two reduction equivalents (Formula 1)



Table 1

Reactions to which the functional groups of the drug undergo in phase I biotransformation

I Biotransformation reaction phase	1. Oxidation 2. Recovery 3. Hydrolysis
The chemical role of Phase I biotransformation	The conjugation reaction, in which a functional group is added to the molecule
Common examples	
$\text{RH} \xrightarrow[\text{O}]{\text{oxidation}} \text{R-OH} \begin{cases} \rightarrow \text{R-O-glucuronic acid} \\ \rightarrow \text{R-O-sulfonic acid} \end{cases}$	
$\text{R-HC=O} \xrightarrow[2\text{H}]{\text{reduction}} \text{R-CH}_2\text{-OH} \begin{cases} \rightarrow \text{R-CH}_2\text{-O-glucuronic acid} \\ \rightarrow \text{R-CH}_2\text{-O-sulfonic acid} \end{cases}$	
$\text{R}^1\text{-O-(C=O)-R}^2 \xrightarrow[\text{HOH}]{\text{hydrolysis}} \text{R}^1\text{-OH} \begin{cases} \rightarrow \text{R}^1\text{-O-glucuronic acid} \\ \rightarrow \text{R}^1\text{-O-sulfonic acid} \end{cases}$	

The enzymes of cytochrome P450 also participate in the catalysis of dehydrogenation, i.e. Removal of 2 hydrogen atoms from the drug molecule (reactive hepatotoxic paracetamol metabolite is formed). Surprisingly, cytochrome P450 can also stimulate contraction, by transferring only one electron to the compound (for example, in a reductive dehalogenation reaction) or as many as 6 electrons to nitro groups, thus converting it to an amino group (a decrease in nitro).

Induction or inhibition by enzymes P450 is the main mechanism of drug interactions. Enzymes of cytochrome P450 (CYP) can transcriptively interact with various xenobiotics and endogenous substrates through the mechanism of receptor dependence. Because of the importance of cytochrome P450 in human physiology and in the metabolism of drugs, genetic variations and regulatory mechanisms of these enzymes have been extensively studied. Genetic polymorphisms have been identified in most cytochrome P450 genes [16], and many of these variants promote interpersonal differences in the expression gene or enzyme activity and, therefore, underpin the susceptibility or pharmacokinetics of drugs.

Phase II biotransformation reactions (also the 'conjugation reaction') usually serve as a detoxification step in the metabolism of drugs (Table 2) [8]. Although several enzymes of phase II of biotransformation are known, three basic enzymes of phase II biotransformation of medicinal substances were considered: UDP-glucuronyltransferase, N-acetyltransferase, glutathione S-transferase. The main attention is paid to the presence of various forms, on the tissue and cellular distribution, on the appropriate substrates, on genetic polymorphism and, finally, on the interspecies differences in these enzymes.

Table 2

Reactions to which the functional groups of the preparation under phase II biotransformation

Phase II biotransformation reactions (conjugation)	1. Glucuronation 2. Sulphation 3. Conjugation with glycine (Gly) 4. Conjugation from glutathione (GSH) 5. Acetylation 6. Methylation
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Table 2 continuation

Chemical role of Phase II biotransformation	The organic acid (or acetyl or methyl group) is conjugated to the molecule in the pre-existing functional group or in the functional group obtained during the first phase of biotransformation
Common examples	
$\text{RH} \xrightarrow[\text{O}]{\text{oxidation}} \text{R-OH} \begin{cases} \rightarrow \text{R-O-glucuronic acid} \\ \rightarrow \text{R-O-sulfonic acid} \end{cases}$	
$\text{R-HC=O} \xrightarrow[2\text{H}]{\text{reduction}} \text{R-CH}_2\text{-OH} \begin{cases} \rightarrow \text{R-CH}_2\text{-O-glucuronic acid} \\ \rightarrow \text{R-CH}_2\text{-O-sulfonic acid} \end{cases}$	
$\text{R}^1\text{-O-(C=O)-R}^2 \xrightarrow[\text{HOH}]{\text{hydrolysis}} \text{R}^1\text{-OH} \begin{cases} \rightarrow \text{R}^1\text{-O-glucuronic acid} \\ \rightarrow \text{R}^1\text{-O-sulfonic acid} \end{cases}$	

UDF-glucuronyltransferase — are among the key enzymes of metabolism of various exogenous, as well as endogenous compounds. A family of membrane-bound enzymes are mainly concentrated in the endoplasmic reticulum (ER) and nuclear envelope of hepatocytes. Most of the enzyme is oriented toward the ER side of the side, where the catalytic site is located. Each enzyme of the UDP-glucuronyltransferase includes an amino-terminal signal peptide that cleaves during the synthesis of the polypeptide chain and a region 17 of hydrophobic amino acids near the C-terminus that attaches the protein to the lipid bilayer (Fig. 2). Indeed, the C terminal of 20–30 amino acid residues is responsible for maintaining UDF-glucuronyl transferases (UGT) in ER. The conjugation of the reactions catalyzed by the superfamilies of these enzymes serve as the most important pathway detoxification for a wide range of drugs, biologically active chemicals, carcinogens and their oxidized metabolites and other various environmental chemicals in all vertebrates. In addition, UDP-glucuronyltransferase is involved in the regulation of several active endogenous compounds, such as bile acids or hydroxysteroids due to their inactivation by glucuronization [17]. In humans, almost 40–70 % of clinically used drugs undergo glucuronization [18].

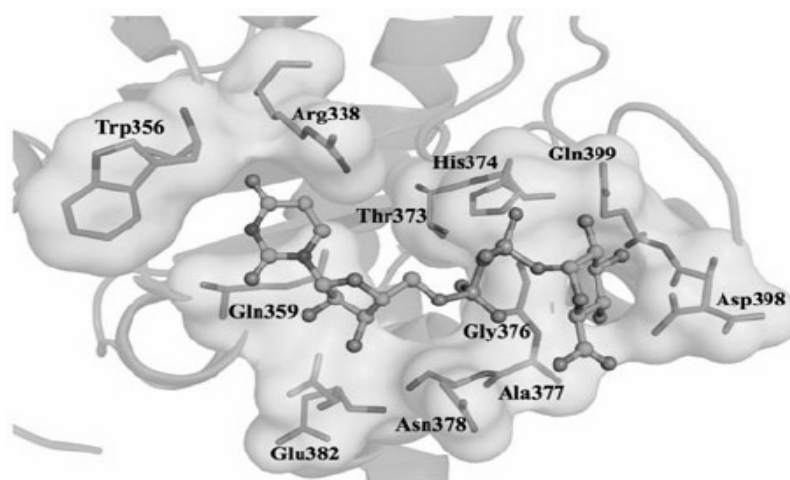


Figure 2. X-ray crystalline structure of human UGT2B7

Glucuronation is the main reaction to the II phase of drug metabolism, which is the conjugation of a substrate with UDP-glucuronic acid (Fig. 3). The reaction is catalyzed by the superfamily UDP-glucuronyl transferases (UGT), which consists of 2 families (UGT1 and UGT2) and more than 20 isozymes. Glucuronation leads to an increase in the polarity of chemical compounds, which facilitates their solubility in water and elimination from the body. In the organism of newborns, the activity of UDP-glucuronyltransferases is low, but by the 1–3 months of life it is the same as in adults.

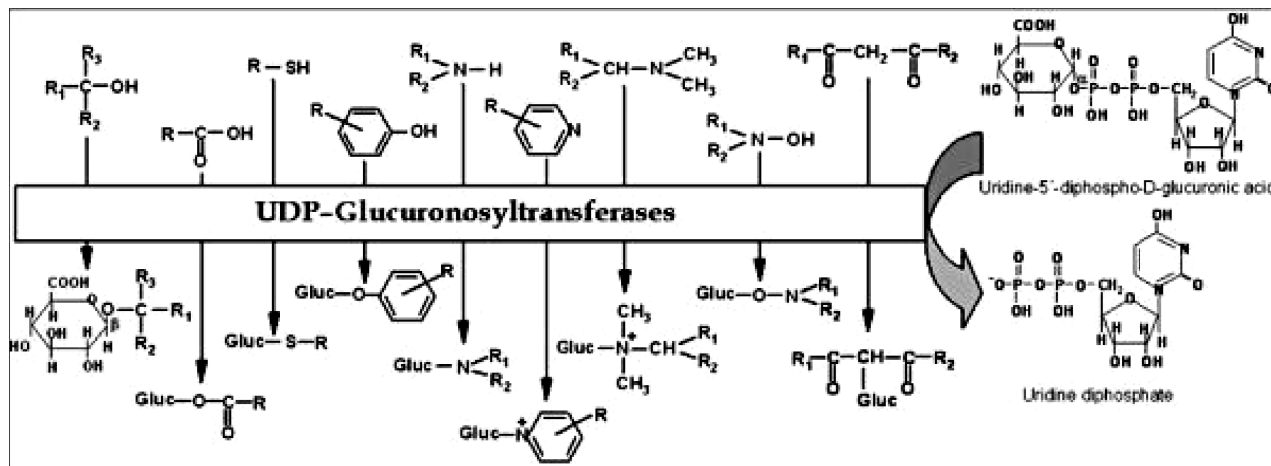


Figure 3. Formation of glucuronides. The chemical structures commonly subjected to glucuronization

For note, the superfamily of the mammalian UDP-glucuronyl transferase gene consists of 117 members. Four families of UDP-glucuronyl transferases were identified in humans: UGT1, UGT2 with the subfamily UGT2A and UGT2B, UGT3 and UGT8. Enzymes included in the subfamily UGT1 and UGT2 are responsible for the glucuronidation of exo and endogenous compounds, whereas members of the UGT3 and UGT8 subfamilies have their different functions [19]. Enzymes UDP-glucuronyltransferases each family has at least 40 % homology in the DNA sequence, whereas the members of the subfamilies of UDP-glucuronyltransferases exhibit at least 60 % identity in the DNA sequence [20]. Currently, 22 human protein described UGT: UGT1A1, UGT1A3, UGT1A4, UGT1A5, UGT1A6, UGT1A7, UGT1A8, UGT1A9, UGT1A10, UGT2A1, UGT2A2, UGT2A3, UGT2B4, UGT2B7 (Fig.2), UGT2B10, UGT2B11, UGT2B15, UGT2B17, UGT2B28, UGT3A1, UGT3A2 and UGT8A1 [19, 21]. In general, human enzymes of UDP-glucuronyltransferases appear to be widely distributed across different tissues, although the liver is the main expression site for many enzymes. UGT1A1, UGT1A3, UGT1A4, UGT1A6, UGT1A9, UGT2B7 and UGT2B15 are major enzymes conjugated to xenobiotics by the liver, whereas UGT1A7, UGT1A8 and UGT1A10 are preferably extrahepatic forms UDP-glucuronyltransferases. In addition, glucuronidation activity was also found in other tissues, such as the kidneys [22], the brain [23], and the placenta [24].

First of all, it should be noted that most xenobiotics metabolized by UDP-glucuronyltransferases show different substrate specificities. UGT8A1 and UGT3A1, they have specific functions in the body. UGT8A1 is involved in the biosynthesis of glycosphingolipids, cerebroside and sulphatides of nerve cells [25]. An enzyme UGT3A1 plays a role in the metabolism of ursodeoxycholic acid, used in the therapy of cholestasis or gallstones. Although many substrates (therapeutic agents, environmental chemicals) are glucuronidated by several UDP-glucuronyltransferases, several compounds show a relative specificity to individual enzymes. So bilirubin is exclusively metabolized by UGT1A1 [26]. In addition, the structure of the UGT1 gene is unique among related groups of genes involved in the metabolism of drug molecules. UGT1 isoforms are generated by alternative transcriptional splicing.

Genetic variability families UGT1 or UGT2 gene has also been proposed to modify the risk of cancer or as a result of declining hormones inactivation, such as estrogens, or due to the reduction of environmental carcinogen detoxification of the environment and their reactive metabolites

Families of enzymes glutathione transferase — play an important role in the metabolism of certain drugs, detoxification of environmental carcinogens and reactive intermediates, formed from various chemical enzymes, metabolizing xenobiotics. In addition, glutathione transferase formulates an important intracellular defense against oxidative stress, and also participates in the synthesis and metabolism of several arachidonic

acid derivatives and steroids. On the other hand, it has been proven that various chemicals are converted into potentially dangerous compounds by these enzymes [27].

Glutathione transferases are localized predominantly in the cytosol of human liver cells and constitute 2–4 % of the total amount of the cytosolic protein. The enzyme is effectively reduced hydrophobic hydroperoxides with a large amount of the molecule (linoleic and arachidonic hydroperoxide polyunsaturated fatty acids, phospholipids), as well as hydroperoxides mononucleotides and DNA, thereby participating in their repair.

At the present time, two different superfamilies of glutathione transferases (GST) have been described. The former includes soluble dimeric enzymes that are located mainly in the cytosol, but some members of this superfamily are also identified in mitochondria [28] and peroxisomes [29]. Superfamily soluble in humans glutathione further divided into eight separate classes: Alpha (A1-A4), Kappa (K1), Mu (M1-M5), Pi (P1), Sigma (S1), Theta (T1-T2), Zeta (Z1) and Omega (O1-O2) [30].

Various electrophilic compounds act as substrates for these groups of enzymes. These include a wide range of ketones, quinones, sulfoxides, esters, peroxides and ozonides. Chemotherapeutic agents (such as busulfan, cisplatin, ethacrynic acid, cyclophosphamide, thiotepea); Industrial chemicals, herbicides, pesticides (acrolein, lindane, malathion, tridifan) are detoxified by glutathione transferases [31].

The reaction catalyzed by the enzyme glutathione peroxidase is as follows:



Where GSH is the reduced monomeric glutathione, and GS-SG is the glutathione disulphide. The glutathione reductase enzyme further reduces oxidized glutathione and completes the cycle (Formula 3)

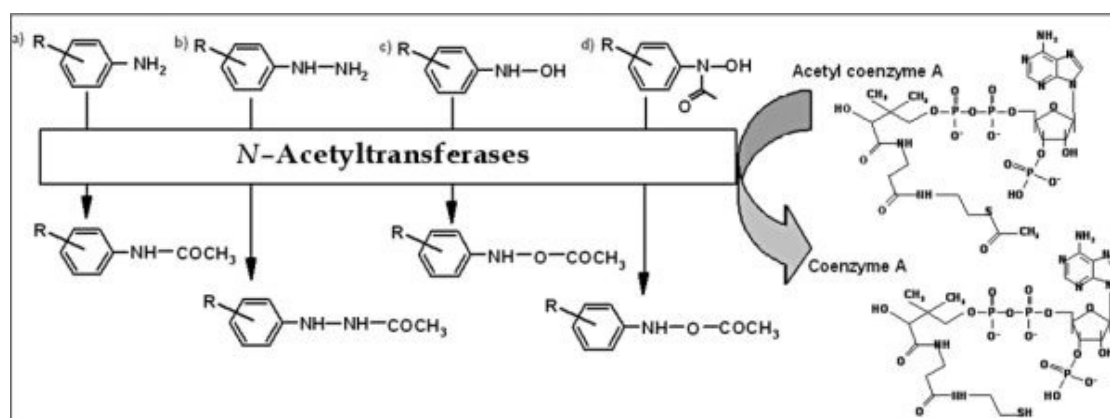


It was found that most members of superfamilies, such as glutathione transglutamine, are genetically polymorphic. It is assumed that several genetic variants of specific glutathione-transferases contribute to the development of some types of cancer or other diseases. In addition, the study of genetic polymorphisms of glutathione transferases, reveals their effect on the metabolism and distribution of various anticancer drugs [32]. For example, GSTP1 is responsible for the metabolism of alkylating agents, topoisomerase inhibitors, antimetabolites or tubulin inhibitors used to treat cancer. GSTP1*A allele is cytoprotective against the toxic effects of chemotherapeutic agents, whereas the functionally less competent GSTP1*B allele is believed to increase the toxicity of anti-cancer drugs in patients with this variant of the gene due to a decrease in the metabolic activity of the damaged enzyme. Cyclophosphamide is biotransformed with GSTA1. The defective GSTA1*B allele was associated with an increase in the survival of patients with breast cancer treated with cyclophosphamide [33]. Persons with a deficiency of functional GSTM1, GSTT1 and GSTP1 have a higher incidence of bladder, breast, colon, head, neck, and lung cancer. Genetically determined defects of these enzymes are also worthy of attention because of their partial responsibility for the increased risk of asthma, allergies, atherosclerosis and rheumatoid arthritis [31, 34].

N-acetyltransferase is an enzyme that plays an important role in the detoxification of a number of arylamine compounds (in particular, 2-aminofluoren, 4-aminobiphenyl and β -naphthylamine), which are strong mutagens and carcinogens; One of the two genes N-a. Human (NAT2) is located on the site of pter-q11 chromosome 8, and its coding region is deprived of introns. Enzymes of this group are three general reactions of acetylation, namely N-, O- and N,O-acetylation (Fig. 4). N-acetylation of aromatic amine is recognized as the main way of detoxification in the metabolism of arylamines in experimental animals and humans. In humans, the acetylation reactions are catalyzed by two isoenzymes of N-acetyltransferase (NAT), N-acetyltransferase 1 (NAT1) and 2 (NAT2). N-acetyltransferases are cytosolic enzymes found in many tissues of various species. NAT1 and NAT2 genes are located on chromosome 8 pter-q11 and have 87 % homology coding sequence [35]. NAT1 and NAT2 have a distinct substrate specificity and differ significantly in the distribution of organs and tissues. The NAT2 protein is present mainly in the liver [30] and in the intestine [36]. Human NAT1 expression was found in adult liver, bladder, digestive system, blood cells, placenta, skin, skeletal muscle, gum [37], breast tissue, prostate and lung by a variety of methods [38].

NAT1 has also been detected in cancer cells in which it can not only play a role in cancer development through enhanced mutagenesis, but it can also promote the resistance of some cancers to cytotoxic drugs [39]. N-acetyltransferases are involved in the metabolism of various compounds, people acetylation is the main pathway for biotransformation for many drugs, arylamine and hydrazine, as well as for a number of known carcinogens present in the diet, cigarette smoke, automobile exhaust and the environment as a whole.

Human NAT1 and human NAT2 have distinct but overlapping substrate profiles, and they also have specific substrates that can be used as probe probes for each particular isoenzyme. Substrates NAT1 include *p*-aminobenzoic acid, *p*-aminosalicylic acid, bacteriostatic antibiotics sulfamethoxazole and sulfonamide, 2-aminofluorene and caffeine [40].



(a, b) N-acetylation of arylamines and arylhydrazine; (c) O-acetylation of N-arylhydroxylamine; (d) N,O-acetyltransfer of N-hydroxamic acid

Figure 4. Reactions catalyzed by N-acetyltransferases

N-acetylation polymorphism is one of the oldest and most intensively studied pharmacogenetic traits and relates to hereditary differences in the acetylation of drugs and toxicants. Genetic polymorphism in NAT activity was first detected in tuberculosis patients who received isoniazid, which was metabolized mainly by N-acetylation. Polymorphism causes individual differences in the metabolic rate of this drug. People with a higher speed are called fast acetylators, and individuals with a lower speed are called slow acetylators. Fast acetylators were competent in the acetylation of isoniazid, but the drug was purified less efficiently in the slow acetylator group, which resulted in increased serum concentrations and resulted in adverse neurological side effects due to the accumulation of an unmetabolized drug [41]. In accordance with the toxicity of isoniazid in slow acetylators, an increase in the toxicity of other drugs in subjects with defective NAT2 alleles, such as lupus, in patients receiving hydralazine or procainamide [42], as well as hemolytic anemia and inflammatory bowel disease after sulfasalazine treatment has been observed [43]. The high frequency of NAT2 and NAT1 acetylation of polymorphism in the human population, together with the ubiquitous effects of aromatic and heterocyclic amines, suggest that NAT1 and NAT2 acetylatory genotypes are important modifiers of susceptibility to human cancer. Many studies have suggested a link between phenotypes of acetylation (in particular, arising from NAT2 genotypes) and the risk of developing various cancers, including colorectal cancer, liver, breast, prostate, head and neck [44] and other diseases such as birth defects [45] or neurodegenerative and autoimmune diseases [46].

Binding to the regulatory region of the biotransformation gene or the drug transporter, this mechanism inhibits enzymes of biotransformation of drugs under the influence of a large amount of the drug (cimetidine, fluoxetine, omeprazole, fluoroquinolones, macrolides, sulfonamides, etc.). Some drugs that have high affinity for certain isoenzymes of cytochrome P-450 (verapamil, nifedipine, isradipine, quinidine) inhibit the biotransformation of drugs with a lower affinity for these isoenzymes. Such mechanism is called a competitive metabolic interaction. Direct inactivation of cytochrome P-450 isoenzymes (gastoden). Oppression of cytochrome P-450 interaction with NADP-H-cytochrome P-450 reductase (fumarocoumarins of grapefruit and lime juice).

The decrease in the activity of enzymes of biotransformation of drugs under the action of appropriate inhibitors leads to an increase in the concentration in the blood plasma of these drugs (substrates for enzymes). At the same time, the half-life of medicinal substances is prolonged. All this causes the development of side effects. Some inhibitors affect several isoenzymes of biotransformation simultaneously. To inhibit several enzyme isoforms, higher concentrations of the inhibitor may be required. Thus, fluconazole (antifungal drug) at a dose of 100 mg per day inhibits the activity of the isoenzyme 2C9 cytochrome P-450. With an increase in the dose of this drug to 400 mg, inhibition of the activity of the isoenzyme 3A4 is also noted. In addition, the higher the dose of the inhibitor — the faster the development (and the higher) its effect. Inhibi-

tion generally develops faster than induction, usually it can be detected already after 24 hours from the time of administration of inhibitors. The rate of inhibition of enzyme activity is also influenced by the route of administration of the LS inhibitor: if the inhibitor is administered intravenously, the interaction process will occur faster.

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Дәрілік заттардың биоөзгеріс жүйесі және фармакогенетикасы

Мақалада бүгінгі таңдағы жекешеленген медицинаның заманауи бағыты — фармакогенетиканың жағдайына және болашағына баға берілді. Фармакогенетикада дәрілік заттардың биоөзгерісі мен метаболизм рөлі туралы жалпы мәліметтер сарапталды, яғни, дәрілік заттардың биотрансформациясына қатысы бар және олардың әсеріне генетикалық бақылау жүргізетін гендердің полиморфизмі, биотрансформацияның I және II фазаларына қатысатын ферменттер туралы ақпарат берілді. Қосылыстың полярлығын ұлғайту үшін тотығу, тотықсыздандыру және гидролиз реакцияларына ұшырайтын биотрансфор-

мацияның бірінші фазасы сипатталды. Бұл кезеңде P450 цитохром ферменттері әсерімен индукциялану немесе ингибирулену дәрілік заттардың әсер етуінің негізгі тетігі болып табылады. P450 цитохром ферменттерінің кристалдық құрылымы сарапталды. Биотрансформацияның II фазалық кезеңінің негізгі процестері: глюкуронизациялану, сульфатациялану, глицинмен түйісу, глутатионмен түйісу, ацетилдену, метилдену. Биотрансформацияның II фазалық кезеңінің метаболизм жолдары, УДФ-глюкуронилтрансфераза, N-ацетилтрансфераза, глутатион-S-трансфераза және тағы басқа ферменттер қаралды. Адам ағзасындағы дәрілік заттардың трансформациясындағы олардың рөлі туралы мәліметтер келтіріліп, тұқымдас ферменттердің жіктелуі, олардың өнімдері суреттелді. Генотиптеу үшін бірнуклеотидті полиморфизмдерді анықтау үшін арналған нақты уақыттағы ПТР, ген көшірмелерінің санын анықтау, пироквенирлеу, масс-спектрометрия, матрицалық-белсендірілген лазерлік десорбциялау/ионизациялау, сонымен қоса микрочиптерді пайдалану жолдары қарастырылды. Дәрілік заттардың қолдану кезіндегі дәрілік улағыштық, жанама және тағы басқа жағымсыз ықпалы жайлы мәселелер қозғалды. Өртүрлі мемлекеттердегі дәрілік заттардың ағзаға әсері туралы зерттеулер нәтижелері көрсетілді. Мемлекетіміздегі геномдық тестілеуді қаржыландырудың жоқтығы, өнеркәсіптік және ғылыми орталықтардың арасындағы ынтымақтастықтың болмауы, кәсіби мамандардың аздығы, нақты және бұл бағыттағы барлық өрістерді қамтитын құқықтық-нормативтік базаны құру мәселесі, сонымен қатар керекті техникалық қамтамасыздандырудың болмауына мән берілді.

Кілт сөздер: фармакогенетика, цитохром P450 изоферментімен, аллель, полиморфты гендер, генотиптеу, ПТР нақты уақыттағы, ЛС маркер, УДФ-глюкуронилтрансфераза, метаболикалық ферменттер, геннің козуы.

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Фармакогенетика и система биотрансформации лекарств

В статье рассмотрены состояние и перспективы одного из современных направлений персонализированной медицины — фармакогенетики. Даны общие представления о роли биотрансформации и метаболизма лекарственных веществ в фармакогенетике, а именно сведения о полиморфизме генов, вовлеченных в биотрансформацию лекарств и в генетический контроль их взаимодействия, описание ферментов I и II фаз биотрансформации лекарственных веществ. Описана первая фаза, на которой они подвергаются реакциям окисления, восстановления и гидролиза с целью увеличения полярности соединения. На этой фазе индукция или ингибирование ферментами P450 является основным механизмом лекарственных взаимодействий. Изучена кристаллическая структура цитохрома P450. Описаны основные процессы второй фазы биотрансформации: глюкуронирование, сульфатация, сопряжение с глицином, сопряжение с глутатионом, ацелирование, метилирование. Рассмотрены пути метаболизма, ферменты, участвующие в них, фазы биотрансформации. Показана роль УДФ-глюкуронилтрансфераз в трансформации лекарственных средств в организме человека. Представлена классификация надсемейства гена UGT, описаны продукты членов этого надсемейства, Рассмотрены возможности генотипирования с использованием ПЦР в реальном времени для выявления индивидуальных однонуклеотидных полиморфизмов, определения числа копий гена, пироквенирование, масс-спектрометрия, матрично-активированная лазерная десорбция/ионизация, а также использование микрочипов. Рассмотрены такие проблемы применения лекарственных средств, как лекарственная токсичность, побочные эффекты и др. Приведены примеры изучения воздействия лекарственных средств на организмы в различных странах. Указаны такие проблемы геномного тестирования в нашей стране, как отсутствие финансирования, отсутствие четкого сотрудничества между промышленными и научными кругами, нехватка специалистов, создание конкретной и всеобъемлющей нормативно-правовой базы, отсутствие необходимого технического оснащения.

Ключевые слова: фармакогенетика, изофермент цитохром P450, аллель, полиморфные гены, генотипирование, ПЦР в режиме реального времени, ЛС-маркер, УДФ-глюкуронилтрансфераза, ферменты метаболизма, экспрессия гена

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Geographic features and tourism development in the Czech Republic

The article deals with tourism development in the Czech Republic, which is one of the leading and most dynamic economic sectors in many countries and is recognized as an economic phenomenon of the century. The main objective of the study is to identify a dynamic demand for tourism and the usage of its potential in the country. Applying the random method, the authors found out tourist vacation preferences, what criteria they take into account when choosing a country for leisure, what goals are pursued and how the service in that country is assessed. Comparing the tourist potential of the two countries, the authors believe that Kazakhstan with a great uniqueness of the natural and historical component, has all the necessary conditions for the tourism cluster development to meet world standards. Developing this economic sector ensures an opportunity to develop and make the country appealing to the world.

Keywords: the Czech Republic, the Republic of Kazakhstan, tourist cluster, tourism, random research method, UNESCO, recreation, Schengen visa, entertainment industry, health resort tourism, cultural and cognitive tourism, business tourism, sports (active) tourism, religious tourism, beach tourism.

The main objective of the research was to identify positive experience in satisfying tourist demands and generated tourism potential in the Check Republic.

According to the Czech Statistical Center in 2013, the Czech Republic was visited by more than 13.9 million tourists. The most visited region of the country was Prague, the capital is visited annually by more than 5 million people. The city was founded in the 9th-10th centuries, but only in 1992 it was included in the UNESCO World Heritage List. It is popular for cultural diversity and cognitive features. A large number of castles, churches, monasteries and museums in the city make it no place parallel in the world. A religious-pilgrimage, business, gastronomic, romantic, wedding and even extreme kinds of tourism have advantage of appealing to people of all ages. In addition, shopping and sex tourism as a separate type of tourism is developed as well. More than 600 thousand tourists annually suburban areas of Prague.

In the course of the research, the task was to find out the tourist vacation preferences, what criteria they took into account when choosing a country for recreation, what objectives were pursued and how the service in that country was assessed. Respondents were selected by random selection, i.e. We interviewed 25 people of different ages, nationalities and genders.

It is known as a country with an ancient culture and history which dates back to 1000 years. The country attracts its tourists both with magnificent landscapes, and a fascinating centuries-old culture. It can be noted that the most popular types of tourism are the following (Fig. 1).

Data of the Figure 1 reflect main objectives of vacationers, and they are rather various, i.e. suit different category of people.

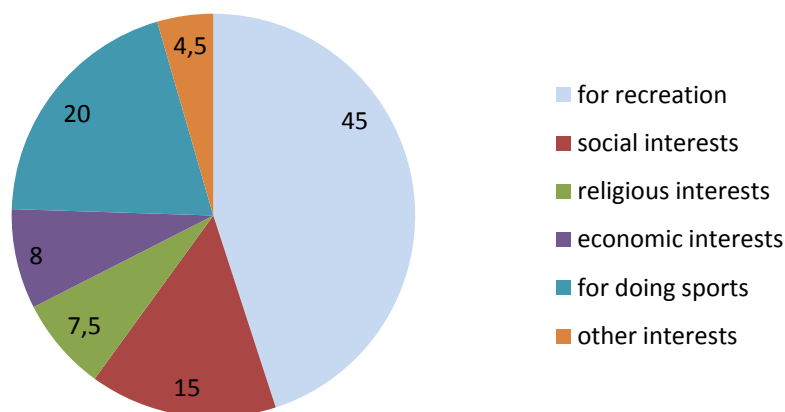


Figure 1. Types of tourism in the Czech Republic

The main objective of the tourists visiting the country is for leisure or cultural-cognitive tourist trips. Other category of people focus more on recreation and less targeted to study cultural potential. Further it is possible to note business travel and shopping tourism. Shopping has become a motive to travel and is now a major tourist activity. Visitors are increasingly choosing shopping as a way to experience local culture through an engagement with local products and local craftspeople, and some destinations provide special tourist shopping activities for tourists to shop for goods which is especially attractive to tourists from Germany. Sports Tourism is defined as a specific travel outside of the usual environment for either passive or active involvement in competitive sport where sport is the prime motivational reason for travel and the touristic or leisure element may act to reinforce the overall experience. Another definition worth noting explains sport tourism as a combination of sports activities and travel. Sports tourism is optimum in winter when tourists come to ski resorts for the purpose of skiing and other sports leisure [1].

A prolonged stay in a visiting destination, the study of its tourism potential, the characteristics of tourists have also been examined, i.e. the visitors who arrived for recreational activities to the Czech Republic. It should be noted that the research was conducted during the summer period excluded the respondents who visited country for sports activities. 25 tourists from the different countries of the world have been polled. The age and gender category of tourists are presented (Fig. 2, 3).

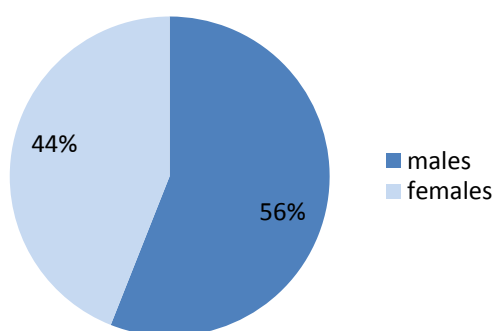


Figure 2. Gender of tourists visiting the Czech Republic

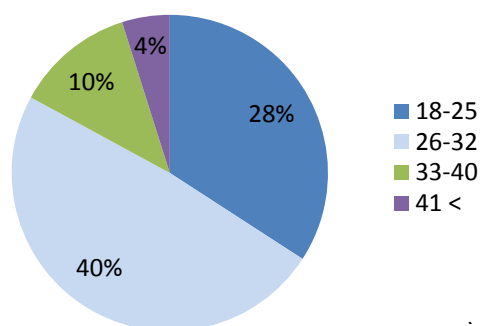


Figure 3. Age category of tourists visiting the Czech Republic

Fifty-six percent of all polled are male respondents. The analysis of the conducted research allows to draw a conclusion that the most number of tourists is a category of people aged from 26 to 33, and another category is under these ages. This is due to the fact that the Czech Republic is a country with a rich nightlife.

Prague is also very popular for its nightlife after Amsterdam in Europe. In addition, there are many universities and colleges, since education in the Czech Republic is relatively cheaper if to compare to other European countries. According to the results of the analysis, 16 % of respondents, who made up 4 people from the total number of respondents, answered that they got the invitation from friends who study in Prague.

There are many beautiful landmarks for sightseeing. It takes approximately 7–8 days. Then it may become boring and the soul will ask for new impressions. It is easy to travel around the country: kiosks are installed at all stations and almost in every square in Prague, where you can buy a ticket for a bus or train to the most remote corner of the country [2].

If we talk about the representatives of other ethnic groups, it is difficult to give an unambiguous answer, because we could not interview tourists from different Asian countries, because of a language barrier.

The results of the survey conducted at the local airport, auto and railway station showed that the majority of respondents were from the CIS. They turned out to be 17 out of 25 people, they account for 68 % (Fig. 4).

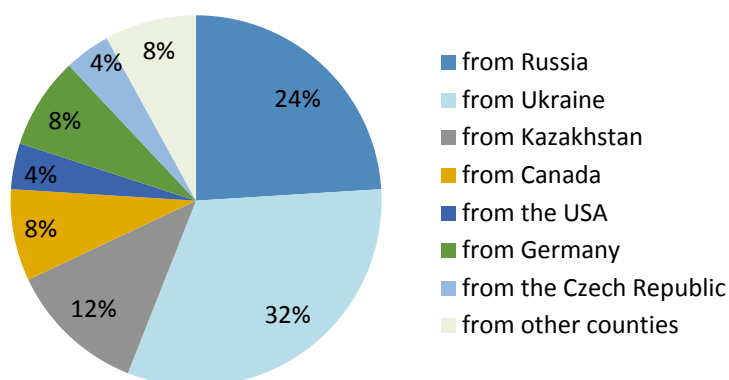


Figure 4. Citizenships of tourists

If to take into account the fact that a large number of flights was carried out by Ukrainian airlines, thus it is possible to assume that dominant number of tourists from this country. In the top list there were also citizens from Russia 24 % and Kazakhstan 12 %. The visitors from Georgia, Germany and Canada (8 % each) come in at a close second place. The least number of tourists from the United States (4 % each).

In terms of service quality, 100 % of respondents answered «excellent», which is not surprising, because tourism is one of the main economic branches of the country, therefore the service is presented at the highest level and meets international standards.

According to the local Internet portal, the number of arriving tourists to the Czech Republic only for the summer of 2016 exceeded the number of 1 million people. The annual income from tourism in the country is more than 200 billion kroons.

Variable weather in the summer of 2016 did not reduce the interest of tourists to travel to the Czech Republic, but the attendance of pools fell more than twofold. The Czech hoteliers said that the current summer season is very successful one.

During the summer of 2016, the number of Czechs staying in local hotels has significantly increased. Instability in the world, including Europe, a deterioration of security environment cause an obstacle for tourists from the Czech Republic to other countries. A regular stay at campings, although most often they used more lodges than tents for overnight stays. During the period under review, because of the very changeable weather, tourists visited more than before. The most visited sight was the Prague Castle. The less visited was pools because of weather conditions [3].

According to hoteliers, in the summer of 2016 tourists rented hotel rooms for a longer time than last year, and there was a certain increase of interests in additional services, for example, to wellness. At this time, tourists actively visited the mountains. The summer flow of tourists to the Krkonoše Mountains was the same as in winter season. The same situation was in the Jizera Mountains. The funicular on Mount Jeshted in Liberec hardly handle the influx of visitor

In comparison with the last tropical summer, the season of 2016, as already noted, became a failure for swimming pools in Prague and throughout the Czech Republic. Their profits fell by tens of percent. For example, in Hultschin in 2015 43,000 visitors were counted, and in 2016 — only 13,000. In Jihlava city where you can find Aquapark Vodní ráj (Water Paradise) suitable for rest and relaxation after a hard day. In hot season 25,000 visitors were registered. The water park saw an attendance slip in twice. A similar situation has been noticed in other Czech basins.

Prague hotels called last summer season successful. In 2016 Prague attracted more tourists and because it is considered a safer place to relax. The number of tourists who stayed in Prague in 2016 grew by 2 %, that was, by 50,000 people. Czech tourists grew by 9 % in number.

All the respondents put security aspect to the first place in the list of the criteria to choose a visiting country. From this we can conclude that the Czech Republic meets consumer demands and attracts more and more new tourists.

The conducted analysis helped to identify the categories of tourists by gender, age and other criteria. Taking into account the tourists' needs, it is possible to monitor the tourist potential of any country, determine its level and improve tourism development programs.

In 2016 the Czech Republic was visited by a record number of foreign tourists — 8.69 million people. This is 7.3 % more than in 2014. Such data was defined by the Czech Statistical Office.

So many foreign guests the republic has never taken before. And the statistics department takes into consideration only those who stayed overnight in hotels, hostels and other hotel rooms for at least one night. The most popular destinations for foreigners were Prague (5.68 million), Karlovy Vary (541 thousand) and South Moravian Region (492 thousand).

In 2016, the number of tourists from Russia and Ukraine decreased significantly — by 37.4 % and 10.7 %. In total, Czech hotels registered 432,768 Russians.

However, more guests came from other countries: from Germany, tourist flow grew by 12.6 %, from Slovakia — 14.6 %, from the USA — 14.9 %. The number of travelers from China (by 35.3 %) and South Korea (by 31.8 %) increased even more. On average, each foreigner spent about three nights in Czech hotels.

The number of local people visiting national landmarks in the Czech Republic over the past year increased by 13.3 % to 8.49 million people. The most popular regions are the South Moravian Region (1 million), the South Bohemian Region (928,000) and Prague (893,700 visitors).

As for the Czech capital, it also boasts a new record. In 2016 the city was visited by 5.68 million foreign tourists, which is 6.9 % more than in the previous year

As for the Czech capital, it also breaks a new record. In 2016 the city was visited by 5.68 million foreign tourists, which is 6.9 % more than in the previous year.

The survey was conducted among tourists, during which it was possible to establish the most popular tourist routes (Table 1).

In addition to Czech cities and major tourist destinations, many tourists who have a Schengen visa also travel outside the Czech border. First of all, this is due to the economic and geographical situation of the Czech Republic itself. The country borders Poland in the north (658 km), Germany — in the northwest and west (646 km), with Austria — in the south (362 km) and Slovakia — in the east (214 km). The total length of the border of the Czech Republic with neighboring states is 1880 km.

The largest number of people who visit the Czech Republic is from Germany. The Germans come to the Czech Republic on weekends, as a usual leisure place or for the purpose of shopping.

Table 1

The percentage of tourists visited cities of the Czech Republic

City	A number of people visited cities given in the list	%
Prague	25	100
Kutna Hora	21	84
Plezn	12	48
Cesky Krumlov	18	72
Drno	10	40
Karlovy Vary	3	12
Olomouc	2	8

Note. Made by authors.

Since the survey was held in the city of Prague, all respondents those who were visiting the city of Prague. Kutná Hora has been found as the most popular tourist destination. This is not surprising: Kutná Hora, the city of silver, is deservedly attributed the other name «national treasury». This is to say that its wealth helped to ensure the boom of the Czech Kingdom. The centre of the city was included in the UNESCO world

heritage list. All of the streets, houses and churches exude a long history full of important events. The symbol of Kutná Hora is the unique late Gothic Cathedral of St. Barbara. It attracts lots of tourists with a mystical legend and atmosphere. The least visited city was Olomouc, this can be explained by it is situated far away from Prague.

The next important information is the travel purpose of all respondents. Usually, the tourism potential of the Czech Republic meets the tourists' needs who came for the purpose of resort, health, cultural, educational, business, sports or active tourism, religious and just few for beach activities (Fig. 5).

Due to the fact that the questioning took place in the summer season, the absence of tourists who came for sport activities does not indicate to the country's unattractiveness from this aspect. This type of tourism becomes popular in winter or in special places, near rivers and mountains.

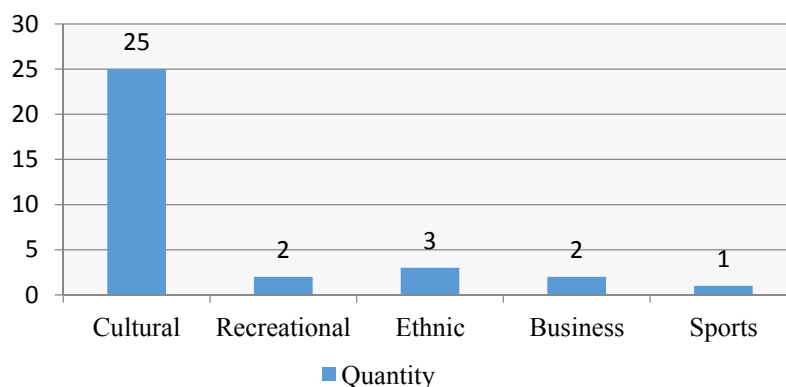


Figure 5. Travel purpose of the respondents

The cultural-cognitive form of tourism turned out to be predominant, ubiquitous along with other types. This shows the unique recreational potential of the Czech Republic, where different consumer services can be simultaneously given. Two respondents took a tour to Karlovy Vary for the purpose of treatment, and after the course of treatment they went to Prague for cultural tourist tracks. Three other respondents answered that they came to relatives which live in Prague. So one family came to the wedding of their niece who received Czech citizenship after her graduation, but that was not a single reason for their trip. Among the respondents who came to the city for business trip were Czech and a young family from Germany that combined business trip with shopping.

An important factor is what motivates the holidaymakers of their choice. We tried to find out what a fundamental criterion was used in choosing a place for pleasure in the Czech Republic. For simplicity of the survey, the respondents were offered several options to one question, which was the main travel reason to the Czech Republic: security, popularity, price, close to home, culture and history, friends' recommendations. Respondents were asked to evaluate the criteria on a 5-score scale, where 5 score corresponds to «yes, important», 4 — «pay attention,» 3 — «indifferent», 2 «unimportant», 1 — «did not take this factor into account when choosing a visiting place.» In the course of this survey, the respondents answered many questions, answered for a long time, as if they did not know themselves what attracted in this country most (Table 2).

Table 2

Motivations to travel in the Czech Republic

Criteria	A number of questions				
	5 scores	4 scores	3 scores	2 scores	1 score
High safety measure	21	3	1	—	—
Popular tourist spot	5	5	5	8	2
Prices	12	6	3	3	1
Close to home	5	4	—	10	—
Culture and history	12	8	—	5	—
Friends' recommendations	4	13	3	3	2

Note. Made by authors.

The most important criterion for visiting tourists was the criterion of «safety», even for amateurs of extreme leisure, however, but they prefer completely different places for tourism. The criteria «price» and «cultural and historical heritage» came out to equal positions. As for the price of a 10 days tour to Prague for a tourist from Kazakhstan is about 220,000 tenge, including visa registration, flight and accommodation. Similar tour to Germany is about 240,000 tenge, but services and entertainment in Munich are several times more expensive than in the Czech Republic, a tour to Vienna for the same number of days — 310,000 tenge, tour to Amsterdam — 400,000 tenge, tour to Paris 290,000 tenge (Fig. 6).

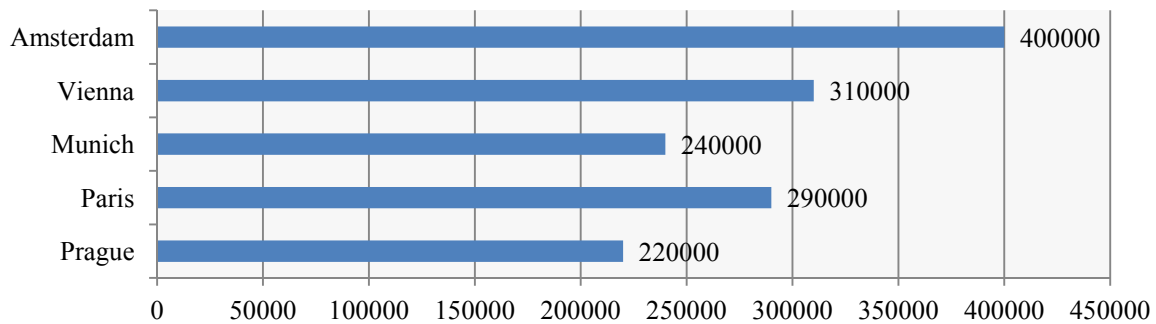


Figure 6. Cost of tours to popular tourist cities in Europe (tenge)

The criterion of «on neighborhood» is out of question, because the majority of respondents from the CIS, and European culture is found to be attractive for people from these countries. As you know, the Czech Republic is a member of the Schengen group, the rules of the Schengen visa apply and the Czech visa holders are entitled to unimpeded movement across the borders of all Schengen countries.

When you get a Schengen visa to the Czech Republic, you should remember that you can enter the country only if you follow all the conditions, the Schengen agreement: it is necessary to confirm the main purposes of the trip, as well as the conditions for foreign citizens in the country and the availability of sufficient funds for living on its territory.

According to the results of the study, the following conclusions can be made about the use of the tourism potential of the Czech Republic:

Firstly, the Czech Republic, as a tourist country, is a single integrated system interconnected by transport networks; Each part (tourist city) exists both separately and together; Each landmark, the region with its economic potential has its own history and will be of interest to any tourist, depending on his/her preferences, and in combination with other cities it broadens the image of the country and shows its true life and people's history.

Secondly, a thoughtful strategy in the entertainment industry is a big advantage and covers the whole range of tourist services; high quality of life, high rates of development of the country provide stability on the political map of the world in external relations between countries; Western model of development, and as a basis, compliance with all international standards, both in social and economic spheres, stipulate a high level of service, and as a consequence of a high degree of attractiveness [4].

Thus, a wide range of services, the full use of recreational resources, historical heritage, proper investment and an approach to tourism industry development make the Czech Republic diverse. What important is the attitude of the Czech people to tourist resources. Regular restoration work and careful attitude to resources as to a precious stone can help to preserve them in their original form.

The conducted study shows that the main criteria for choosing a visiting country are security. In addition to security, respondents also noted that the Czech Republic is attractive for its history and culture. If to comparing our states, we can note the following. Kazakhstan has a great uniqueness — it originated at the junction of the Eastern and Slavic cultures, went a long way to its independence and managed to maintain its territorial integrity in peace and harmony among the people living in it, and the ancestors were able to convey the traditions and culture of the Kazakh people to the present. Every Kazakhstani today can be proud of the historical heritage of his country. Considering the above, one can affirmatively state that in our country, as in other developed countries of the world, including the Czech Republic, there are all the necessary conditions for the developing a tourist cluster in accordance with world standards. Developing this economic sector, there is an opportunity to become an even more developed and attractive state in the world.

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Г.Н. Чистякова, Ж. Хустыи, А.Р. Жунусова

Чех Республикасының жағрафиялық ерекшеліктері мен туризмнің дамуы

Мақалада әлемнің көптеген елдерінде жетекші және ең серпінді салаларының бірі болып табылатын туризм саласы Чехия елінде дамуы қарастырылды. Зерттеудің негізгі мақсаты Чех Республикасының туристік сегментті қанағаттандыратын сұранысты және елдің туристік әлеуетін пайдалану ерекшеліктерді айқындау болып табылады. Рандомды әдісті қолдана отырып, авторлар демалуға аттанатын туристер елді таңдауда қандай мақсатты көздейді, келген елдегі қызмет көрсету сапасын қалай бағалайды, қандай көрсеткіштерді қалайды. Екі елдің туристік әлеуетін салыстыра келе, авторлар Қазақстан көп бірегей табиғи және тарихи компоненттері, халықаралық стандарттарға сәйкес туристік кластерді дамыту үшін барлық қажетті жағдайлар жасалған ба соны зерттеді. Экономиканың осы секторын дамыту әлемдегі озық және тартымды елдер бірі ретінде жан-жақты танылуға мүмкіндік береді.

Кілт сөздер: Чех Республикасы, Қазақстан Республикасы, туристік кластер, туризм, ғылыми зерттеу, ЮНЕСКО, демалыс, шенген визасы, ойын-сауық, курорттың және денсаулық туризм кездейсоқ әдісі, мәдени туризм, бизнес туризмі, спорт (белсенді) туризмі, діни туризм, жағажайлық туризм.

Г.Н. Чистякова, Ж. Хустыи, А.Р. Жунусова

Географические особенности и развитие туризма в Чешской Республике

В статье рассматриваются особенности развития туризма на примере Чехии. Туризм является одной из ведущих и наиболее динамичных отраслей экономики многих стран мира и признан экономическим феноменом столетия. Основной целью исследования явилось выявление спроса, удовлетворяющего туристский сегмент Чехии, и особенностей использования туристского потенциала страны. Применяя рандомный метод, авторы выяснили предпочтения у отдыхающих туристов: какие критерии они учитывали при выборе страны для отдыха, какие цели преследовали и как оценивают сервис в данной стране. Сравнивая туристский потенциал двух стран, авторы считают, что Казахстан, имея большую уникальность природной и исторической составляющей, имеет все необходимые условия для развития туристского кластера в соответствии с мировыми стандартами. Развитие этого сектора экономики дает возможность стать еще более развитым и привлекательным государством в мире.

Ключевые слова: Республика Чехия, Республика Казахстан, туристский кластер, туризм, рандомный метод исследования, ЮНЕСКО, отдых, шенгенская виза, индустрия развлечений, курортно-оздоровительный туризм, культурно-познавательный туризм, деловой туризм, спортивный (активный) туризм, религиозный туризм, пляжный туризм.

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Territorial development of social infrastructure of the Aktyubinsk oblast

Article is devoted to study features of territorial development of social infrastructure of the Aktyubinsk oblast which has developed under the influence of formation process and development of territorial and branch structure of economy and system of resettlement of the population. Here at work is offered author's interpretation of the concept «social infrastructure». Using technique of the security assessment of the population with social objects offered by N.M. Logacheva, and was made attempt to define territorial differentiation on a levels of development of social infrastructure of the Aktyubinsk oblast in a section of administrative regions. On the basis of calculations of integrated indicators of security of the population with social objects counting on 1000 inhabitants and the level of development of social infrastructure is made map-scheme «Territorial differentiation of social infrastructure development of the Aktyubinsk oblast in 2015». As a result there were revealed level of social and infrastructure system and security of the population of administrative regions of the Aktyubinsk oblast with social objects development. Calculations and the comparative analysis have shown that the maximum level of development and high degree of security of the population with objects of social infrastructure is characteristic territories of the Aktyubinsk city administration, namely the Aktyubinsk agglomeration which is the center of concentration of the population and economic entities of the Aktyubinsk oblast. Uilskiy and Kargalinskiy districts have the lowest level of development of social infrastructure and security of the population with social institutions.

Keywords: Aktyubinsk oblast, social infrastructure, security of the population, territorial development, administrative regions.

Actuality

In economical and geographical researches the concept of «infrastructure» is treated as set of constructions, buildings, roads and systems, i.e. the immobile part of fixed assets providing material conditions for normal reproduction process. It follows from this that infrastructure can't be moved from one region to another, only it is possible gradual development in borders of a certain space. Thanks to these properties infrastructure and all its components and elements become closely connected with the territory and with all processes of its economic development, forming the image of the territory [1].

Social infrastructure is a system of the branches located in a certain territory which perform various social functions (educational, improving, cultural, recreational) and the creating conditions for the effective territorial organization of society functioning.

Development of social infrastructure as complex of the branches and institutions providing normal activity of the population is the most important component of dynamic social and economic development of the region. Achievement of the high standard of living of the population isn't possible without formation and development of social and infrastructure base, satisfying needs of all inhabitants. But features of the territorial organization of economy and the population define spatial asymmetry in the level of development of social infrastructure and is as a result shown territorial distinctions in providing inhabitants with social facilities.

In turn negative aspects in development of social infrastructure have concrete manifestations: deterioration in a physical condition of material resources of social infrastructure; sharp recession of investments into non-productive construction; absence or small volumes of construction of social objects (schools, clubs, sports constructions, libraries); deterioration in living conditions (growth of a share of the shabby and hazardous dwelling); poor quality of medical and library care, cultural and entertaining service [2] that as a result influences territorial development of economy, resettlement and the standard of living of the population.

Relevance and the importance of an assessment of territorial development of social infrastructure of regions of the country is defined by implementation of state programs, in particular Programs of development of regions till 2020 [3]. Detection of features of a territorial differentiation of social infrastructure will allow to define the priority directions of development of the social sphere and promotes implementation of the Program of development of the territory of the Aktyubinsk oblast for 2016–2020 [4].

Objects and methodology

Object of a research is social infrastructure of the Aktyubinsk oblast. Observation was carried out on the basis of use of statistical data of Department of statistics, Department of education, Management of physical culture and sport, Management of culture, archives and documentation of the Aktyubinsk oblast for 2009–2015.

In a research were used methods of scientific abstraction, the analysis and synthesis, induction and deduction, analogy and comparison, system and logical approaches. Also were applied other methods of a research, comparative and geographical, mathematical, statistical, descriptive, cartographical.

The following system of indicators which is used in N.M. Logacheva [5] technique, taking into account available statistical information was applied to an assessment of an index of security of residents of administrative regions of the Aktyubinsk oblast with social infrastructure: number of the organizations of the sphere of culture; number of the preschool organizations; number of high comprehensive schools; quantity of objects of secondary professional education (colleges); number of sporting venues; number of the medical organizations. On everyone above to the listed indicator the index of security of the population with objects of education, health care, culture and sport was determined by the following formula:

$$IPSPSO = \frac{P_{co}}{Q_n} \times 1000, \quad (1)$$

where $IPSPSO$ — is an index of security of the population with social objects counting on 1000 inhabitants; P_{co} — population; Q_n — quantity of social objects.

The integrated indicator of security of the population with social infrastructure counting on 1000 inhabitants decides on the help of a method which essence consists that on each index a certain territory gets points according to the following scale: I 0.001–0.006 — 1 point; I 0.010–0.029 — 2 points; I 0.031–0.078 — 3 points; I 0.080–0.097 — 4 points; I 0.124–0.577 — 5 points.

The assessment of territorial development of social infrastructure of the Aktyubinsk oblast was also carried out with use of the technique offered N.M. Logacheva [5], but with change of system of indicators. The assessment was carried out with use of the following 11 indicators: number of the medical organizations; number of recreation centers and clubs; number of libraries; number of the museums; number of movie theaters; number of recreation parks; number of the preschool organizations; number of high comprehensive schools; number of secondary vocational education institutions; quantity of higher educational institutions; number of sporting venues.

For reduction of 11 indicators in a comparable form as base are used corresponding data in general on area and it is calculated by a formula:

$$I_1 = \frac{I_{ar}}{I_o} \times 100 \%, \quad (2)$$

where I_1 — an indicator index; I_{ar} — an indicator of the administrative region; I_o — an oblast indicator.

The integrated indicator of the level of development of social infrastructure is determined on the basis of assignment of each territory by each index of points according to the following scheme: from 57.8 % to 33.3 % — 5 points; from 25.0 % to 14.0 % — 4 points; from 13.8 % to 11.0 % — 3 points; from 10.6 % to 5.0 % — 2 points; from 4.7 % to 2.6 % — 1 point; from 1.3 % to 0 % — 0 points. The territory having the greatest number of points is characterized by rather high rate of development of objects of social infrastructure [5].

Results and their discussion

Aktyubinsk oblast has the features in territorial development of social infrastructure as the oblast is characterized as a big area (300.6 thousand sq.km), low population density (as of the end of 2015 — 2.8 persons of 1 sq.km) [6; 5], asymmetry in economic development of the territory (Table 1).

For 2009–2014 in the territory of the Aktyubinsk oblast balance (minus wear) the cost of objects of social infrastructure has grown from 37,1 to 83,1 billion tenges [7; 16]. In all types of economic activity participating in process of providing social services to the population growth balance (minus wear) costs of supply available is observed. Among types of economic activity for 2009–2014 in the total cost of fixed assets of area the share of education, health care and social services increases, at reduction of a specific weight of art, entertainments and rest (Table 2).

Table 1

Territorial differentiation of population density, production of the industry and agriculture of the Aktyubinsk oblast on states for 2015

Name of administrative region	Population density of the people on 1 sq. km	Industry		Agriculture	
		Output of industrial output (goods, services), billion tenges	Specific weight in the total production of industrial output (goods, services) of area, %	Gross production (services) of agriculture in the current prices, billion tenges	Specific weight generally output volume of production (services) of agriculture of area, %
Territory of Aktyubinsk city administration	195,6	280,1	27,7	19,7	11,9
Alginskiy	5,4	6,0	0,6	16,8	10,2
Martukskiy	4,6	2,5	0,2	15,4	9,3
Kargalinskiy	3,5	1,5	0,1	12,4	7,5
Khromtauskiy	3,2	207,8	20,5	12,3	7,5
Temirskiy	3,0	103,1	10,2	12,3	7,5
Mugalzharskiy	2,4	292,3	28,9	13,6	8,2
Uilskiy	1,7	1,9	0,2	7,6	4,6
Khobdinskiy	1,4	1,5	0,1	12,4	7,5
Aytekebiyskiy	0,7	1,3	0,1	15,7	9,5
Shalkarskiy	0,6	12,4	1,2	10,3	6,2
Bayganinskiy	0,4	103,5	10,2	8,8	5,3
Irgizskiy	0,4	0,5	0,0	7,8	4,8
Aktyubinsk oblast	2,8	1 011,9	100	165,1	100

Note. Made by authors on [6; 24–133].

Table 2

Change of specific weight of social infrastructure in structure of fixed assets of the Aktyubinsk oblast for 2009–2014 (%)

Type of economic activity	2009	2014
Education	2,1	2,7
Health care and social services	0,7	1,8
Art, entertainments and rest	0,7	0,3

Note. Made by authors on [7; 16].

As for 2015 in the Aktyubinsk oblast carry out the activity and function 530 preschool institutions of education, 429 high comprehensive schools, 41 organizations of secondary professional education (colleges), 3 higher educational institutions, 940 sporting venues, 477 cultural institutions and recreation areas [8–10].

The assessment of security of residents of administrative regions of the Aktyubinsk region with social infrastructure was carried out on a formula (1).

Calculation of an index of security of the population with cultural institutions (I_c) has shown that the population of Hobdinskiy and Martukskiy districts, in comparison with other administrative regions of area, are better provided with objects of the cultural sphere. The low indicator of security of the population with cultural institutions is characteristic to Irgizskiy and Temirskiy districts. The highest rate of an index of security of the population with the preschool organizations (I_{po}) is traced in the territory of the Aktyubinsk city administration, and the minimum value is characteristic to Kargalinskiy district. The leader in an index of security of the population with high comprehensive schools (I_{hco}) is the territory of the Aktyubinsk city administration, on the second place Mugalzharskiy district. The population of Kargalinskiy district concerning other 12 administrative regions are less provided with comprehensive schools. The index of security of the population with secondary vocational education institutions (I_{vei}) is high in the territory of the Aktyubinsk city administration. On this indicator residents of Irgizskiy and Temirskiy districts are less provided. Inhabitants of the territory of the Aktyubinsk city administration are more provided with sporting venues that reflects the calculated index (I_{sv}). The population of Bayganinskiy district has the minimum indicator of security with subjects to sports appointment (Table 3).

Assessment of security of the population of administrative regions of the Aktyubinsk oblast with objects of social infrastructure counting on 1000 inhabitants in 2015

Name of administrative regions	Indexes				
	I_c	I_{po}	I_{hco}	I_{vei}	I_{sv}
Alginskiy	0,037	0,041	0,037	0,001	0,069
Aytekebiyskiy	0,049	0,051	0,036	0,001	0,049
Bayganinskiy	0,047	0,036	0,027	0,001	0,036
Irgizskiy	0,035	0,034	0,026	0,000	0,088
Kargalinskiy	0,037	0,021	0,020	0,001	0,040
Khobdinskiy	0,062	0,044	0,036	0,001	0,063
Martuskiy	0,052	0,046	0,040	0,001	0,081
Mugalzharskiy	0,049	0,063	0,052	0,003	0,071
Temirskiy	0,035	0,049	0,036	0,000	0,058
Uilskiy	0,046	0,027	0,027	0,001	0,041
Khromtauskiy	0,044	0,034	0,034	0,001	0,079
Shalkarskiy	0,041	0,066	0,044	0,001	0,071
Territory of Aktyubinsk city administration	0,040	0,124	0,099	0,035	0,403

Note. Calculated and made by authors on [8–11].

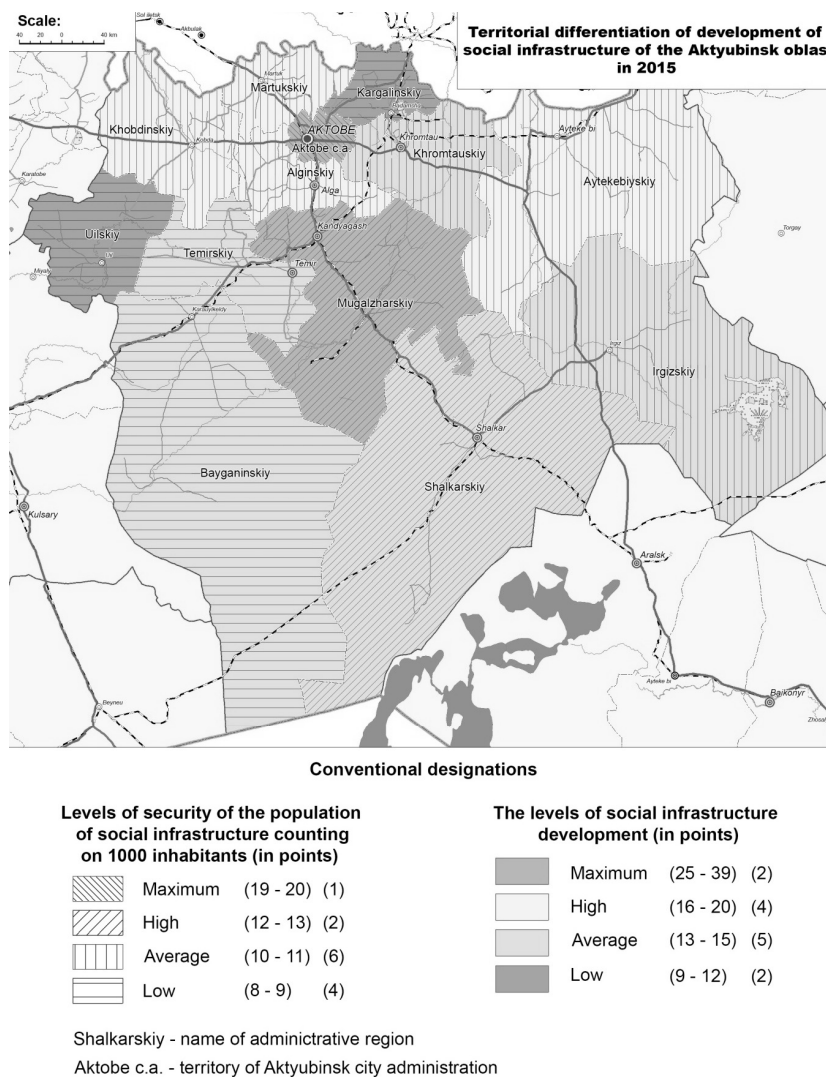


Figure. Territorial differentiation of social infrastructure development of the Aktyubinsk oblast in 2015. (made by authors on [8–11])

The integrated index has shown that inhabitants of the territory of the Aktyubinsk city administration it is better than other 12 administrative regions of area are provided with objects of social infrastructure. Mugalzharskiy and Shalkarskiy districts have the high level of security of the population with social infrastructure. The average level is characteristic to Martukskiy, Alginskiy, Aytekebiyskiy, Irgizskiy, Hobdinskiy and Khromtauskiy regions. The population of Bayganinskiy, Kargalinskiy, Temirskiy, Uilskiy regions have the lowest degree of security with social infrastructure counting on 1000 inhabitants (Fig.).

As an alternative the assessment of territorial development of social infrastructure of the Aktyubinsk region was also carried out with use of the technique offered N.M. Logacheva (2).

Calculations have shown that in the Aktyubinskiy oblast the territory of the Aktyubinsk city administration and Mugalzharskiy district have the maximum level of development of social infrastructure. The high rate of development of social infrastructure is characteristic to Alginskiy, Aytekebiyskiy, Khobdinskiy and Martukskiy districts. With average the level of development of social infrastructure characterizes the following administrative regions of area: Bayganinskiy, Shalkarskiy, Khromtauskiy, Irgizskiy, Temirskiy districts. The low level of development of social infrastructure are traced in the territory of Uilskiy and Kargalinskiy districts (Fig.).

Conclusion

Thus, comparison of integrated indicators of security of the population counting on 1000 inhabitants and the level of social infrastructure development demonstrates that the territory of the Aktyubinsk city administration has the best indicator of territorial development of social facilities. The major factor defining rather high rate of social infrastructure development of the territory of the Aktyubinsk city administration is placement and development of the Aktyubinsk agglomeration, giving concerts 53,4 % of the population, 27,7 % of industrial and 11,9 % of agricultural production of area. On the level of development and security of the population with social infrastructure is allocated Mugalzharskiy region. The lowest level of development of social infrastructure and security of the population with social institutions is characteristic territories of Uilsky and Kargalinsky regions.

Now it is impossible to consider the developed social and infrastructure system of the Aktyubinsk region sufficient. The effective territorial organization of economy and the population of the Aktyubinsk region requires the further advancing development of social infrastructure taking into account needs of the population.

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Ақтөбе облысының әлеуметтік инфрақұрылымының аумақтық дамуы

Мақала шаруашылықтың территориялық-салалық құрылымын және халықтың қоныстану жүйесінің қалыптасу мен дамуы үрдісі әсерінен пайда болған Ақтөбе облысының әлеуметтік инфрақұрылымының территориялық даму ерекшеліктерін зерттеуге арналған. «Әлеуметтік инфрақұрылым» түсінігіне авторлық анықтама ұсынылды. Н.М. Логачеваның халықтың әлеуметтік нысандармен қамтамасыз етілуін бағалау әдістемесін қолдана отырып, әкімшілік аудандар деңгейінде Ақтөбе облысының әлеуметтік инфрақұрылымының даму деңгейі бойынша территориялық дифференциациясын анықтауға әрекет жасалды. 1000 тұрғынға шаққанда әлеуметтік нысандармен қамтамасыз етілуінің интегралдық көрсеткіштерін есептеу негізінде және әлеуметтік инфрақұрылымның даму деңгейін анықтау бойынша «2015 ж. Ақтөбе облысының әлеуметтік инфрақұрылымы дамуының территориялық дифференциациясы» атты карта-сызбасы құрастырылды. Нәтижесінде Ақтөбе облысы әкімшілік аудандары халқының әлеуметтік нысандармен қамтамасыз етілуі мен әлеуметтік-инфрақұрылымдық жүйесінің даму деңгейі анықталды. Есептеулер мен салыстырмалы талдау көрсеткендей, халықтың әлеуметтік инфрақұрылым нысандармен қамтамасыз етілуінің жоғары дәрежесі мен дамуының максималды деңгейі Ақтөбе қалалық әкімшілік территориясына, атап айтқанда, Ақтөбе облысының шаруашылық субъектілер мен халықтың шоғырлануының орталығы болып табылатын Ақтөбе агломерациясына тиесілі. Ойыл және Қарғалы аудандары әлеуметтік инфрақұрылымның дамуы мен халықтың әлеуметтік мекемелермен қамтамасыз етілуінің көрсеткіші бойынша төмен деңгейге ие.

Кілт сөздер: Ақтөбе облысы, әлеуметтік инфрақұрылым, тұрғындардың қамтамасыз етілуі, аумақтық дамуы, әкімшілік аудандар.

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Территориальное развитие социальной инфраструктуры Актюбинской области

Статья посвящена изучению особенностей территориального развития социальной инфраструктуры Актюбинской области, которая сложилась под влиянием процесса формирования и развития территориально-отраслевой структуры хозяйства и системы расселения населения. В работе предложена авторская трактовка понятия «социальная инфраструктура». С использованием методики оценки обеспеченности населения социальными объектами, предложенной Н.М. Логачевой, предпринята попытка определить территориальную дифференциацию по уровню развития социальной инфраструктуры Актюбинской области в разрезе административных районов. На основе расчетов интегральных показателей обеспеченности населения социальными объектами в расчете на 1000 жителей и уровня развития социальной инфраструктуры составлена картосхема «Территориальная дифференциация развития социальной инфраструктуры Актюбинской области в 2015 г.». В результате выявлен уровень развития социально-инфраструктурной системы и обеспеченности населения административных районов Актюбинской области социальными объектами. Расчеты и сравнительный анализ показали, что максимальный уровень развития и высокая степень обеспеченности населения объектами социальной инфраструктуры характерны для территории Актюбинской городской администрации, а именно Актюбинской агломерации, которая является центром концентрации населения и хозяйствующих субъектов Актюбинской области. Уилский и Каргалинский районы имеют самый низкий уровень развития социальной инфраструктуры и обеспеченности населения социальными учреждениями.

Ключевые слова: Актюбинская область, социальная инфраструктура, обеспеченность населения, территориальное развитие, административные районы.

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Integrated assessment of the geocological situations of the Nura river basin

Extensive farming in the basin of the Nura river led to widespread degradation of soils of agricultural lands and a significant decrease in their potential fertility. One of the main ones is the activation of soil erosion in anthropogenically transformed geosystems by flushing and deflation processes or complete erosion of soils by linear erosion. A significant part of agricultural land in the Nura River basin is represented by soils that are estimated as erosion-deflation. In this connection, the authors analyze the current component indicators of the geocological situation in the Nura basin, which allows us to systematize the criteria for its assessment in dependence on the severity of environmental degradation. Based on the analysis of the quality of surface water and the theoretical regularities of the region, the authors identify geocological areas for the given territory.

Keywords: destabilization, anthropogenic pollution, geo-ecological situation, degradation, soil erosion, anthropogenically transformed geosystems, ecotone structure, tense situation, critical situation, transport and settlement impact, transformation of geosystems, anthropogenic disturbance, deflation, artificial landscape, soil diffusion.

Cartography of the geocological situation is always complicated not by the sufficient development of the system of ecological monitoring and by the availability of fragmentary data on the state of specific territories. For example, according to this regional city hall, the group with particularly unfavorable environmental conditions for the person included 20 % of the populated territory of the region. The entire other part of the territory is characterized as having normal ecological conditions. According to our data, up to 65 % of the territory of the region is characterized by a high degree of inferior geocological situation. It is established that the study area is characterized by a mismatch between the organization of the natural and economic infrastructure to the requirements of the scientifically-grounded system of rational land use, and the specific features of local geosystems. There are many examples of inconsistency of the organization of agroecosystems to the contours of natural complexes, which is accompanied by the destabilization of the geocological stability of the natural framework of the territory and the development of a number of negative physical and geographic processes (exacerbation of the earthquake, erosion, desiccation, desertification, seizure) [1]. Extensive farming in the Nura River basin has led to widespread depletion of soils of agricultural lands and a significant decrease in their potential fertility. One of the main ones is the activation of soil erosion in anthropogenically transformed geosystems by flushing and deflation processes or complete erosion of soils by linear erosion. A significant part of agricultural land is represented by soils that are assessed as erosion-deflation. More than 45 % of the soils are poorly and mildly non-humid in the hill areas, the degradation of the humus layer as a result of deflation is 3–6 cm for 10 years. The intensification of erosion processes is caused by a decrease in the protective functions of natural vegetation and the erosion resistance of soils subjected to long-term economic impacts.

A significant amount of information on the state of agricultural land and the development of erosion was obtained during the analysis of satellite images from Landaft satellite in 2008. A feature of the manifestation of a cosmic image of erosion processes is the variability of brightness characteristics in different areas of the image, which arises as a result of reaching the surface of deeper horizons Soil, diffusion of arable and subsoil layers, as well as enhancement of the biomass of vegetation on erosion sites, which is associated with the erosion of fertile soil In places of movement of water streams. In the process of deciphering the localities subjected to linear erosion, an important role was played by the characteristic form of imaging. Investigations and analysis of the basic regularities of deciphering the quality of lands by space images have shown that it is clearly defined on the basis of the change in the photon, texture, shape and size of the soil. In areas subject to water erosion, a consequent change in the image pattern is observed, which in turn allows us to subdivide geosystems into categories of erosion free, potentially erosion-hazardous and eroded. The ratio of the following areas was taken into following ones while mapping geocological situation and determining the degree of severity of its destabilization on the territory of each geocological area: a) industrial-technological industrial zone with fragments of elementary, transformed natural subsystem; b) an industrial-

technological agricultural zone with fragments of an elementary, transboundary, almost completely controlled and controlled natural subsystem; C) Areas of ecotone structures.

Industrial-technological industrial and agricultural areas with fragments of elemental, transboundary, almost completely controlled and man-controlled natural subsystem are characterized by the following: the transformation of technogenic relief, technologically organized and dispersed technology, the altered hydrological and hydrochemical regime, the availability of agrarian landscapes and artificial forest plantations. The regions of the ecotone structures are divided into two categories: a) the territories immediately adjacent to the production and technology zone with elements of auxiliary, associated and other industries — watering, the location of the settlements, the objects of the territory's infrastructure; The land of industrial and agricultural use is separated by an open structure of highly transformed and degraded geosystems. The organization of which is largely controlled by technological processes and is characterized by strong fluctuations; b) zone of diffuse, indirect influence of economic activity, geosystemic organization of which is controlled mainly by modified natural factors; From the geoecological standpoint it is characterized by the presence of hearths with an unevenly and medium narcissistic soil and vegetation cover and indirect influence on the other components of natural geosystems [2].

Technical and natural technogenic elements (engineering structures of production and auxiliary purposes — buildings, transport systems, etc.), as well as artificial elements of the ecological carcass (swards, woody plants, etc.) are characterized by geometrically correct outlines of shapes (rectangular, linear, rounded) With relatively even, sharp, sharp borders. In the limits of residential complexes and production areas, they form a system of interconnected elements. By the limits of the production and technological zone, their distribution is mainly diffuse, with an increased density along the roads. Natural-resource and natural-ecological elements of the Nura River basin, represented by modified natural complexes, have not sharp, not rectilinear, but fuzzy diffuse boundaries and geometrically inappropriate forms of contours. They usually form an openwork net that is denser to the periphery or the boundaries of industrial sites in the Nura River basin or grouped in relation to certain elements of the landscape ecological fleet of the territory (along the valleys of the rivers Nura, Cherubainur, UlkenKundyszdy, Aschysu and coastal lines of reservoirs, etc.) [3].

One of the compiling assessments of the geoecological situation was data on the medical and environmental risks of drinking water use, related to the supply and the level of contamination of drinking water according to the following parameters: 1) the distribution of harmful substances (according to sanitary regulations and drinking water standards) according to safety class (I — extremely II — highly dangerous, III — dangerous, IV — moderately dangerous); 2) the nature of pollution. The combination of the above characteristics makes it possible to assess the degree of safety of the detected level of contamination of the source and the degree of its suitability for drinking water use.

Analysis of modern component indicators of geoecological situation in the Nura River basin made it possible to detect and systematize the criteria for its assessment, depending on the severity of environmental destabilization (Table 1).

Table 1

Criteria of evaluating of types of geoecological situation

Criteria	Type of geoecological situation		
	Relatively satisfactory (I)	Tense (II)	Critical (III)
1	2	3	4
Spatial criteria			
Area of degraded land, %:			
Not representing immediate threats to man (dumps, pits, degradation of agriculture, forest land)	Less than 5	5–20	More than 40
Representing the threat of destruction of buildings and structures (landslides, faults)	absent	Less than 5	More than 5
dumps of toxic rocks isolated from groundwater, with the possible transfer of particles through the air, runoff to surface water bodies	Less than 5	25–50	More than 50
Pit excavations and dumps of toxic rocks with the threat of groundwater contamination	Less than 1	5–10	10–20
Dividing of the territory by swarms, km / km ²	Less than 0.5	0,5–2,2	More than 2,2
Depth of erosion and water level of relative surface, sm	Less than 25	25–220	More than 220
Projective coverage of grazing vegetation, % of the zone	More than 80	20–80	Less than 20

Table 1 continuation

1	2	3	4
Presence of micro-objects with drinking water quality of the next hazard class	III	IV	VI
The difference of hydro objects with drinking water of the following character of pollution (according to toxic indicators of harmfulness)	Admissible	Moderate	High and extremely high
Dynamic criteria			
The rate of degassing of geosystems,% of space per year	Less than 0,1	2–5	More than 5
Speed increase in the area of downed pastures,% of land per year	Less than 4	4–16	More than 16
The rate of increase in the area of saline land,% of land per year	Less than 1	2–8	More than 8
Rate of increase in the area of eroded lands,% of the area per year	Less than 0.1	2–5	More than 5
The rate of increase in land area with favorable agglomerative conditions, 5 from the area of agricultural land per year	Less than 0,1	0,2–1,0	More than 1
Additional criteria			
Ratio of land plots of land of different degree of erosion, %			
strongly changed	Less than 10	30–55	more than 55
- Very changed	Less than 5	5–45	more than 45
Excess of groundwater level,% of background value	Allowable level	25–30	more than 50
Density,% coverage	Less than 6	6–80	more than 80
Conformity of the facility for the disposal of waste to environmental requirements	Territories intended for storage	Territories intended for storage partially meet the environmental requirements	Not equipped facilities do not meet the environmental requirements

The aforementioned evaluation criteria allowed to obtain an average total indicator of the degree of anthropogenic disruption of natural geosystems in%, based on the share of the PTC with its different values in the total area of the natural area, which made it possible to classify the territories to be classified as a certain type of destabilization of geocological situation: I — relatively satisfactory (0–20 %); II — strained (41–60 %); III — critical (more than 60 %) (Table 2).

Relatively satisfactory geocological situation is characteristic for the following regions: KaraSor lake seasonal-grazing, Karkaraly-Kent small-grass poppy-agricultural. Local transformation of natural geosystems, permissible contamination of surface and groundwaters, transgression of vegetation cover, and narrow-scale land degradation are noted [4, 5].

Table 2

Criteria for assessing the type of geocological situation

Geocological area	Degree of anthropogenic disruption of natural geosystems, %	Type of ecological situation
Teniz-Korgalzhinsky lake-ravniny with agricultural loading	45	Tense
Ladyshko-Sredne-Nurinsky ravninniy with significant industrial-residential and hydrotechnical impact	45–65	Tense
Karaganda small-mouthed with settlement-transport and hydrotechnical influence	90 %	Critical
Károsory lake seasonal-grazing	10–15	Relatively satisfactory
Karkalaly-Kent small-grass poppy-agricultural	5–15	Relatively satisfactory

An intensive geocological situation has developed in the following areas — Teniz-Korgalzhinskoe lake-ravninniy with agricultural loading, Ladyshko-Sredne-Nurinsky ravninniy with significant industrial-residential and hydrotechnical impact. Small-scale transformation of natural geosystems, moderate pollution

of water, extensive transformation of vegetation cover, shallow manifestation of processes of land degradation are noted.

Critical geoecological situation characterizes the following region: Karagandinskiy melkosopchny with residential-transport and hydrotechnical impact. Here, the destruction of individual components of the natural resource potential occurs, which can lead to their complete disappearance, which requires timely intervention to eliminate the negative processes and phenomena in these territories.

Analysis of the main stage and the direction of the transformation of the basin, the modern assessment of geoecological situations, allows two provisions of the future development of the country to be put forward. For the first position, the anthropogenic loads are characteristic, which for the historical period have turned the natural steppe communities into a continuous artificial landscape. When taking urgent measures for the protection of nature, the landscapes can be partially restored. The second provision, to develop a scheme for the geoecological decay of the Nura basin as the basis for measures to address environmental problems.

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Г.М. Жангожина, Г.Б. Абиева

Нұра өзені алабының геоэкологиялық жағдайын кешенді бағалау

Нұра өзені алабында ауылшаруашылықтың күрт дамуы егістік жерлердің топырақтарының тозуға ұшырауына, олардың құнарлылығының азаюына әкеліп соғуда. Топырақтың осындай белсенді пайдалануының нәтижесінде антропогендік қайта қалыптасқан геожүйелерде шайылу және дефляция үрдістері немесе топырақ эрозиясының сызықты түрінің дамуына әсерін тигізеді. Нұра өзені алабындағы ауылшаруашылыққа жарамды жерлерінде топырақтар эрозиялық-дефляциялық түрге бағаланады. Осыған байланысты авторлар Нұра өзені алабының геоэкологиялық жағдайын қазіргі кездегі компоненттер тармағы бойынша талдап, оның экологиялық өзгеріске ұшырауының критерийлерін бөліп көрсетеді. Жер беті суларының сапасын анықтау арқылы және зерттеліп отырған аймақтың теориялық заңдылықтарын ескере отырып, авторлар осы аумақты геоэкологиялық аудандарға бөліп қарастыруды ұсынады.

Кілт сөздер: өзгеру, антропогендік ластану, геоэкологиялық ахуал, топырақтың бұзылуы, топырақтың шайылуы, антропогендік-қайта қалыптасқан геожүйелер, экотондық құрылым, шиеленіскен жағдай, сыни жағдай, селителік-көліктік әсер ету, геожүйенің түрленуі, антропогендік бұзылушылық, желге үрлену, жасанды ландшафт, топырақ диффузиясы.

Г.М. Жангожина, Г.Б. Абиева

Комплексная оценка геоэкологической ситуации бассейна реки Нуры

Экстенсивное ведение земледелия в бассейне р. Нуры привело к повсеместной деградации почв пахотных угодий и значительному снижению их потенциального плодородия. Одной из основных причин является активизация разрушения почв антропогенно-преобразованных геосистем процессами смыва и дефляции или полное уничтожение почв линейной эрозией. Значительную часть сельскохозяйственных угодий в бассейне р. Нуры представляют почвы, которые оцениваются как эрозионно-дефляционные. В связи с этим авторы анализируют современные покомпонентные показатели геоэкологической ситуации в бассейне р. Нуры, что позволяет систематизировать критерии ее оценки в

зависимости от остроты экологической дестабилизации. На основе анализа качества воды поверхностных вод и по теоретическим закономерностям исследуемого региона выявлены геоэкологические районы для данной территории.

Ключевые слова: дестабилизация, антропогенное загрязнение, геоэкологическая ситуация, деградация, эрозия почв, антропогенно-преобразованные геосистемы, экотонная структура, напряженная ситуация, критическая ситуация, селитебно-транспортное воздействие, трансформация геосистем, антропогенная нарушенность, дефляция, искусственный ландшафт, диффузия почв.

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Ақмола облысындағы шағын қалалар тұрғындарының көші-қоны

Мақалада Ақмола облысының шағын қалалардың халқының көші-қоны, оның геодемографиялық үрдістерге ықпалы, атап айтатын болсақ, тұрғындардың жастық және жыныстық құрамы қарастырылған. Сонымен қатар көші-қонның сандық және сапалық көрсеткіштеріне талдау жасалған. Ақмола облысының Статистика департаментінің ресми ұсынған мәліметтерін талдау негізінде авторлар келесі мәселелерді ерекше бөліп көрсетеді, олар: қала халқының жастық құрамы бойынша қарт адамдардың үлесінің артуы, жастарды шағын қалаларда қалдыру мәселелері. Мақалада көші-қонның сандық көрсеткіштеріне нақтылап талдау жүргізу жұмыстарына ерекше көңіл бөлінген. Зерттеліп жатқан тақырып бойынша Ақмола облысының шағын қалаларында жүріп жатқан геодемографиялық үрдістер туралы жаңа тың мәліметтер келтірілген.

Кілт сөздер: көші-қон, шағын қала, жастық құрамы, қартаю, көші-қон айырымы, геодемографиялық үрдіс, механикалық өсім, жыныстық құрамы, эмиграция, иммиграция.

Қазіргі кездегі Ақмола облысының шағын қалаларының әлеуметтік-экономикалық даму кезеңі өте күрделілігімен және өтіп жатқан үрдістерге қарама-қайшылықтарымен ерекшеленеді. Соңғы 2013–2015 жж. шағын қалалардағы көші-қон үрдістерінің негізгі бағыттары мен көрсеткіштеріне осы мақалада талдау жасалған.

Мақаланың басты мақсаты — Ақмола облысының шағын қалаларында жүріп жатқан геодемографиялық үрдістерге көші-қонның әсерін көрсету. Халық санының өсіп-өнуіне табиғи өсім көрсеткішімен қатар, механикалық өсімде айтарлықтай ықпал ететіні белгілі. Әсіресе шағын елді мекендерден экономикалық және әлеуметтік себептерге байланысты адамдар орын ауыстырып отырады. Осыған байланысты мақсатқа жету үшін мынадай міндеттер қойылды:

- шағын қалалардың 2012–2013 жылдардағы көші-қон көрсеткіштеріне талдау жасау;
- көші-қонның шағын қалаларда жүріп жатқан геодемографиялық үрдістерге әсерін бағалау.

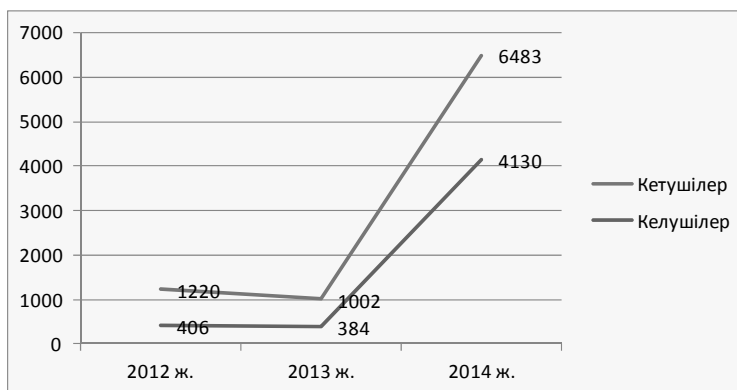
Ақмола облысы территориясындағы шағын қалалардың басым көпшілігінде жалпы өсімді анықтауда механикалық өсім айтарлықтай әсер етеді. Мәселені анықтау үшін аумақтар бойынша көші-қон көрсеткіштеріне назар аударайық. Олай болса, 2013 ж. ішкі көші-қон, соның ішінде облысаралық бағытта белсенді жүрген. Мәселен, республиканың басқа облыстарына кеткендер саны жөнінен абсолютті көшбасшы Степногорск қаласы, мұнда бұл көрсеткіш — 654 адам. Бірақ басқа облыстан көшіп келушілерде айтарлықтай жоғары, 706 адам. Көшіп кетушілерден келушілердің санының басым болуы Щучинск және Макинск қалаларында да байқалады. Сәйкесінше 407 және 801 адам, 207 және 261 адамды құрады. Ал қалған қалалардың барлығында көшіп кетушілердің саны басым. Әсіресе Ерейментау мен Атбасар қалалары ерекше көзге түседі, сәйкесінше 475 және 452 адам. Облыс ішіндегі көші-қон бағыты көрсеткіштеріне тоқталар болсақ, мұнда жағдай келесідей. Степногорск, Щучинск, Атбасар қалаларына жақын елді мекендерден көшіп келушілердің саны артқан. Степняк, Ерейментау, Есіл қалаларында жағдай керісінше.

Сыртқы көші-қонға келетін болсақ, мұнда жақын шетелдерге кетушілер саны басым. Әрине, келушілерден кетушілердің саны әлдеқайда жоғары болғандықтан, барлық қалаларда көші-қон сальдосы теріс мәнге ие, тек Степногорск мен Макинскте жақын шетелдерге көшіп-қону сальдосы оң мәнді құрайды.

2012 ж. сыртқы көші-қон көрсеткіштері бойынша, Атбасар, Степногорск, Щучье қалалары ерекшеленеді. Мұнда сәйкесінше –208, –144, –138 адам. Ал Степняк және Державин қалаларында келушілер мен кетушілердің саны мүлдем төмен. Мәселен, Степняктан 3 адам жақын шетелдерге кетсе, 1 адам келген. Алыс (жақын) шетелдерге кетушілердің саны барлық қалаларды қоса есептегенде 49 (1171) адам, келушілер 31 (375) адам [1].

2014 (2013) ж. жақын шетелдерге Ақмола облысының шағын қалаларынан 5 553 (941) адам көшіп кетсе, 3 845 (341) адам келген. Ал алыс шетелдерге 930 (61) адам кетіп, 285 (43) адам келген. Соңғы жылғы көрсеткіштер әлдеқайда жоғары алыс және жақын шетелдерге 6483 адам кеткен.

2014 ж. болса, бұл көрсеткіш 1002 адамды құраған, яғни, кетушілердің саны 2015 ж. 6,5 есеге артқан (1-сур.).

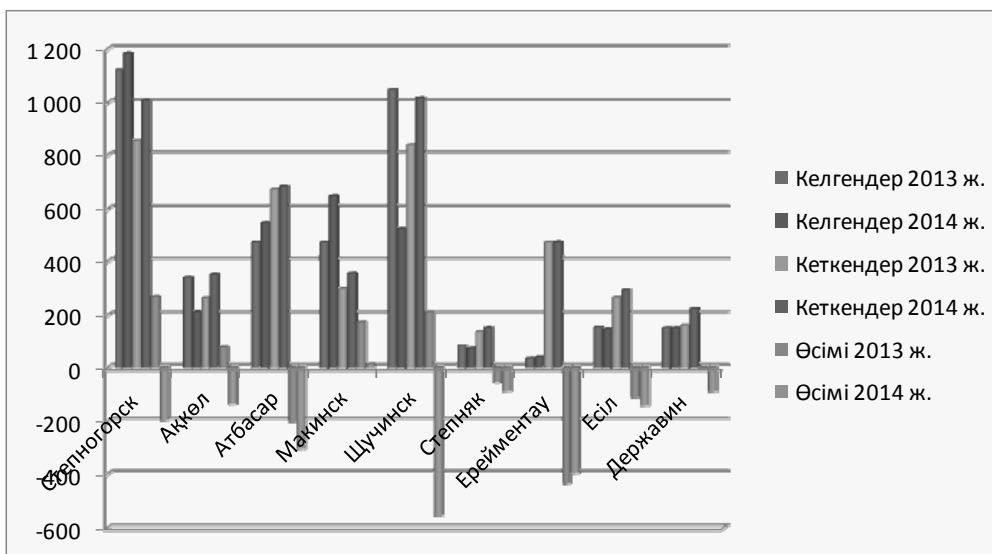


1-сурет. Сыртқы көші-кон көрсеткіштері

Осылайша 2012–2014 жж. аралығында шағын қалалардың халқының саны сыртқа кетушілердің есебінен 8 705 адамға азайып, келушілермен 4 920 адамға толыққан. Нәтижесінде механикалық қозғалыс есебінен халық саны –3 785 адамға кеміген. Облыс аумақтары бойынша 2013 ж. көші-кон көрсеткіштерін өткен жылғымен салыстырар болсақ, айтарлықтай өзгерістер байқалмайды. Бұрынғысынша Атбасар, Степногорск, Щучинск қалаларында халық санының, басқаларға қарағанда, көптігіне байланысты кетушілер мен келушілердің көрсеткіштері жоғары.

Сыртқы көші-кон бағыттары бойынша, соның ішінде алыс шетелдер арасында кетушілердің басым бөлігі Германия, Монғолияға мемлекеттеріне бағытталған. Келушілердің көпшілігі Қытай, Монғолия елдерінен қоныс аударушылар. Ақмола облыстық Статистика департаментінің мәліметтері бойынша, 2013 ж. облысымызға Қытайдан 116 адам, Монғолиядан 79 адам, яғни шет жерлердегі қазақтар, көшіп келген. Олардың басым бөлігі Ақкөл, Ерейментау, Макинск қалаларында орналасқан.

Шағын қалалардың 2012–2014 жж. аралығындағы ішкі көші-кон көрсеткіштеріне талдау жүргізілді. 2012 ж. республиканың басқа облыстарына 2 900 адам, 2013 ж. 3 015 адам, 2014 ж. 66 адам көшіп кетсе, ал келгендер саны 2012 ж. 2 451 адам, 2013 ж. 2 327 адам, 2014 ж. 31 адамды құрады. Осы аралықта барлығы 5 981 адам кетіп, 4 809 адам келген. Нәтижесінде басқа облыстарға кетушілер есебінен –1 172 адамға кеміген (2-сур.).



2-сурет. Халық көші-қонының өсімі

Облыс бойынша келгендер арасында ауылдық жерден қоныс аударушылар басым, кеткендердің ішінде керісінше. Ал шағын қалаларда келгендердің де кеткендердің ішінде қалалықтар басым. Халық көші-қонының өсіміне тоқталсақ, Макинск қаласынан өзгесінің барлығында теріс нәтиже байқалады.

Бұл көрсеткіштерді 2012 ж. мәліметтермен салыстыратын болсақ, жалпы жағдай сол үрдісте қала береді. Жағдайды объективті бағалау үшін үш қаланың көрсеткіштерін салыстырып көрейік. Мәселен, 2012 ж., ресми мәліметтер бойынша, Атбасарға 481 адам келген, оның 234 адамы қалалық, 247 — ауылдықтар. Есілге 171 адам келген, оның 94 адамы қалалықтар, 77 — ауылдық. Степнякта барлығы 58 адам келген, оның 33 адамы қалалықтар, 25 — ауылдықтар. 2013 ж. Атбасарға барлығы 471 адам келсе, оның 258 қалалық жерден, 213 ауылдық жерден. Есілге барлығы 155 адам, оның ішінде 74 адам қалалықтар, 81 адам ауылдық жерден келгендер, ал Степнякқа 84 адам келген, оның 55 адамы қалалықтар, 29 — ауылдықтар. Алдыңғы жылмен салыстырғанда келушілер саны Атбасарда 10 адамға, Есіл 16 адамға азайған, ал Степнякта 26 адамға артқан.

1 - к е с т е

Ақмола облысы шағын қалалары халқының жастық құрамы, %

Қала	0–14жас	15–59 жас	60 жас жоғары
Ақкөл	22,8	62,0	15,2
Атбасар	21,8	64,7	13,5
Макинск	24,2	62,4	13,4
Щучье	19,8	66,4	13,8
Степняк	23,1	61,4	15,5
Ерейментау	23,8	61,4	14,8
Есіл	23,0	64,4	12,6
Державин	25,0	63,5	11,5
Степногорск	20,0	63,6	16,4
Облыс бойынша	22,3	64,8	12,9

Жоғарыдағы 1-кестеден байқағанымыз, қалалардың барлығында дерлік жасы 60-тан жоғары халықтың үлес салмағы республикалық деңгейден басым болуымен ерекшеленеді. Бұл көрсеткіштер 11,5–16,4 % аралығында, ал жалпы облыс бойынша көрсеткіш 12,9 % құрайды. Державин, Есіл қалаларының көрсеткіштері облыстыққа жақын болса, қалғандарында одан асып түседі.

Шағын қалалардағы тұрғын халықардың қартаюның геодемографиялық үрдістерінің деңгейіне баға беру үшін француз зерттеушісі Ж. Боже-Гарнье мен поляк демографы Э. Россеттің жасаған шкаласы алынды [2]. Бұл шкала бойынша облыстық көрсеткіш 4 кезеңге демографиялық қартаюдың бастапқы деңгейіне сай келсе, республикалық көрсеткіш 2 кезең, қартаюдың бірінші сатысының алдында тұр. Осы шкала бойынша демографиялық жас болып 8 % төмен көрсеткішке ие халықтар жатады. Ал енді шағын қалалардағы халықтың деңгейіне тоқталайық. Демографиялық қартаю деңгейі бойынша Степногорск қаласы ерекше дабыл қағуда, мұндағы көрсеткіш шкала бойынша 4 кезеңнің демографиялық қартаюдың жоғарғы деңгейіне жатады. Степняк, Ақкөл, Ерейментау қалалары 4 кезеңнің демографиялық қартаюдың ортаңғы деңгейіне сәйкес келеді. Щучье, Атбасар, Макинск, Есіл қалалары 4 кезеңнің демографиялық қартаюдың бастапқы деңгейінде тұр. Тек Державин қаласы 2 кезең қартаюдың бірінші сатысына жатады.

Осылайша, шағын қалалардағы халықтардың қартаюының геодемографиялық үрдістері аталған шкала бойынша ерекше дабыл қақтыруда. Державин қаласынан басқалары төртінші кезеңге жатады, яғни демографиялық кәрі халықтар болып табылады. Шағын қалалардан жастардың көптеп кетуіне, орташа өмір сүру жасының ұзақтығының артуына байланысты кәрі адамдардың үлесі артып отыр.

Геодемографиялық маңызды көрсеткіштердің бірі тұрғындардың жыныстық құрамы болып табылады. Жалпы республика бойынша, 2009 ж. санақ көрсеткіші бойынша, ерлер 48,2 %, әйелдер 51,8 % құрайды. Шағын қалалардағы халықтардың жыныстық құрамы 2-кестеде берілген.

Шағын қалалар халқының жыныстық құрамы, 2015 ж., %

Қала	Ерлер	Әйелдер
Ақкөл	48,3	51,7
Атбасар	47,9	52,1
Макинск	47,2	52,8
Щучье	46,8	53,2
Степняк	48,3	51,7
Ерейментау	49,3	50,7
Есіл	48,3	51,7
Державин	46,9	53,1
Степногорск	46,9	53,1
Облыс бойынша	48,3	51,7

Кесте мәліметтерінен байқағанымыз, барлық шағын қалаларда әйелдердің үлесі басым, әсіресе Щучье, Степногорск, Державин, Макинск қалаларында. Ерейментау, Ақкөл, Есіл, Степняк қалаларында ерлердің үлесі әйелдердің көрсеткішіне жақынырақ. Ал облыс бойынша көрсеткіш республикалыққа өте жақын: ерлер 48,3 %, әйелдер 51,7 %.

Сонымен, Ақмола облысының шағын қалаларындағы көші-қон үрдісі күрделілігімен сипатталады. Қалалардың басым көпшілігінде көші-қон сальдосы теріс мәнге ие. Кетушілердің басым көпшілігі жастар болғандықтан, қала халқының үлесінде қарттар саны артқан. Шағын қалалардан жастардың көптеп кетуінің себебі — білім алу, жақсы өмір сүру жағдайын іздеу, арман және болашақ. Ал алыс және жақын шетелдерге кетушілер өздерінің тарихи отандарына немесе қызмет бабымен көшіп жатады. Шағын қалаларға көшіп келушілердің көбі жақын ауылдардан, өзгелері — шағын қаладан шыққандар. Шағын қала тұрғындарын сол жерде қалдырудың амалы — олардың әлеуметтік, тұрмыстық жағдайын жақсарту, халықты жұмыспен қамту, қаланың өнеркәсібін қалыптастыру және оны дамыту, инфрақұрылым кешенін жақсарту, яғни халықтың жайлы өмір сүруіне барынша жағдай жасау.

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А. Зандыбай, Б.Х. Есенжолов, Г.Р. Есенжолова

Миграция населения в малых городах Акмолинской области

В статье рассмотрены миграция населения в малых городах Акмолинской области, влияние миграции на геодемографические процессы, а именно на половозрастной состав населения. Кроме того, был сделан анализ количественных и качественных показателей миграции. На основании анализа официальных сведений Департамента статистики Акмолинской области авторы особо выделили проблемы повышения доли пожилых людей в составе населения города и утечки молодежи из малых городов. В статье особое внимание уделено проведению детального анализа количественных показателей миграции. По исследуемой теме приведены новые сведения о геодемографических процессах малых городов Акмолинской области.

Ключевые слова: миграция, малые города, возрастной состав, старение, сальдо миграции, геодемографический процесс, механический рост, половой состав, эмиграция, иммиграция.

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Migration in small towns Akmola region

This article describes the migration of the population in small towns in the Akmola region, the impact of migration on geodemographic processes, namely, on sex and age composition of the population. Further analysis of quantitative and qualitative indicators of migration was made. On the basis of the analysis of official data of Department of statistics of the Akmola region, authors have especially allocated the following problems. The increase in a share of elderly people as a part of the population of the city and a problem of deduction of youth in the small cities. In article special attention is paid to carrying out the detailed analysis of quantitative indices of migration. On the studied subject new data about geodemographic processes of the small cities of the Akmola region are provided.

Keywords: migration, small town, age composition, aging, balance of migration, geodemographic process, mechanical growth, sex composition, emigration, immigration.

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