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F. A. Iskakova[1], M. M. Adenov[2], L. T.Yeraliyeva[2] , G. Tsogt[3]

[1]NLC Asfendiarov Kazakh National Medical University, Almaty, Kazakhstan,
[2]National Scientific Center of phthisiopulmonology MOH RK, Kazakhstan,
[3]Ministry of Health, Mongolia.
E-mail: iskakova.f@kaznmu.kz, madenov@mail.ru; l.yeraliyeva@gmail.com; gombogoram@yahoo.com

CORRELATION ANALYSIS OF EPIDEMIOLOGICAL DATA TO ASSESS THE TB SITUATION AND THE EFFECTIVENESS OF THE TB PROGRAMME UNDER MODERN CONDITIONS

Abstract.

Background: Worldwide, TB is one of the top 10 causes of death and the leading cause from a single infectious agent. Millions of people continue to fall sick with TB each year. In 2017, TB caused an estimated 1.3 million deaths (range, 1.2–1.4 million) among HIV-negative people and there were an additional 300 000 deaths from TB (range, 266 000–335 000) among HIV-positive people. Thanks to the internationally recommended TB control program, including diagnostics, treatment and care patients, burden of TB is reduced in 30 countries of Asia, Africa and Europe with high incidence and mortality rate.

Methods: An estimation of burden of TB in Kazakhstan, Almaty region and Almaty city, three level of TB control program based on Incidence, Prevalence and Mortality rates. It carried out research of epidemiologic pattern analysis using Pearson correlation coefficient in regional and national level based on period of time, estimated by main determinants.

Results: The results showed relationship between determinants and dynamics of TB epidemiological rates as Mortality, Incidence and Prevalence in observational areas.

Conclusion: TB epidemiological pattern depends on impact of many factors of the bio-social environment, which have a negative or positive impact on epidemiology of TB. Determining the real situation is important for evaluating the effectiveness of the TB program, identifying priorities and planning for TB measures.

Key words: TB, Mortality rate, Incidence rate, Prevalence rate, Pearson coefficient, DOTS strategy, WHO.

TB is one of the most common and studied infectious diseases. It reached epidemic proportions in Europe and North America during the 18th and 19th centuries. Then it began to decline thanks to discovery of the *mycobacterium* TB, anti-TB drugs, BCG vaccine and treatment regimens that led to the perception of TB as an eliminateddisease.

As a result of the growth of the number of patients and deaths from TB by the end of the 20th century WHO announced TB as a worldwide emergency and recommended the DOTS Strategy in 1993 as the most cost- effective way to stop the spread of TB in communities with a high incidence. DOTS aimed at the detection of a TB case by sputum smear microscopy, standardized treatment regimen and a standardized recording and reporting system. DOTS is expanded to “Stop TB” strategy and DOTS-Plus. These actions of WHO led to the reduction of TB cases and deaths. And also, disease burden caused by TB is falling globally. So in 2018 all member states of WHO and UN are committed to the endorsement of “End TB”strategy and adoption of the UN Sustainable DevelopmentGoals.

Specific targets are set until the end of 2030. “End TB” strategy aims at 90% reduction in the absolute number of TB deaths and an 80% reduction in TB incidence (compared with levels in 2015).

In Kazakhstan there were similar trends in the epidemiological situation of TB, accompanied by the introduction of TB programs, in accordance with the current concepts of the TB control system (7). The time period from 1998 to 2002 is characterized as the implementation of the DOTS strategy; since 2002 the program has been adapted to the conditions of the country, and since 2007 has been strengthened by

elements of the program “Stop TB”. As a response to DOTS, Stop TB and DOTS-Plus the incidence rate of TB decreased from118 to 48.2 per 100 000 people, mortality rate from 37.8 to 4.2 per 100 000 people (1998-2017) The result shows success of TB control programs in Kazakhstan. The introduction and activity of TB service in conditions of new programs are today an important issue of discussion in the medical society and the media (10, 11). The epidemiological pattern of TB is characterized by intense morbidity, prevalence and mortality, their level and changes are determined by the epidemic process. At the same time, the information capacity of epidemiological indicators are influenced by many factors that are not always taken into account in the analyses of the epidemiological situation of TB.

The purpose of the study was to conduct a scientific analysis of the epidemiological situation of TB and the effectiveness of TB control program in Kazakhstan in terms of evidence-based medicine using modern statistical methods.

The objectives of the study are: an analysis of the epidemiological situation of TB by assessing the level of the main indicators: incidence rate, mortality rate, prevalence rate and correlation analysis of incidence and mortality rates from 1973 to 2008 in certain periods of observation, determined by the presence of risk factors of the bio-social environment in the country.

Incidence rate is one of the most important and reliable criteria for the intensity of the epidemic process. At the same time, the indicator is influenced by objective factors (preferential detection by the X-ray method, insufficient detection by the microscopy method, the absence of quick methods of evidence-based diagnosis of TB) and a subjective character (struggle to reduce an indicator. Today, the term “incidence index”, which reflects the program’s efforts to detect cases and the effectiveness of mainly microscopy and x-ray diagnostic methods. The ratio of patients with new cases of pulmonary TB to a positive smear for patients with a negative smear of sputum determines the success of the program as a whole in the task of identifying priority patients who influence to the epidemic process ofTB.

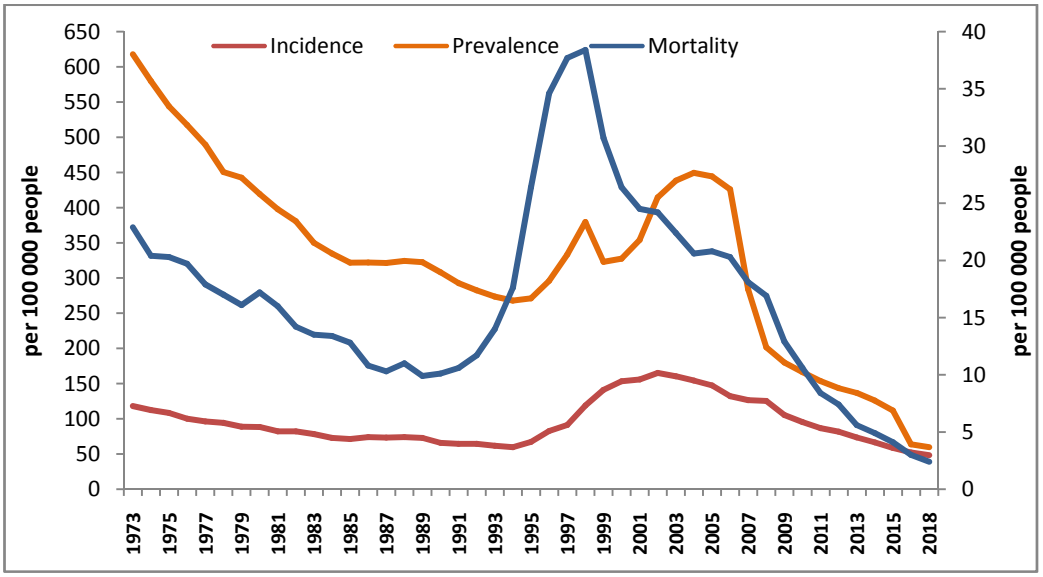
TB mortality rate is a reliable criterion reflecting the effectiveness of TB patients’ treatment to a greater extent and the time of detection of disease cases. The indicator is the most informative in case of correct registration of death and determination of cause of death with postmortem confirmation. The prevalence rate reflects an effectiveness of TB patients’ treatment, duration of follow-up, and depends on approaches of TB care service to solving terms and conditions of follow-up observation of TB center contingents. We used the ratio of morbidity to of an epidemic process: a smaller ratio means the worse TB situation. The ratio of prevalence to morbidity, which reflects a length of observation time for patients with active TB forms and an effectiveness of treatment. The smaller range of the ratio means the more effectiveness the TB control program(figure).

To assess the level of the main epidemiological indicators, the observational time is divided into five periods, taking into account an influence of socio-economic factors, public health measures to improve the population’s heath (anti-alcohol company), and TB control strategies.

The first observation period (1973–1985), tentatively called the “Soviet period,” is associated with the period of Kazakhstan’s presence in the USSR, and is characterized by a stable economic system, an effective Health Care System and a TB program. Activity is regulated by Order "On measures to strengthen the fight against TB of the USSR Ministry of Health" No. 747 of September 7, 1972 and Order "On approval of a new classification of TB" No. 361 of April 23, 1974. During this period, in Kazakhstan therewasasteadydeclineintheincidencerate,by39.8%ingeneral(range118-71.1 per 100 000 people). The average ratio of Incidence to Mortality rates was 5.4 (5.2 to 5.6). There was a decrease in mortality by 2 times (the scale of .9 - 12.8 per 100 000 people) and PR. 1.9 times, the average value of the indicator was 449.7 per 100 000 people (range 321.7 - 618). A strong positive correlation was determined between morbidity and mortality in Kazakhstan (r = 0.98) and between prevalence and morbidity (r = 0.99), which reflects the relationship between indicators; a decrease in incidence leads to a decrease in mortality, a decrease in prevalence leads to a decrease in incidence (tables 1, 2).

In the Almaty region, there was a moderate decrease in the incidence by 23.8%, a prevalence of 32.5% andmortalityby14.9%. The averageincidenceratewas76.4per100000people(range 87.8 - 66.9 per 100 000 people). The indicator of the ratio of morbidity for mortality was 6.7 (6.6-5.9). The mortality rate was also decreasing from 13.4 to 11.4 per 100 000 people, the average value was 13.1 per 100 000 people.

A



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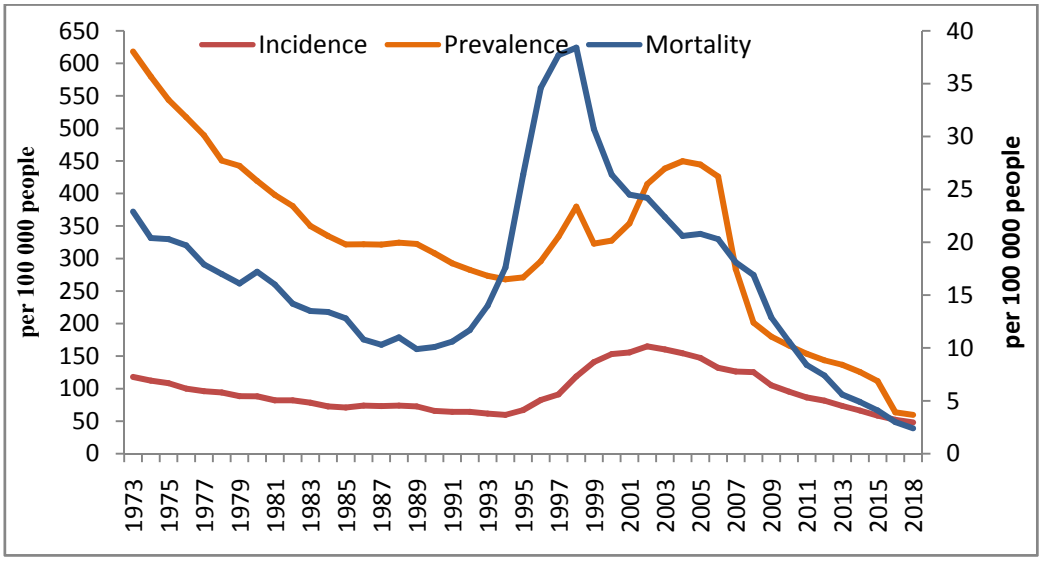

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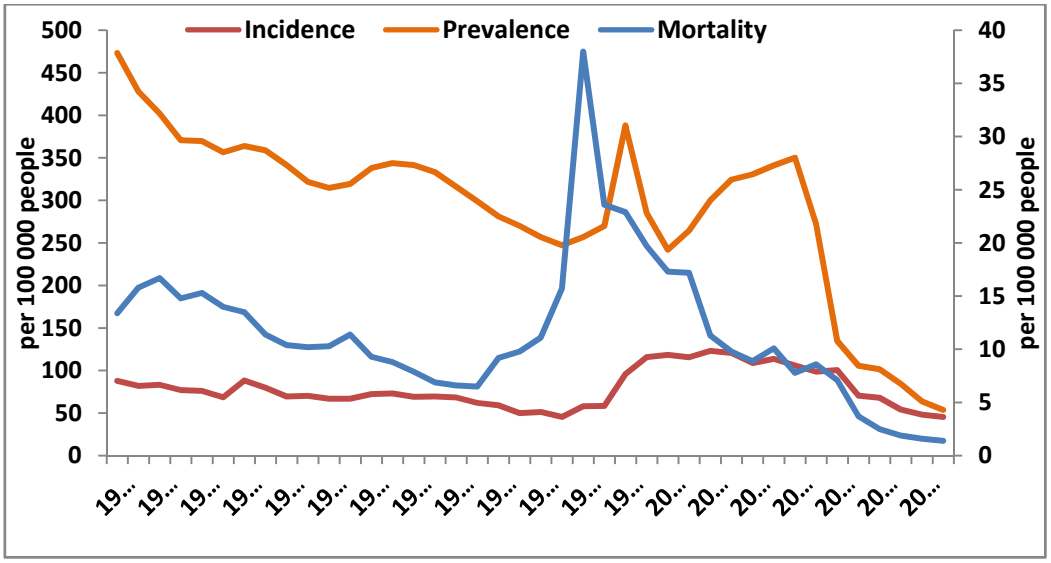

Mortality, Incidence and Prevalence rates of TB in Kazakhstan (A), Almaty region (B) and Almaty city (C), 1973-2018

Table 1 – Correlation analysis of Incidence and Mortality rates of TB in Kazakhstan, Almaty region and Almaty city, 1973–2009

Period	Observation time	Pearson correlation coefficient		
		Kazakhstan	Almaty region	Almaty city
1973-1985	Soviet period	0.98	0.57	0.84
1986-1991	Anti-alcohol campaign	0.13	0.29	0.46
1992-1998	Socio-economic crisis	0.84	0.25	0.91
1999-2004	Implementation of DOTS	-0.93	-0.54	0.94
2005-2008	Stabilization	0.81	0.73	- 0.49

Table 2 – Correlation analysis of Prevalence and Incidence rates of TB in Kazakhstan, Almaty region and Almaty city, 1973–2009

Period	Observation time	Pearson correlation coefficient		
		Kazakhstan	Almaty region	Almaty city
1973-1985	Soviet period	0.99	0.79	0.98
1986-1991	Anti-alcohol campaign	0.94	0.91	0.77
1992-1998	Socio-economic crisis	0.97	0.97	0.97
1999-2004	Implementation of DOTS	0.34	-0.19	-0.73
2005-2008	Stabilization	0.81	0.65	- 0.84

do not correlate with the incidence rate, which decreased in this period, the rate of decline was 6.7% in the period 1974-1975, increased by 1.6% from 1975-1976. Since 1977, there has been a steady decline in morbidity and mortality. The positive correlation of the average intensity of morbidity and mortality during this period was determined (r = 0.57). During this period, there was a decrease in the prevalence of 1.5 times, the average value was 368.5 per 100 000 people (range 314.6-473.3 per 100 000 people). A strong correlation was found between the prevalence and incidence rates (r = 0.79).

In Almaty city - 2.4 times decrease in incidence rate (range 119.5-49.2 per 100 000 people), the average value was 72.6 per 100 000 people; a decrease in the mortality rate by 2.1 times (range 14.1 - 6.8 per 100 000 people), the average value was 10.3 per 100 000 people. The indicator of the ratio of morbidity to mortality is 4.8 (8.5-7.2). The average mortality rate is 10.0 per 100 000 people (range 6.8-14.1 per 100 000 people). During this period, the prevalence of TB was also halved, the average value was 330.6 per 100 000 people (239.7- 488.5 per 100 000 population), the annual rate of decline was 2.9%. The ratio of prevalence to morbidity averaged over a period of 4.6 (a range of 4.1–5 years). A strong positive correlation between the morbidity and mortality were determined. (r = 0, 84) and between prevalence and morbidity (r = 0.98).

The second observation period (1986-1991) was marked by an anti-alcohol campaign. On May 7 and 16, 1985 legislative acts of the Central Committee of the CPSU and the Council of Ministers of the USSR on strengthening the fight against drunkenness and home brewing were published. Since 1960, in the USSR, there has been an increase in alcohol mortality associated with the highest use of legal and illegal alcoholic beverages in the world and low life expectancy compared with other countries of the world (10). During the ban on the use of alcoholic beverages in Kazakhstan, the most favorable situation is observed in terms of the ratio of the incidence rate for mortality, the average value of which was 6.6 ± 0.3 times (6.8-6.1). The incidence rate between the 1986 level by 1991 decreased by 9.4% (range 64.4 - 73.9 per 100 000 people) with an annual decrease of 1.9%; the prevalence rate is 9.0% (the range is 308.2-292.6 per 100 000 people) with an annual decrease of 1.8% and the mortality rate 17.2% (12.8-9.9 per 100 000 people)) with an annual decline of 3.4%. During this period of time in Kazakhstan, there was a weak positive correlation between morbidity and mortality rates (r = 0.23) and (r = 0.91). There was a significant reduction in mortality with a fairly high annual rate of decline against the background of consistently high rates of morbidity and prevalence.

In Almaty region there was a 1.8-fold decrease in mortality from TB (range 6.5–11.4 per 100 000 people) with an annual decrease of 6.1% against the background of relatively stable incidence rates (-7.2%, scale 62.1 - 66.9 per 100 000 people) with an annual decline of 1% and prevalence (+ 6.4%, the magnitude of the indicator 299.1 - 319.4 per 100 000 people) with an annual decrease of 0.9%. The ratio of morbidity to mortality was 8.5 (range 5.9-10.4), and the ratio of the prevalence of incidence 4.7 (range 4.7 - 4.9 years). A weak positive correlation between morbidity and mortality (r = 0.29) and prevalence and morbidity (r = 0.91) was determined.

In Almaty city there was a significant decrease in prevalence of 29.2%, the scale of the indicator was 169.6 - 239.7 per 100 000 people, and the annual decline of the indicator was 4.2%. The ratio of prevalence and incidence was 4.1 (range 3.7-4.9 years). During this period, an increase in the mortality rate was determined in the megalopolis (by 17.6%), the scale was 6.2 - 8 per 100 000 people with an annual growth rate of 2.5%; and a slight increase in the incidence rate of 7.1%, the scale of the indicator was 45.7 - 55.3 per 100 000 people). The ratio of morbidity and mortality was 7.5 (range 5.71 - 9.2). The Pearson correlation analysis determined a moderate relationship between morbidity and mortality (r = 0.46) and a strong degree of positive correlation between prevalence and morbidity (r = 0.77). Differences in the rate of decline in TB rates, especially mortality, are associated with different degrees of alcohol consumption and the correctness of the calculation of epidemiological indicators.

The third observation period (1992-1998) is connected with socioeconomic crisis and the policy of reconstruction, which was supposed to improve the state of the economy and liberalize the political life of the country. Restructuring period led to the collapse of the USSR into independent republics. Independent countries continued to undergo socioeconomic changes, accompanied by a decrease in funding for the health care system, including the TB service. During this period, there is a 3.3-fold increase in mortality in Kazakhstan (the magnitude of the indicator is 11.7 - 38.4 per 100 000 people) with an annual growth rate of 38%; an increase in the incidence of 1.8 times (range 59.7 - 118.8 per 100 000 people) with an annual growth rate of 14.1%. The ratio of morbidity and mortality averaged 3.4 (2.4 - 5.5), which was the lowest in 36 years of observation.

The lowest ratio of persons who fell ill with deaths from TB was observed from 1995 to 1997 (2.5-2.4), when the number of deaths was the highest. At the same time, the incidence rate remains stable during 1992-1995. (64.4 -67.1 per 100 000 people), which is explained by a decrease in diagnostic measures to detect cases of TB. From 1996 to 1998 there is an increase in the incidence of 1.5 times (82.5-118.8 per 100 000 people), the annual growth rate was 38%. The prevalence rate increased by 34.4%, the scale of the indicator was 268 - 379.6 per 100 000 people, and the annual growth rate was 5.7%. The ratio of prevalence and incidence averaged 4 (range 3.2 - 4.5 years). The growth of epidemiological indicators to TB occurred against the background of destabilization of the TB service: poor funding, lack of anti-TB drugs, reduced detection of cases, and an uncontrolled increase in TB mortality. During this period, there was a strong positive correlation between morbidity and mortality (r = 0.84), between prevalence and morbidity (r = 0.97). There is a 2.5-fold increase in mortality (a range of 9.2-38 per 100 000 people) with an annual growth rate of 24.8%; incidence of 61.6% (range 45.5 - 95.8 per 100 000 people) with an annual growth rate of 10.3% and prevalence of 38.1% (range 247.4 - 388.3 per 100 000 people) with an annual growth rate 6, 4% in Almaty region. The ratio of morbidity and mortality was 3.9 on average (1.5-6.4). The worst TB situation was noted in 1996, when the death rate was 38 per 100 000 people, and the ratio of the sick, of the dead was 1.5. The ratio of prevalence and incidence averaged 4.8 (range 4.1-5.4 years). During the socioeconomic crisis, there was a weak positive correlation between the incidence and mortality rates (r = 0.25) and a strong positive relationship between the prevalence and incidence rates (r = 0.97). There is a 2.5-fold increase in the death rate (11-27.5 per 100 000 people) with an annual growth rate of 25%; an increase in the incidence rate of 1.6 times (range 50 - 78.7 per 100 000 people) with an annual growth rate of 9.6% in Almaty. The ratio of morbidity and mortality averaged 3.4 (range 2.6-4.5). During this period, there was a 1.4-fold increase in the prevalence rate (range 164.3 - 228.6 per 100 000 people) with an annual growth rate of 5.9%. The ratio of prevalence and incidence averaged 3.1 (range 2.9-3.4 years). A strong positive relationship between morbidity and mortality (r = 0.91) and between prevalence and morbidity (r = 0.97) was determined. The increase in deaths from TB is associated with an increase in the number of persons with newly diagnosed forms and individuals with active forms of TB. The sharp deterioration of the situation on TB in Kazakhstan caused

the introduction of the DOTS strategy recommended by WHO to countries with a severe situation of TB in October 1998.

The fourth observation period (1999–2004) is related to the activity of TB service and implementation of the DOTS strategy. The period is characterized by a further increase in the incidence in Kazakhstan by 29.9% (range 141 - 165.1 per 100 000 people) with an annual growth rate of 5%. The increase in incidence is associated with a significant increase in the efficiency of detecting cases of TB by microscopy of sputum smears and other methods (mainly by X-ray), which is confirmed by the proportion of new cases with a positive smear in 1/3 and 2/3 with a negative smear of sputum. In 2002 - 2003 the highest incidence rates are observed (165.1 - 160.4 per 100 000 people). At the same time, the mortality rate decreased by 1.9 times (range 20.6 - 38.8 per 100 000 people) with an annual rate of decline of 7.7%. The ratio of morbidity and mortality in this period was 5.9 on average(3.1–7.5). The prevalence rate increased by 18.4% (range 323 - 449.5 per 100 000 people) with an annual growth rate of 5%. The ratio of prevalence and incidence rates was 2.6 on average (range 2.1–3.2 years). There was a strong negative correlation between mortality and morbidity in Kazakhstan (r = -0.93) and a weak negative relationship between prevalence and morbidity (r = 0.34). There is a decrease in mortality by 2.6 times (the range of8.9 - 22.9 per 100 000 people) with an annual rate of decline of 10.2%; a decrease in incidence of 13.7%(range 95.8 - 123.1 per 100 000 people) with an annual rate of decline of 2.3% in the Almaty region. The ratio of morbidity and mortality averaged 8.4 (range 4.2–12.3). During this period, there was a decrease in the prevalence of 14.8% (range 242 - 388.3 per 100 000 people) with an annual rate of decline of 2.5%. The ratio of prevalence and incidence averaged 2.7 (range 2 - 4.1 years).The negative correlation between the incidence and mortality rates (r = -0.54) and the weak negative correlation between the prevalence and incidence rates (r = –0.19) were determined. There was a 1.6-fold decrease in mortality (12-27.5 per100 000 people) with an annual decline rate of 6.3%; a decrease in the incidence rate of 11.2% (range 67.9 -78.7 per 100 000 people) with an annual decline rate of 1.9% and a decrease in prevalence rate of 12.8% (range 133.8 - 228.6 per 100 000 people) with an annual rate of decline of 2.1%. The ratio of morbidity and mortality over the entire period was 4.3 (range 2.9-5.7), while the ratio of prevalence rates was 2.5 (range 1.9-2.9 years) in the Almaty. There was a strong positive correlationbet ween mortality and morbidity rates (r = 0.94) and a strong negative relationship between prevalence and morbidity (r = -0.73). A significant reduction in mortality is accompanied by a relatively moderate decrease in morbidity and prevalence.

The fifth observation period (2005–2009) is characterized by a further decrease in epidemiological indicators in Kazakhstan. There was a decrease in mortality by 1.6 times (span 12.9 - 20.8 per 100 000 people) with an annual rate of decline of 7.5%; am 1.5-fold decrease in the incidence (105.3 - 154.3 per 100 000 people) with an annual decrease rate of 6.4%.The ratio of morbidity and mortality was 7.3 (range 6.5–8.2), which was the most favorable ratio in Kazakhstan. The present observation period is comparable in intensity of morbidity and mortality with the Soviet period (1973 - 1985). During this period, a decrease in prevalence of 2.5 times (a range of 180 - 449.5 per 100 000 people) with an annual rate of decline of 12% was determined. The ratio of prevalence and morbidity averaged 2.5 (the range of 1.6-3.2 years), which is largely associated with organizational approaches to the definitions and duration of observation of dispensary groups. A strong positive correlation was determined between morbidity and mortality (r = 0.84) and between prevalence and morbidity (r = 0.81).

In the Almaty region, there was a decrease in the incidence rate of 16.5% (a range of 90.9 - 113.7 per 100 000 people) with an annual rate of decline of 3.3% and a mortality rate of 1.8 times (range of 4.9-10, 1 per 100 000 people) with an annual rate of decline of 9%. The ratio of morbidity and mortality averaged 13.5) range 11.5 - 18.6).During this period, there was a decrease in the prevalence of 2.9 times (range 113.3 - 350.2 per 100 000 people) with an annual rate of decline of 13.1%. The ratio of the prevalence of incidence averaged 2.4 (range 1.2 - 3.3 years). A strong positive correlation was found between the incidence and mortality rates (r = 0.73) and the average strength; the positive correlation relationship between the prevalence and incidence rates (r = 0.65).Until 2006, in Almaty, there was adecrease of 6.7% (span 65.2 - 65.2 per 100 000 people) with an annual decline rate of 3.4%, since 2007 an increase in the incidence rate has been determined by 15% with an annual growth rate / decrease of 5%.During this period, there was a further decrease in the death rate, which decreased by 2.1 times (range 8-17.1 per 100 000 people) with an annual rate of decline of 10.6%. The ratio of morbidity and mortality averaged

8.6 (4.1 - 24). A 2-fold decrease in prevalence (97.9 - 199.4 per 100 000 people) with an annual decline rate of 10.2% was determined. The ratio of prevalence and incidence averaged 2 years (range 0.5 - 2.9 years). The negative correlation between the incidence and mortality rates (r = –0.49) and the strong negative relationship between the prevalence and incidence rates (r = –0.84) were determined. The data of the correlation analysis demonstrate the disconnection between the intensive indicators, which, possibly, is connected with the change in the conditions of registration and observation in dispensary contingents; and what is important with the correctness of the data obtained.

Consequently, the analysis of TB epidemiological patterns of traditional assessment of epidemiological indicators for TB and correlation analysis of a relationship between morbidity and mortality and prevalence with morbidity at different periods of time revealed certain trends associated with complexes of determinants as socioeconomic factors, Health System measures and the effectiveness of TB programs.

The Soviet period of observation characterized by a decreasing of mortality, incidence and prevalence rates in the country and regions, and had the presence of a strong positive correlation between epidemiological indicators that is associated with an effective TB control program. The then existing program had broad objectives for prevention, diagnostics, treatment and survey over TB patients that was developed against the background of socioeconomicstability. During the anti-alcohol campaign registers a further decrease in intensive indicators and a weak correlation between morbidity and mortality rates, which shows the impact of other factors on the epidemiology of TB, namely the improvement in the overall health of people associated with a sharp decrease in alcohol consumption across the country.

The period of socioeconomic crisis and restructuring against the background of deteriorating socioeconomic conditions and the collapse of the health care system, including the TB service, marked the development of a TB epidemic in the country in terms of intensive morbidity, prevalence and mortality rates and the presence of a positive relationship between indicators at the national, regional and metropolis. The DOTS strategy implementation period was marked by a significant decrease in TB mortality (in Kazakhstan by 1.9 times, in Almaty oblast/region by 2.6 times and in Almaty city by 1.6 times), a slight decrease in prevalence (14.8%, 14.6% and 12.8%, respectively) against the background of an increase in the incidence in Kazakhstan and Almaty region (29.9%, 13.7%) and a decrease in Almaty (11.2%). This situation follows the objectives of the DOTS program the detection at least 70% of TB cases and cure 85% of these cases. At the same time, a decrease in TB mortality associated with effective treatment does not correlate with an increase in the number of new cases of TB, due to an increase in the recorded incidence. During this period, there was a negative correlation between the indicators in Kazakhstan (r = -0.93) and the average power in the Almaty region (r = -0.54). The strong positive correlation between morbidity and mortality in Almaty (r = 0.91) reflects the features of registering new cases and deaths. The same tendency is typical for the correlation analysis of the relationship between prevalence and incidence rates: weak positive in Kazakhstan, weak negative in Almaty region and strong negative relationship in Almaty (r = 0.34, r = -0.19, r = - 0, 73).

The period from 2005 to 2009 is characterized by the most favorable situation for TB; the country for the first time approached the epidemic threshold in terms of incidence of 105.3 per 100 000 people. There was a decrease in all major indicators of TB, especially the prevalence and mortality rate of more than 2 times in the country, in the Almaty region and in Almaty city; and morbidity in Kazakhstan by 1.5 times, by 16.5% in Almaty oblast. In Almaty, the trend of increasing incidence (+ 7.9%) continues. In this period, a statistically significant relationship was established between morbidity and mortality rates, prevalence and morbidity in Kazakhstan and Almaty oblast and the lack of communication in Almaty, which demonstrates a somewhat special approach to registering cases of disease and death. The informativeness of data in Almaty requires monitoring of the tasks of identifying and determining lethal outcomes.

Thus, the TB epidemiological pattern depends on the impact of many factors of the bio-social environment, which have a negative or positive impact to the epidemiology of TB. Determining the real situation on TB is as important as evaluating the effectiveness of the TB program, identifying priorities and planning for TB measures. New approaches to analytical epidemiology to assess the situation of TB and the effectiveness of anti-epidemic measures are necessary to determine the reliability of intensive indicators and to improve prompt response to them.

Ф. А. Искакова[1], М. М. Аденов[2], Л. Т. Ералиева[2], Г. Тоқта[3]

[1]LCC Ж. Асфендияров атындағы Қазақ ұлттық медициналық университеті, Алматы, Қазақстан,
[2]Қазақстан Республикасы Денсаулық сақтау министрлігінің
Фтизиопульмонология ұлттық ғылыми орталығы, Қазақстан,
[3]Моңғолия Денсаулық сақтау министрлігі, Моңғолия

ТУБЕРКУЛЕЗГЕ ҚАРСЫ ЭПИДЕМИОЛОГИЯЛЫҚ ДЕРЕКТЕРДІҢ АУЫТҚУЫ

Абстракт.

Алғышарттар. Туберкулез (ТБ) әлемінде өлім-жітімнің 10 жетекші себептерінің бірі және біржұқпалы агент болған кезде негізгі себеп болып табылады. Жылсайын миллиондаған туберкулезбен науқастар анықталады. 2017 жылы індетін жұқтырғандар арасында 1,1 өлім (1,2-1,4 миллион диапазонда) және 300 мыңадам (266 000-335 000 диапазонында) өлімге әкелді. Пациенттерді диагностикалауда, емдеу және күтуді қамтитын Халықаралық туберкулезге қарсы бағдарламаның арқасында туберездің ауыртпалығы жоғары ауру мен өлімжітіммен Азия, Африка және Еуропа елдерінде 30-ға жуық жерде орналасқан.

Әдістері: Қазақстанда, Алматы облысында және Алматыда туберкулезбен ауыратындарды бағалау, елде, облыста және қала деңгейінде науқастану, таралу және өлім жағдайында туберкулезге қарсы бағдарлама. ТБ эпидемиологиялық жағдайын талдау негізгі детерминанттармен бағаланған уақыт кезеңіне қарай аймақтық және ұлттық деңгейлерде Pearson корреляция коэффициентін қолдану арқылы жүргізілді.

Нәтижелер: Нәтижелер детерминанттар мен туберкулездің эпидемиологиялық көрсеткіштерінің динамикасын, мысалы, өлім-жітім, ауру-сырқау және байқау салаларында таралуы сияқты қатынастарды көрсетті.

Қорытынды: Туберкулездің эпидемиологиялық жағдайына және эпидемиологиясына теріс немесе жағымсыз әсер ететін көптеген факторлар бар. Нақты жағдайды анықтау туберкулездің тиімділігін бағалау, туберкулезбен күрестің басымдықтарын және жоспарлау шараларын анықтау үшін маңызды.

Түйін сөздер: туберкулез, өлім-жітім, науқастанудеңгейі, таралуы, Pearsonкоэффициенті, DOTS стратегиясы, ДДҰ.

Ф. А. Искакова[1], М. М. Аденов[2], Л. Т. Ералиева[2], Г. Цогт[3]

[1]LCC Казахский национальный медицинский университет им. С. Д. Асфендиярова, Алматы, Казахстан,
[2]Национальный научный центр фтизиопульмонологии МЗ РК, Казахстан,
[3]Министерство Здравоохранения Монголии, Монголия

КОРРЕЛЯЦИОННЫЙ АНАЛИЗ ЭПИДЕМИОЛОГИЧЕСКИХ ДАННЫХ В ОЦЕНКЕ СИТУАЦИИ ТУБЕРКУЛЕЗА И ЭФФЕКТИВНОСТИ ПРОГРАММЫ БОРЬБЫ С ТУБЕРКУЛЕЗОМ В СОВРЕМЕННЫХ УСЛОВИЯХ

Абстракт.

Предпосылки. В мире туберкулез (ТБ) является одной из 10 основных причин смерти и основной причиной при наличии одного инфекционного агента. Ежегодно выявляются миллионы больных ТБ. В 2017 году ТБ стал причиной 1,3 смертей (в диапазоне 1,2–1,4 миллиона) среди ВИЧ-отрицательных людей, и 300 000 смертей (в диапазоне 266 000–335 000) среди ВИЧ-позитивных людей. Благодаря Международной программе борьбы с ТБ, включающей диагностику, лечение и уход за больными, бремя ТБ локализовано в 30 странах Азии, Африки и Европы с высоким уровнем заболеваемости и смертности.

Методы: оценка бремени ТБ в Казахстане, Алматинской области и г. Алматы, программа контроля ТБ по показателям заболеваемости, распространенности и смертности на уровне страны, области и города. Был проведен анализ эпидемиологической ситуации по ТБ с использованием коэффициента корреляции Пирсона на региональном и национальном уровнях в зависимости от периода времени, оцененного по основным детерминантам.

Результаты: Результаты показали взаимосвязь между детерминантами и динамикой эпидемиологических показателей туберкулеза, таких как смертность, заболеваемость и распространенность в областях наблюдения.

Заключение. Эпидемиологическая ситуация по ТБ зависит от воздействия многих факторов биосоциальной среды, которые оказывают негативное или положительное влияние на эпидемиологию туберкулеза. Определение реальной ситуации важно для оценки эффективности противотуберкулезной программы, определения приоритетов и планирования мер по борьбе с туберкулезом.

Ключевые слова: туберкулез, уровень смертности, уровень заболеваемости, коэффициент распространенности, коэффициент Пирсона, стратегия DOTS, ВОЗ.

Information about authors:

Iskakova Farida, MD, PhD, associate professor, LC National Medical University, Almaty, Kazakhstan; iskakova.f@kaznmu.kz; https://orcid.org/0000-0003-2988-7816

Adenov Malik, MD, PhD, National Scientific Center of phthisiopulmonology MOH RK, Kazakhstan; madenov@mail.ru; https://orcid.org/0000-0002-0994-2569

Yeraliyeva Lyazzat, MD, DMedSci, professor Deputy director of clinical and scientific work "National Scientific center of phthisiopulmonology MON RK", Kazakhstan; l.yeraliyeva@gmail.com; https://orcid.org/0000-0002-0892-166X

Tsogt G., Senior TB specialist, Ministry of Health, Mongolia; gombogoram@yahoo.com

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A. V. Balmukhanova[1], G. D. Seitkazina[2], Zh. K. Chingissova[2]

[1]Asfendiyarov Kazakh national medical university, Almaty, Kazakhstan,
[2]Kazakh Institute of Oncology and Radiology, Almaty, Kazakhstan.
E-mail: bav_med@mail.ru; g.seitkazina@mail.ru; zh.chingissova@mail.ru;

THE INCIDENCE AND PREVALENCE OF UVEAL MELANOMA IN THE REPUBLIC OF KAZAKHSTAN

Abstract. Uveal melanoma is the most common intraocular tumor, which threatens not only to the eyesight, but the patient life as well. In spite of this, uveal melanoma is rare and the portion of uveal melanoma is small (3.7%) in the structure of general oncopathology, it occurs in 75-94% among malignant intraocular neoplasms.

In this study we obtained the results on the frequency and prevalence of uveal melanomas in the Republic of Kazakhstan.

Thus, the incidence of uveal melanoma in Kazakhstan on average over the study period was $0{,}16^{0}/_{0000}$, and morbidity trends to increase. Women prevailed in 1.6 times the number of men. The incidence rates of the urban population remain stable, while the incidence rate of the rural population is increasing. The incidence of uveal melanomas among people of Asian nationality has doubled, and among European ethnic groups this indicator has remained stable and quite high over the past 5 years. Trends in the incidence of spindle-cell type melanoma in the second five-year period have significantly decreased in 2 times; however, the more aggressive forms (epithelioid and mixed cell) tend to increase.

Key words: uveal melanoma, intraocular tumors, morbidity trends, frequency, prevalence, oncoepidemiology.

Introduction. Over the last years the increasing trend of ocular melanoma is observed. According to the world data, the rate of patients with ocular neoplasms seeking medical assistance accounts for 110-120 people per 1 000000 population every year [1-3].

Intra ocular tumors account for up to 30% of all eye neoplasms.

Uveal melanoma is the most frequently occurring intraocular tumor threatening not only to eyesight but alsoto the life of the patient. Despite the fact that uveal melanoma is quite rare and its share in the overall oncopathology is insignificant (3,7%), it represents75% - 94%of all malignant eye neoplasms, while the part of this tumor in the death rate from metastasis in all types of cancer is 15% [4-6].

The relevancy of choroidal melanoma is defined by a high relative density of this pathology in the structure of primary intraocular neoplasms (80-90%) [3, 7, 8].

Annual incidence of choroidal melanoma in different parts of the world comprises 7-12 people per 1 million population [1]. However, according to other authors, the total rate of choroidal melanoma around the world varies between 2 to 10 people per 1 million population [1, 9-11].

According to Pane A.R., the annual rate of disease in the USA and Europe is 4-6 people per 1 million population. In Russia, the rate of uveal melanoma based on patient applications in different regions varies from 6,23 to 8 people per 1 million adult population [9, 12]. According to Buiko A.S. and Vit V.V., the rate of patient applications for uveal melanoma in Ukraine accounts for about 3,2 people per 1 million population [13]. In the Republic Belarus, in the last decade, the incidence of uveal melanoma is 7-8 people per 1 million adult population (70-90 people annually) [14]. In Central Asia, the rate was considerably lower (2 persons per 1 million population) [1, 15]. In Tajikistan, the rate of ocular melanoma is 0,08 per 100 thousand population [20]. On average in the USA [16], Russia [17], Beloruss [18] and Kazakhstan [19, 20] an ocular melanoma occurs with incidence of 6 cases per 1 million people, while skin melanoma occurs more frequently and comprises 153,5 cases per 1 million [21, 22].

All of the above necessitates the study of incidence and prevalence of uveal melanoma in the last decades in the Republic of Kazakhstan.

The purpose of this search was the study of incidence and prevalence of uveal melanoma in the Republic of Kazakhstan.

The material is based on the data of 259 patients with uveal melanoma for 2006-2015, which were on hospital treatment in Kazakh Scientific Research Institute of Eye Diseases and Kazakh Institute of Oncology and Radiology (verified diagnosis).The main method in study in of uveal melanoma was a retrospective study with descriptive and analytical methods in contemporary oncoepidemiology. The extensive and intensive morbidity rates were defined by generally accepted methodology in modern statistics. The morbidity trends were defined by the method of the least quadrant method (y=a+bx).We used average intensive morbidity rates for 10 years (2006-2015) to make a map of the prevalence of uveal melanoma.

Methods. For the period in study (2006 - 2015) 259 cases of uveal melanoma are registered in the Republic. There were 100 (38,6 ± 5,0%) men and 159 (61,4 ± 4,0%) women. The number of women was 1.6 times higher than men, and 95% amplitude of relative density of the patients does not overlap, the differences are statistically significant (t=4,03; p<0,001).Therefore, the factors affecting occurrence of malignant eye tumors are not ambiguous. Average intensive morbidity rates for uveal melanomas of both genders of Kazakhstan population for the study period (since 2006 to 2015) are $0,16^{0}/_{0000}$, i.e. 1,6 per 1 million population and the morbidity rate has a trend for increase. Intensive morbidity rates for uveal melanoma depending on gender show that annual rate for men is $0,13^{0}/_{0000}$, and for women is $0,19^{0}/_{0000}$. That being said, the rate for men is decreasing, while rate for women has a tendency for growth. Such changes in trends of uveal melanoma confirm once again that female morbidity rates for these forms of tumors are comparably higher than male ones, have a tendency for growth in dynamics, especially for the last 5 years.

Territorial prevalence of the patients revealed that the share of urban residents was 54,1 ± 4,2% (140 patients) and rural – 45,9 ± 4,6% (119 patients), and 95% amplitude of relative density of patients between urban and ruralresidentsintersect and the statistical differences are insignificant (t=1,32; p>0,05). Annual mean of intensive morbidity rates for uveal melanoma in urban residents for the last 10 years are $0,143\ ^{0}/_{0000}$, in rural – $0,171\ ^{0}/_{0000}$. That being said, morbidity rate in urban residents has a tendency for slight decrease, these trends are insignificant and remain stable for the study period, while rural morbidity rate has a growing tendency, and its growth is quite significant.

The share of patients with uveal melanoma in Asian population equals 9,3 ± 1,84% (24 patients), European – 90,7±1,9% (233 patients), statistical differences are significant (t=3,07; p<0,001), and 95% amplitude of relative density of patientsin the specified ethnic groups does not overlap. Therefore, the factors affecting occurrence of malignant pigment eye neoplasm are different. The morbidity rates for uveal melanoma in Asians have increased from $0,03\pm0,02^{0}/_{0000}$in 2006to $0,06\pm0,03^{0}/_{0000}$ in 2015, while in European ethnic groups this indicator remains stable and high ($0,51\pm0,11^{0}/_{0000}$) in the last 5 years (2011-2015), and the differences are statistically significant (t=3,75; p<0,01).

Annual mean of intensive morbidity rates for uveal melanoma of spindle cell type is $0,06\pm0,06^{0}/_{0000}$, epithelium cell type – $0,05\pm0,05^{0}/_{0000}$ and mixed cell type – $0,05\pm0,02^{0}/_{0000}$. Moreover, the rate for spindle cell type have decreased double in the last five years, while epithelium cell typeand mixed cell typehave a tendency for growth.

Annual mean of grouped prevalence of patients with malignant ocular melanoma by degree of process development has been presented as follows. The number of registered patients with ocular melanoma in periods (2006-2010 and 2011-2015) is relatively similar, 133 (51,4%) and 126 (48,6%) patients respectively, however, advanced forms of the stage IV ocular melanoma in the second 5–year period (19,1%) was almost 4 times higher than in the first 5-year period (5,2%). In overall, the share of advanced forms of tumor of vascular tract for the period in study was 12,0%. At the same time, the relative density of tumor in the I stage was only 9,2%. The majority of patients with malignant ocular pigment tumors were in stages II (41,3%) and III (37,5%), and the share of these patients in the last 5 years had a tendency for decrease. That being said, patients with early stages of uveal tract tumor (I–II stages) accounted for 50,5%, while the rest had stages III – IV of tumor process.

The epidemiological research of prevalence of uveal melanoma on the territory of Republic Kazakhstan for 10 years (since 2006 to2015) revealed that the incidence of the studied malignant pigment ocular tumors has its peculiarities, which are characterized by the fact that extensive and intensive as well as aligned rates of morbidity vary depending on gender, ethnic composition of population, cell type, as well as place of residency of patients. Rank-abundant prevalence of stages of malignant tumor of eye vascular tract were also revealed. Itwasidentifiedthatthe share of patients with early stages of tumor (I-II) is still low, the relative density of advanced stages in the last 5 years has a tendency for growth.

The uveal melanoma prevalence map was designed for separate regions of Kazakhstan.We recalculated incidence rates by estimation of the average annual indicators for 10 years.

In compiling cartograms of prevalence of intraocular melanomas, we used the mapping method suggested by S. I. Igissinov, based on the determination of the standard square deviation from the average level of incidence rates, which clearly gives the distribution of the incidence rate on a scale of cartograms of the prevalence of different forms of cancer. The morbidity stage scale clearly defines the level of disease as low, medium and high.

Prevalence map of ocular melanoma in regions of Republic Kazakhstan for 100000 population (2006-2015)

No	Morbidity level	Morbidity scale	City & Regions
1	Low	Up to 0,07	Aktobe (0.013) South Kazakhstan (0.02) Mangystau (0.032) Kyzylorda (0.049) Atyrau (0.067)
2	Middle	0,07-0,1	Karaganda (0.072) West Kazakhstan (0.076) Zhambyl (0.087) North Kazakhstan (0.091) Pavlodar (0.101)
3	High	Over 0,1	Akmola (0.141) Kostanay (0.219) East Kazakhstan (0.245) Astana (0.47) Almaty (0.616) Almaty region (0.645)

Hence, the designed uveal melanoma prevalence map enables to define space-time prevalence of the disease in separate administrative territorial regions of Kazakhstan, which must be considered in development of programs for oncological assistance to population, setting-up of anti-cancer activities in separate regions of the Republic.

Conclusion. The morbidity rate for uveal melanoma of both genders of population of Kazakhstan in average for the period in study was accounted for $0{,}16^{0}/_{0000}$, i.e. 1,6per 1 million population, and the trend has a tendency for growth. With that, thenumberofwomenwas1,6 higher than men, which can be explained by the impact of female endocrine profile on formation of pigment neoplasms. The male morbidity trends are decreasing; while female have a tendency for growth. The morbidity rates in urban population have a tendency for a slight decrease, these trends are insignificant and remain stable, while the same rate for rural population is growing, and its growth is significant. The rate of morbidity among Asians have doubled, and among Europeans this rate remains stable and relatively high $0{,}51\pm0{,}11\ ^{0}/_{0000}$ within the last 5 years. The rate of morbidity in spindle cell types of melanoma in the second 5-year period have decreased double, however, the more aggressive form types (epithelium cell typeand mixed cell type) have a trend for growth.

The highest rates of uveal melanoma prevalence defined by the morbidity scale are in Almaty region, Almaty city, Astana city, which isprobably connected with availability of advanced diagnostics during screening examinations, as well as oncological awareness of ophthalmologists.

А. В. Балмуханова[1], Г. Д. Сейтказина[2], Ж. К. Чингисова[2]

[1]С. Ж. Асфендияров атындағы Қазақ ұлттық медицина университеті, Алматы, Қазақстан,
[2]Қазақ онкология және радиология ғылыми-зерттеу институты, Алматы, Қазақстан

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНДА УВЕАЛЬДІ МЕЛАНОМАНЫҢ ЖИІЛІГІ МЕН ТАРАЛУЫ

Аннотация. Увеальді меланомасы – ең көп кездесетін көз іші ісігі, бұл тек көру мүшелеріне қауіп төндірмей қоймай, сонымен бірге науқастың өміріне қауіп төндіреді. Увеальді меланомасы сирек кездесетініне қарамастан және жалпы онкопатология құрылымында оның үлесі үлкен емес (3,7%), қатерлі ісік аурулары арасында 75-94% жағдайларда кездеседі.

Аталмыш зерттеу жұмыста Қазақстандағы увеальді меланомдардың жиілігі мен таралуы үшін нәтижелер алдық.

Осылайша, Қазақстанда увеальді меланоманың орташа зерттеу кезеңінде орташа есеппен $0{,}16^{0}/_{0000}$, құрады және бұл көрсеткіштің өсу үрдісі байқалады. Сонымен қатар, ерлердің саны бойынша әйелдер 1,6 есе көп болды.Қалалық тұрғындардың сырқаттанушылық деңгейі тұрақты қалпыпта, ал ауыл халқының ауру көрсеткіштері артып келуде. Азиялық ұлт өкілдері арасында увеальді меланомалардың пайда болуы екі есе өсті, ал еуропалық этникалық топтар арасында бұл көрсеткіш соңғы 5 жылда тұрақты және жоғары болып қалды. Екінші бесжылдықта меланоманың шпиндель жасушаларының түріне шалдығу үрдістері 2 есеге азайған, алайда түрінің пішіні (эпителиялы жасуша және аралас жасуша) анағұрлым агрессивті болып келеді.

Увеальді меланом ауруларының таралуы жағынан, ең жоғары көрсеткіш бойынша Алматы облысы, Алматы қаласы және Астана қаласы анықталып отыр, мұндай көрсеткіш болу себебі скринингтік зерттеу әдістері кезінде диагностиканың жақсаруымен, сонымен қатар офтальмолог дәрігерлерінің онкологиялық сақтылықтарының жақсаруымен байланысты.

Түйін сөздер: увеальді меланома, көз іші ісік аурулары, аурудың таралу трендтері, жиілігі, таралуы, онкоэпидемиология.

А. В. Балмуханова[1], Г. Д. Сейтказина[2], Ж. К. Чингисова[2]

[1]Казахский национальный медицинский университет им. С. Д. Асфендиярова, Алматы, Казахстан,
[2]Казахский научно-исследовательский институт Онкологии и Радиологии, Алматы, Казахстан

ЧАСТОТА И РАСПРОСТРАНЕННОСТЬ УВЕАЛЬНЫХ МЕЛАНОМ В РЕСПУБЛИКЕ КАЗАХСТАН

Аннотация. Увеальная меланома – наиболее часто встречающаяся внутриглазная опухоль, представляющая угрозу не только зрению, но и жизни пациента. Несмотря на то, увеальная меланома встречается редко и в структуре общей онкопатологии доля ее невелика (3,7%), среди злокачественных внутриглазных новообразований она встречается в 75-94 % случаев.

В данном исследовании нами получены результаты по частоте и распространенности увеальных меланом по Республике Казахстан.

Так, заболеваемость увеальными меланомами Казахстана в среднем за изучаемый период составили $0{,}16^{0}/_{0000}$, и тренды заболеваемости имеют тенденции к росту. При этом женщин преобладало в 1,6 раза над числом мужчин. Показатели заболеваемости городского населения остаются стойкими, в тоже время показатель заболеваемости сельского населения растет. Заболеваемость увеальными меланомами среди лиц азиатской национальности увеличились в два раза, а среди европейских этнических групп этот показатель остается стабильным и достаточно высоким в течение последних 5 лет. Тренды заболеваемости веретеноклеточного типа меланомы во втором пятилетии значительно уменьшились в 2 раза, однако, более агрессивные по типу формы (эпителиоидноклеточный и смешанноклеточный) имеют тенденцию к увеличению.

По распространенности увеальными меланомами заболеваемость определяется как наиболее высокая в Алматинской области, г.Алматы, г.Астане, что вероятно связано с улучшением диагностики при скрининговых методах обследования, а также онкологической настороженностью врачей офтальмологов.

Ключевые слова: увеальная меланома, внутриглазные опухоли, тренды заболеваемости, частота, распространенность, онкоэпидемиология.

Information about authors:

Balmukhanova Aigul, Asfendiyarov Kazakh national medical university, Almaty, Kazakhstan; bav_med@mail.ru; https://orcid.org/0000-0002-2593-629X

Gaziza Seitkazina, Kazakh Institute of Oncology and Radiology, Almaty, Kazakhstan; g.seitkazina@mail.ru; https://orcid.org/0000-0002-2905-5692

Chingissova Zhanna, Kazakh Institute of Oncology and Radiology, Almaty, Kazakhstan; zh.chingissova@mail.ru; https://orcid.org/0000-0003-1884-0166

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N. A. Abilkayir

Higher School of Public Health, Almaty, Kazakhstan.
E-mail: abilkaiyr.nazerke@gmail.com

POPULATION HEALTH AS A MAJOR FACTOR OF QUALITY OF LIFE

Abstract. The article examines the category of quality of life of the population from the public health point of view. The criteria for evaluation and characteristics of the analysis of quality of life associated with health at the individual and social levels are considered. Existing methods for measuring health indicators as a factor in quality of life are studied An integral indicator of health qualities was compiled based on the hierarchy of the system model for assessing the quality of public health. The model of assessment proposed by the authors takes into account all main factors influencing the quality of health and their interrelation and can be applied at regional or state levels, where institutional and external factors affecting public health play a large role. The indicators of the state of health of the Kazakhstan population in comparison with the countries of the same standards of living were analyzed. In this paper, special attention is paid to the influence of the environment on public health. The high level of environmental pollution in Almaty was noted compared with the world leaders in pollution. The development of health care in order to improve the quality of life of the population indicated the need to support educational and research institutions in the medical field.

Key words: quality of life of the population, health, healthcare, life expectancy.

Introduction. Improvement of the quality of life and public healthcare are one of the most topical tasks of the social and economic policy of the Republic of Kazakhstan. During the past ten years, Kazakhstan has made a lot of steps toward enhancing the effectiveness of the national healthcare system described in the National Program of healthcare system reforming and development "Salamatty Kazakhstan" for 2011 – 2015, and in the National Program of the Republic of Kazakhstan on the health care system development "Densayulyk" for 2016 – 2019 that were to bring the national healthcare system to the next qualitatively new level.

As a result of the taken steps implementation the expected lifetime in Kazakhstan increased, but the issues of the healthcare improvement remain open. The solution of the existing issues of the healthcare requires an integrated analysis of factors affecting the population health to form on this base a scientifically justified regional model of the healthcare system management model. The further development of the theory and methodology of population health state investigation is topical in view of the living standards improvement.

Methods and materials. During the investigation the methods of abstract and logical analysis, comparative method were applied. The information bases for the investigation were monograph researches of foreign authors, data by the Committee on Statistics of the MNE RK, ratings of the international organizations.

Results and discussion. The most of researchers investigating the quality of life topic agree that there is no unique definition for this notion, as well as there is no united methodology for its definition. Quality of life is a complex notion studied by sociology, economy, psychology, and medicine. In this regard, some western scientists in the field of psychology assume that the closest definition to "quality of life" is "happiness"; this kind of comparison can be found in works by M. Argyle (The Psychology of Happiness), I. Dzhidaryan (Imagination of happiness in Russian mentality), E. Diener and R. Emmons (On the independence of positive and negative affect). However, in scientific context the notion of happiness does not have a clear definition and, thus, does not facilitate the task of quality of life definition

search. At the same time, some scientists believe that the quality of life means a degree of human needs satisfaction. This can be found in the work by S. Bazhenov and N. Malikov: "the human needs are considered as inner reason of his life activity", and quality of life is determined as "a level and degree of satisfaction of the whole complex of needs and interests of people" [1].

Conditionally, the quality of life can be divided into several levels constituting the life activity [2]:

- Quality of life on the level of survival allows the population to satisfy the most necessary physiological needs only; the society and the State help in receiving the minimum social guarantees and services.
- Quality of life on the base level allows satisfying all physiological needs, and providing spiritual and intellectual demands of some groups of the population.
- Quality of life on the high level satisfies the whole diversity of needs, the high level of material welfare is observed, within the support of integrity of the city system there is enough leisure time for creative and spiritual growth, the conditions for enhancing the educational level of cultural growth are provided.

A lot of factors are engaged to cover the needs of each level, among them the state of health is one of the most important.

The first monograph in Russian that suggested the bases of the life quality investigation methodology for the medicine in view of the healthcare was published in 1999 [3]. One of the main ideas of this concept is that for the evaluation of the quality of life, an objective criterion that includes at least four constituents of a human health is needed: physical, psychological, social, and spiritual. The most popular definition of health in the context of the quality of life is the definition given by the World Health Organization (WHO): "Health is a state of complete physical, social and psychological welfare of a human, not absence of disease" [4].

The contemporary medicine and social sciences also apply a term ""the quality of life related to health" that was suggested for the first time in 1982. It is understood on two levels:

- On the individual level the term means apprehension of physical and mental health (mood, level of energy) by a person. This level also covers risks to health, life conditions, social support, and social and economic status of a person influencing on individual apprehension.
- On the social level the term means all public resources, institutes, and conditions of life influencing on public health.

The health as a factor of the life quality is closely connected with definition of disease and issues of its treatment [5]. The quality of life becomes the main purpose of disease treatment not limiting the life duration, and additional – if a disease limits the length of life, and the one – for incurables. The contemporary concept of the life quality in view of the healthcare includes three main constituents:

1. multidimensionality – the quality of life bears the information on all main fields of human life and activities, and this also includes the state of its health. In its turn, the state of health is also interconnected with all aspects of the life quality;
2. variability in time – data on the life quality change depending on a human state of health;
3. person contribution into estimation of his own state – i.e. the quality of life is estimated by a specialist, and a respondent. The same is for the health.

The importance of introducing and investigation of issues connected with a term "quality of life related to health" is determined by the necessity to fill the gaps in interdisciplinary researches of the life quality.

The medical interpretation of the notion "quality of life related to health" influenced on its interpretation on social sciences. The interconnection of satisfaction with life value (social) and health is explained by such theories as a theory of capital (social and human), a theory of social status (health as an indicator of social status, and estimation of life quality through it), a theory of inequality and social equity. According to the definition of health, the WHO determines the quality of life as person's individual estimation of his status in the society life, in the context of his culture, system of values, with his goals, plans, opportunities, and degree of disorder [6].

This diversity of explaining concepts leads to plenty of methodological approaches to study of life quality related to health. For instance, the Russian researcher I. Nazarova provides an example of researches by the Institute of Social and Economic Issues of Human Population of RAS. The qualitative state of population was "represented in terms of potentials of such important properties of a human as health

(physical, psychological, social), education and qualification (intellectual level), culture and morality (social activity). The special attention is paid to measurement of labor ability (labor potential)" [7]. It should be noted that in medicine the factors related to labor ability of a human are also the main in estimations of social, medical, and economic efficiency of the healthcare.

The Center for Disease Control and Prevention of the United States Department of Health and Human Services applies the questionnaire method for assessment of the life quality related to health. The standard questionnaire consists of 14 questions the answer to which the respondents have to give during some period. The questions are divided into three large modules: Healthy Days Core Module, Activity Limitations Module, Healthy Days Symptoms Module. The respondents have to keep a calendar where they mark healthy days, physical and emotional disturbance days, and symptoms days not followed by a disease. Basing on the observations during some time (one, three, six months) the statistics bulletin is made; it allows measuring the quality of population health, and determining main health problems and its influence on estimation of the life quality given by the respondents.

The Russian researchers B. Ilyasov, V. Martynov, I. Gerasimova, Ye. Makarova, Ye. Zakiyeva have developed a systematic hierarchy model of population health quality estimation. The main assumption of the model is that the health as an indicator of the life quality is structurally complex, hierarchically arranged indicator. For its measurement and estimation it is necessary to determine its components and relations between them (table 1).

Table 1 – The hierarchy of the system model of the population health quality estimation

Rank	Indicator name								
1	Quality of population health								
2	Quality of medical aid			Quality of human environment			Quality of health state		
3	Level of medical personnel qualification	Level of medical facility provision with equip-ment, techno-logies and medicines	Level of available in-patient department	Quality of ecology	Quality of social environ-ment	Quality of life environ-ment	Index of satis-faction with life	Index of psycho-logical health	Index of physical health
Note. Reference [8].									

Basing on this hierarchical structure the authors have deduced an integral indicator of health qualities that can be calculated as weighted sum of its constituent components (system indicators):

$$J = \alpha_1 K_1 + \alpha_2 K_2 + \alpha_3 K_3, \quad (1)$$

where K_1 – quality of medical aid; K_2 – quality of human environment; K_3 – quality of health state; α_1, α_2, α_3 – weighting coefficients characterizing the significance of K_i component and determined by expert way, considering that

$$\sum_{i=1}^{3} \alpha_1 = 1. \quad (2)$$

The model uses the following suppositions:

- The values of weighting coefficients characterizing mutual influence of indicators are set by experts and are not changed.
- The start values of special indicators are also set by experts as the issues of origin statistic data norming within the model are not considered.
- The estimation of integral indicator of health quality under the considered situations does not take into account the dynamics of special and system indicators change.

This method allows working with large massifs of data and considers all main factors influencing on the quality of health and its interrelation. Thus, this method is applicable at regional and national level where the big role belongs to institutional and outside factors influencing on public health.

In Kazakhstan, the index of population life quality is used for estimation of the life quality of population. The conceptual bases of index measuring methods stipulate the measurement of health state [9]. It describes the health state as an important constituent for estimation of life quality together with income level or good work. This indicator includes the following:

- Self-assessment of the health state.
- Length of life.

The indicator of self-assessment of the health state and its satisfaction is formed on the base of statistical observation data. The expected length of population life at birth does not characterize the length of life of one person, but the whole population.

Table 2 – Self-assessment of health state of Kazakhstan population

Year	Degree of satisfaction with health	Share of respondents (%)
2017	Satisfied	47,2
	Partially satisfied	46,8
	Not satisfied	5,8
2018	Satisfied	46,7
	Partially satisfied	48,6
	Not satisfied	4,6
Note. Compiled basing on data from references [10, 11].		

Table 2 shows that the satisfaction of RK population with its health in 2018 changed by several parameters: less of respondents are satisfied with their health completely, and more are satisfied partially. At the same time, the share of respondents unsatisfied with its health decreased.

Table 3 – The expected length of life in the world countries

Country	Expected length of life (years)	
	2010	2016
Armenia	73,3	74,6
Azerbaijan	70,9	72
Belgium	80,2	81
Belarus	70,4	73,8
Canada	81,2	82,3
China	75,2	76,3
Germany	79,9	80,6
Georgia	72,6	73,3
Kazakhstan	68,3	72,3
Kyrgyzstan	69,3	70,9
Russia	68,8	71,6
Turkey	74,1	75,8
Uzbekistan	70	71,3
Upper middle income countries	73,9	75,3
Note. Compiled basing on reference [12].		

Table 3 shows that the expected length of life in Kazakhstan, as of 2016, by data of the World Bank has not reached yet the average indicator for upper middle income countries to which it is related. In addition to these two indicators, the following indicators are not included into the index of life quality, but are used for statistics:

- Satisfaction with services in the field of the healthcare.
- Opinion on problems while visiting the healthcare facilities.

In addition to the indicator related directly to the health state in the method, the quality of environment is also measured. This component also includes two fields:

- Quality of water.
- Level of air pollution.

The quality of water is calculated via percent ratio of people informing on their satisfaction with local water quality. The indicator of air pollution is reflected as average indicator weighted by number of population, and showing the concentration of weighted small particles in air. For the comparison with the world indicators the data of Numbeo organization were taken. The index of air pollution is calculated for cities individually as the situation with air quality in different cities could vary a lot.

Table 4 – Index of environment pollution (air and water) for European and Asia cities in 2018

City, country	Index of air pollution
Chelyabinsk, Russia	89,19
Beijing, China	88,71
Naples, Italy	80,93
Shanghai, China	80,43
Baku, Azerbaijan	79,63
Tbilisi, Georgia	77,04
Almaty, Kazakhstan	76,69
Paris, France	67,71
Moscow, Russia	61,32
London, Great Britain	59,65
Tokyo, Japan	44,65
Note. Compiled basing on reference [13].	

Table 4 shows that the level of environment pollution by indicators affecting the living standards in Almaty is high even comparing to the world leaders on pollution. At the same time, large number of citizens does not lead to high pollution of environment – examples are Tokyo (10 million population), and London (more than 8 million population).

Numbeo also calculates the index of life quality throughout the world, and the constituent of this index is also the healthcare.

Table 5 – Healthcare index of Numbeo for the world countries in 2019

Position in rating by indicator	Country	Value of healthcare index
1	Taiwan	86,22
14	Germany	74,32
23	Canada	70,99
44	China	64,03
52	Latvia	59,71
55	Belarus	58,01
56	Russia	57,63
57	Greece	55,16
64	Georgia	51,29
65	Kazakhstan	51,27
66	Iran	51,18
67	Ukraine	50,95
71	Egypt	44,22
Note. Compiled by data of reference [14].		

Among 71 countries participated in the research, Kazakhstan is ranked 65 on the healthcare index that shows the low satisfaction of population with the health care system services, and arrangement of the health system in whole. At the same time, the highest values of healthcare index belong to the East Asia, after that with some gap are the countries of the Western and Northern Europe.

The goal of any national policy in the field of improving of population life quality is transition to the high level of life quality. For the transition to high standard of life quality in the field of the healthcare it is necessary to achieve several goals:

1. Provision of qualitative treatment. It implies that treatment of diseases will release from diseases at the shortest period and with minimum long-term consequences for patients.

2. Provision of medical and diagnostics services not only for treatment, but timely and maximum complete diagnostics of patients.

3. Provision of sanatorium-resort treatment. Sanatoriums and treatment resorts not only allow treating the diseases, but enhancing the life quality and subjective estimation of life conditions by people due to additional recreation functions.

4. Availability of sport and physical culture facilities, creation of conditions for outdoor activities. This goal is rather preventive aimed at improving of the common level of public health than on treatment of diseases.

To protect the population health it is necessary to conduct systematically the preventive activities, early diagnostics of diseases, treatment and health assessment of population, health-improving and recovery work. The cumulative measures on keeping and strengthening physical and psychological health of society should include economic, social, legal, cultural, scientific, medical aspects as only in its integrity these can have positive influence on country's inhabitants apprehension of individual and public health.

An important aspect is support of city's health departments as s separate field of the State work on improving the quality of life related to health. The importance of the aspect is that cities usually have very dense population, and as consequence there are large risks of diseases appearance and distribution. The establishment of city healthcare must be of a special priority supposing the creation of developed network of medical facilities within a city, equal access of all citizens to these facilities, its material and technical, technological, staffing and medicine support.

The contemporary medicine cannot function in isolation from technical progress – for diseases treatment the advanced scientific and technical developments are used. Therefore, urban authorities shall render all possible support to research and educational establishments having medical departments, as namely these, in future, will be the suppliers of new technologies and methods of treatment, qualified staff, and medicines. Otherwise, the whole medical sphere of a city becomes dependent on presence of foreign medical companies. Even the subsidies into the medical sphere can be considered as investments into improvement of population life quality and, as consequence, enhancement of human capital within a city or a country [15].

In addition to provision of physical health of city or country inhabitants, it is necessary to take into account the quality of spiritual or mental health of population. The modern society unavoidably needs qualitative information society formed by social institutes and education, scientific, and culture establishments. Development and accessibility of these institutes for the population determines the level of spiritual constituent of population life quality related to health.

As for the mental health, here the big role belongs to education system and integrity of psychological health establishments. The education system should teach of critical thinking and information sorting skills to avoid the overload of coming information, and the psychological health establishments should ensure the treatment in situations when the preventive measures did not help.

To facilitate the analysis and development of common policy on enhancing the life quality related to health, it is reasonable to introduce the concept of four human intelligences by Steven Covey [16]. Steven Covey has proposed this concept for more detailed understanding of human intellectual development features in the context of business, but the idea is also applicable for the health field. Each of the intelligence types is responsible for a definite aspect of life connected also to a definite type of health. These four types of intelligences are shown below:

Mental intelligence – is a combination of analytical , cognitive abilities allowing expressing thoughts and making plans. During its functioning the mental intelligence receives information the abundance of which can lead to disorder and overload.

Physical intelligence – ability of organism to self-regulation without conscious control, and ability of a human to understand changes in his body, and respond to disorders in time. This type is associated with physical health.

Emotional intelligence – is ability for safe-knowledge, empathy and ability to communicate with others, and understand the reasons and consequences of own emotional states.

Spiritual intelligence – is ability to create and apply meanings in daily life. Together with emotional intelligence it is responsible for spiritual health of a human; developed spiritual and emotional intelligence allows preventing the development of mental illness if its appearance is not due to physiological reasons.

Basing on this concept, while estimating a human health it is necessary to consider four types of intelligence for more complete analysis of life quality related to health.

Conclusion. Basing on the stated above the following conclusions were made:

- Quality of life is a complex notion studied by a lot of disciplines including medicine. Each discipline considers the quality of life from its point of view. For medicine such point of view is quality of life related to health.
- The quality of life notion related to health creates the interconnections between social sciences and medicine allowing for more complete analysis of health as a factor of population life quality. The term can be considered on individual and social level – each has its own assessment criteria and features of analysis.
- There are different methods of life quality analysis regarding the health; for instance, the American Centre for Disease Control and Prevention uses a special questionnaire and determines the health quality basing on it. A group of Russian scientists, in its turn, has proposed a mathematical model to measure health quality as a factor of life quality based on hierarchy of factors of health quality and its interaction.
- Kazakhstan also uses a lot of indicators to estimate the quality of life, among which there is state of health. By composite indicators Kazakhstan falls behind the countries that have the same living standards, but the lad is not critical. In the international rating of life quality calculated by Numbeo, in the section of healthcare index Kazakhstan is on one of the latest places among the analyzed countries.
- As for the ecological indicators as influencing on public health, Kazakhstan also experiences some difficulties; especially notable are problems of Almaty that is one of the first in the rating of environment pollution among the world largest cities.
- To improve the public health and the quality of life it is proposed to pay attention on urban health care as the most loaded field of the healthcare. Special attention should be paid to support of educational and research establishments in the field of medicine as namely these create a potential for the healthcare development. Otherwise, there will be dependence on foreign technologies and developments.
- It is also necessary to extend the comprehension of health as a factor of life quality in Kazakhstan practice – it should include not only physical and psychological constituents, but features of functioning of spiritual and emotional intelligences – creation of conditions for its development increases its motivation for self-perfection, and as result enhances the quality of human capital the importance of which increases every year.

Н. А. Әбілқайыр

Қоғамдық денсаулық сақтау мектебі, Алматы қ., Қазақстан

ХАЛЫҚТЫҢ ДЕНСАУЛЫҒЫ ӨМІР СҮРУ САПАСЫНЫҢ НЕГІЗГІ ФАКТОРЫ РЕТІНДЕ

Аннотация. Мақалада халық денсаулығы тұрғысынан халықтың өмір сүру сапасының санаты зерттелген. Денсаулыққа байланысты, жеке және әлеуметтік деңгейде өмір сүру сапасын талдау критерийлері мен сипаттамалары қарастырылған. Өмір сапасының факторы ретінде денсаулық көрсеткіштерін өлшеудің қолданыстағы әдістері зерттелген. Денсаулық сақтау сапасын бағалаудың жүйелік үлгісінің иерархиясына негізделген денсаулық қасиеттерінің интегралдық көрсеткіші әзірленген. Авторлар ұсынған бағалау үлгісі денсаулықтың сапасына және олардың өзара байланысына әсер ететін барлық негізгі факторларды ескереді және қоғамдық денсаулыққа әсер ететін институционалдық және сыртқы факторлар үлкен рөл атқаратын аймақтық немесе мемлекеттік деңгейлерде қолданылуы мүмкін. Қазақстан халқының денсаулығының жай-күйінің көрсеткіштері талданып, өмір сүру деңгейлері шамалас елдердің көрсеткішімен салыстырылған. Мақалада қоршаған ортаның денсаулыққа ықпал етуіне ерекше көңіл бөлінген. Алматыдағы қоршаған ортаның ластануының деңгейі ластану бойынша әлемдік көшбасшыларымен салыстырғанда жоғары екендігі анықталған. Халықтың өмір сүру сапасын жақсарту мақсатында денсаулық сақтауды дамыту үшін медицина саласындағы оқыту және зерттеу институттарын қолдау қажеттілігі көрсетілген.

Түйін сөздер: халықтың өмір сүру сапасы, денсаулық, денсаулық сақтау, өмір сүру ұзақтығы.

Н. А. Абилкайыр

Высшая школа общественного здравоохранения, Алматы, Казахстан

ЗДОРОВЬЕ НАСЕЛЕНИЯ КАК ОСНОВНОЙ ФАКТОР КАЧЕСТВА ЖИЗНИ

Аннотация. В статье исследуется категория качества жизни населения с точки зрения здравохранения. Рассмотрены критерии оценки и особенности анализа качества жизни, связанные со здоровьем, на индивидуальном и социальном уровнях. Изучены существующие методы измерения показателей здоровья как фактора качества жизни. Составлен интегральный показатель качеств здоровья, исходя из иерархии системной модели оценки качества здоровья населения. Предложенная авторами модель оценки учитывает все основные факторы, влияющие на качество здоровья и их взаимосвязь и может применяться на региональном или государственном уровнях, где большую роль играют институциональные и внешние факторы, влияющие на общественное здоровье. Проведен анализ показателей состояния здоровья населения Казахстана в сравнении со странами одного с ним уровня жизни. В работе особое внимание уделено влиянию окружающей среды на здоровье населения. Отмечен высокий уровень загрязнения окружающей среды г. Алматы по сравнению с мировыми лидерами по загрязнению. Для развития здравоохранения в целях повышения качества жизни населения обозначена необходимость поддержки образовательных и исследовательских учреждений в медицинской сфере.

Ключевые слова: качество жизни населения, здоровье, здровоохранение, продолжительность жизни.

Information about author:

Abilkayir N. A., Higher School of Public Health, Almaty, Kazakhstan; abilkaiyr.nazerke@gmail.com; https://orcid.org/0000-0003-1603-5577

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S. N. Zhumashov, K. R. Tukhtaev, B. S. Shumashov

Khoja Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan.
E-mail: saidulla51@mail.ru, kadir.tukhtaev@tma.uz, zhumbake@mail.ru

IMMUNOLOGICAL INDICATORS IN PATIENTS WITH CHRONIC PHOSPHORUS INTOXICATION AFTER IMMUNOTHERAPY

Abstract. Studies were conducted on the basis of the medical unit of the Shymkent city production association "Phosphorus". A total of 95 patients with CHPI were examined. Subpopulation of T-helper, T-killers increased. Humoral immunity has been changed. Immunomodulin improves the immune system. After immunotherapy, multidirectional shifts in the concentration of IgM, IgG and IgA were detected. The number of lymphocytes in patients with CHPI of the initial degree of intoxication increased by 12.2%. The subpopulation of lymphocytes CDZ +, CD4 + decreased. The content of immunoglobulin IgG after immunotherapy increased by 34.5%, 55% and 35% compared with the control. Phagocytic activity of leukocytes increased. The rate of completion of phagocytosis increased. Phagocytic index decreased. Thus, immunomodulin stimulates immunopathy. Stimulates hematopoiesis. Effectiveness is noticed.

Key words: T-lymphocytes. T-helper, phagocytosis, immunomodulin, phosphorus.

Introduction. Many xenobiotic substances in the long-term intake of the body have a depressing effect on both specific resistance and cellular and humoral immunity [1].

Currently, the study of hematopoiesis and immune status is of paramount importance, since many pathological processes in humans can be both a consequence and cause of various disorders of the immune system, especially in secondary immunodeficiency States [2].

The aim of the work was to study the state of lymphocyte subpopulations in the blood of patients with chronic intoxication with phosphorus compounds (HISF) of various degrees.

Materials and methods. Blood sampling was carried out from the ulnar vein to the heparinized solution of the medium. Peripheral blood lymphocytes were isolated in ficoll-verografin density gradients the number of T-helpers,T-suppressors and immunoregulatory subpopulations of t-lymphocytes with DZ+, CD4+, CD8+, CD9+ and CD56+ were determined by mono-clonal antibodies in rosette formation reactions. The content of serum IgA, IgM, IgG were estimated by radial immunodiffusion according to G. MAPP et. all. (1965). Phagocytic activity was determined by the method of K. B. Ospanov [3].

The studies were conducted on the basis of the medical unit of Shymkent city production Association "Phosphorus". The study included 95 patients with CPCI, including 35 patients with early stage, S0 moderate and 30 with severe degree CPCI; as a control, were examined 54 healthy workers-builders of Shymkent. As an immunostimulant used the drug immunomodulin [4, 5], which was administered to patients with CPCI composed of conventional therapy daily for 5-10 days. Depending on the degree of intoxication, treatment with immunomodulin with a dose of 0.01 g was: with an initial degree of -5 days, with a moderate degree - 10 days and with a pronounced degree - 15 days.

Results. The content of CD56+ in patients with HYSF after therapy, including immunomodulin, increased with an initial degree of intoxication by 19.9% ($p<0.05$), with a moderate degree - by 24.9% ($P<0.05$) and with a pronounced degree of intoxication by 40.8% compared with the indicators before therapy. The relative and absolute content of subpopulation of CD8 + lymphocytes after immunotherapy

decreased with an initial degree of intoxication by 20.2%, with a moderate degree by 25 and 40% in persons with a pronounced degree of intoxication.

Multidirectional shifts in IgM, IgG and IgA concentrations were detected in the blood of patients with HISF after immunotherapy in the determination of immunoglobulins. Thus, the content of IgM after therapy in patients with initial, moderate and severe degree of intoxication DECREASED by 15% 14.6% and 26%,respectively, compared with the control. The inclusion of immunomodulin in the treatment of patients with HISF had a positive effect on the content of lymphocytes. The number of lymphocytes in patients with initial degree of HISF intoxication increased by 12.2%. The most pronounced increase in the number of lymphocytes was found in the appointment of immunomodulin for 10 days in persons with moderate and severe degrees of intoxication, while the level of lymphocytes increased by 41.6% and 106.5% compared with the control. When determining the lymphocyte subpopulations were observed multidirectional changes, in particular, the increase of relative and absolute content of lymphocyte subpopulations: CLE+, CD4+, СД56+, CD 19+ and at the same time, a reduction in the relative and absolute content of СД19+. The content of SDH+ after immunotherapy in patients with initial, moderate and severe degree of intoxication INCREASED by 19%, 30%, 39.9% compared with the control indicators. Absolute and relative content of CD4+ increased in patients with HISF with initial and moderate degrees of intoxication by an average of 20% and 30.2% compared with the control. The greatest increase in the content of CD4+ was established after immunotherapy in patients with a pronounced degree of intoxication, with an increase of B9%on average. The content of DM 19+ in patients with initial and moderate degrees of intoxication increased by 49.7%, and 50.3% compared with the control indicators, and the greatest increase in the relative and absolute number of subpopulations of DM 19+ was established after immunotherapy in patients with HYSF with a pronounced degree of intoxication. The content of IgG immunoglobulin in patients with initial, moderate and severe degree of HISF after immunotherapy increased by 34.5%, 55% and 35% compared to the control. The content of IgA after immunotherapy in patients with primary CPCI stepeni decreased by 33%, in individuals with moderate and severe degrees of intoxication, the decrease was 42.9% and 33.4%, compared to benchmarks. Patients with CPCI immunotherapy significantly reduced to intensified treatment of the index paracetamol activity and the index of completeness of phagocytosis of neutrophils with a significant decrease in phagocytic index .Phagocytic activity of leukocytes increased by 58.1% 57.9% and 49.8% in patients with initial, moderate and severe degrees. The index of completeness of phagocytosis increased by 61.8%, 65,8% and 70.5% in comparison with indicators before treatment, the indicators of completeness of phagocytosis in individuals with primary and moderate degree close to that of the control data. The phagocytic index, on the contrary, decreased in persons with an initial degree of HISF once, with moderate and severe degrees of intoxication - by 5.1% and 29.1% compared with pre-therapy.

Thus, the inclusion in the traditional therapy of immunomodulin to some extent leads to the normalization of the content of lymphocytes and its subpopulations.

С. Н. Жумашов, Қ. Р. Туқтаев, Б. С. Жумашов

Қ. А. Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

СОЗЫЛМАЛЫ ФОСФОРМЕН УЛАНҒАН НАУҚАСТАРДЫҢ ИММУНАЛОГИЯЛЫҚ БҰЗЫЛЫСТАРЫ ЖӘНЕ ОЛАРДЫ КОРРЕКЦИЯЛАУ

Аннотация. Зерттеулер «Фосфор» Шымкент қалалық өндірістік бірлестігінің медициналық бөлімі базасында жүргізілді. СФУ мен ауырған 95 науқас зерттелді. Т-хелпер, Т-киллер саны арта бастады. Гуморал иммунитеті өзгерді. Иммуномодулин иммундық жүйені жақсартады. Иммунотерапиядан кейін IgM, IgG және IgA концентрациясында көп бағытты ауысулар анықталды. Ішкі масштабты интоксикация дәрежесі бар науқастарда лимфоциттердің саны 12,2%-ға артты. CD3 +, CD4 + лимфоциттердің субпопуляциясы төмендеді. Иммунотерапиядан кейін иммуноглобулин IgG мазмұны 34,5%-ға, бақылауға қарағанда 55 және 35%-ға артты. Лейкоциттердің фагоцитарлық белсенділігі артты. Фагоцитоздың аяқталу жылдамдығы артты. Фагоцитарлы индекс төмендеді. Осылайша, иммуномодулин иммунопатияны ынталандырады. Гематопоэзді ынталандырады. Тиімділігі байқалады.

Түйін сөздер: Т-лимфоциттер. Т-хелпер, фагоцитоз,иммуномодулин, фосфор.

С. Н. Жумашов, К. Р. Тухтаев, Б. С. Жумашов

Международный казахско-турецкий университет им. Х. А. Ясави, Туркестан Казахстан

ИММУНОЛОГИЧЕСКИЕ ПОКАЗАТЕЛИ У БОЛЬНЫХ С ХРОНИЧЕСКОЙ ФОСФОРНОЙ ИНТОКСИКАЦИЕЙ ПОСЛЕ КОРРЕКЦИИ

Аннотация. Исследования проводились на базе медсанчасти Шымкентского городского производственного объединения «Фосфор». Всего обследовано 95 больных с ХФИ. Субпопуляция Т-хелпер, Т-киллеры увеличились. Гуморальный иммунитет были изменены. Иммуномодулин улучшает состояние иммунной системы. После иммунотерапии выявлены разнонаправленные сдвиги концентрации IgM, IgG и IgA. Количество лимфоцитов у больных с ХФИ начальной степени интоксикации увеличивалось на 12,2%. Субпопуляция лимфоцитов CD3+,CD4+ снижалось. Содержание иммуноглобулина IgG после иммунотерапии увеличилась на 34,5%, 55% и 35% по сравнению с контролем. Фагоцитарная активность лейкоцитов увеличивалась. Показатель завершенности фагоцитоза увеличивался. Фагоцитарный индекс снизился. Таким образом иммуномодулин стимулирует иммунопоэз. Стимулирует гемопоэз. Замечен эго эффективность.

Ключевые слова: Т-лимфоциты, Т-хелперы, фагоцитоз, иммуномодулин, фосфор.

Information about authors:

Zhumashov Saidulla Nurakhovich, M.D, Professor Professor of the Department of human morphology and physiology of the Khoja Ahmet Yasawi Kazakh-Turkish University, Turkestan, Kazakhstan; saidulla51@mail.ru; https://orcid.org/0000-0002-7478-6347

Kodir Rakhimovich Tukhtaev, doctor of medical sciences, professor of the department of histology 2-Tashkent Medical Academy, Tashkent, Uzbekistan.

Zhumashov Baktbek Saydullaevich, Ph.D., Acting Associate Professor, Department of Surgical Diseases, Shymkent Medical Institute, Kazakhstan

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A. K. Yedilova, D. V. Volkov, M. H. Shamekova, K. Zh. Zhambakin

RSE "Institute of Plant Biology and Biotechnology" CS MES RK, Almaty, Kazakhstan.
E-mail: edil_aigul@mail.ru, spiritdem@mail.ru, shamekov@gmail.com, zhambaki@mail.ru

MONITORING THE DISTRIBUTION OF TRANSGENES FROM THE GENETICALLY MODIFIED RAPESEED LINE

Abstract. Use of the modern and high performance technologies in the agrarian industry has to become the main priority for development of agro-industrial complex of our republic. One of such technologies is the genetic engineering of plants. Creation and cultivation genetically of the modified cultures creates particular scratches, mainly ecological and agrotechnical. As there is a potential possibility of transfer of transgenes to not the modified grades and wild relatives due to repollination. The pollen transfer strongly depends on the geographic location of plants and stay near wild relatives. In the Kazakhstan ecosystem rapeseed has a large number of relatives that favorably affects a possibility of cross-pollination. In this regard decrease in a biodiversity of wild flora and fauna is possible. Also such agrotechnical scratches as decrease in a biodiversity of cultivars, change of inappropriate signs and properties, emergence of super weeds can take place. During the presented scientific work the Kazakhstan's first practical monitoring of transfer of stranger genes from the genetically modified rapeseed to grades of rapeseed and its relatives in the open environment was carried out.

Keywords: rapeseed, rape, mustard, genetic transformation, transfer of genes, gene expression.

Introduction. Genetic engineering of plants is the most effective way to obtain plants with desired properties, which provides access to the endless gene pool, allowing the transfer of genes, both from one plant to another, and from other organisms to plants.

The flow of genes from rapeseed can occur on a cultivated field or through a field over long distances due to the spread of pollen or seeds. Unintentional spread of seeds sometimes occurs many years after harvesting due to the germination of dormant seeds in the soil. It can also occur at a considerable distance from farmed GM due to losses during transportation [20].

Influence of the genetic and modified rapeseed on grades and wild-growing flora is well studied in world practice. Rapeseed is not a rigorous self-pollinator, and the value of cross-pollination can reach 30%. The entomophily given about the quantitative ratio or wind are absent, however both factors are important and, perhaps, insects have key value. Depending on environmental conditions, a grade, design of crops, a land relief emergence and frequency of a stream of genes of intraspecific crossing can change.

It is necessary to conduct in-depth studies of influence of the genetically modified plants on a condition of components of concrete ecosystems as the problem of monitoring of environmental risks of transgene plants more and more becomes aggravated in connection with development of genetic engineering. It is necessary to consider genetic features of everyone of the modified plant new genetically at a release in a surrounding medium and commercial use in specific conditions of this or that ecosystem.

In the presented work transfer of stranger genes from the transformed grades to routine grades and their relatives on the example of rapeseed (*Brassica napus*) was studied. Various, carried-out in the world tests show that the majority of crossings between plants happens at short distances, it is less than 10 m, in certain cases cross-pollination is possible apart in 3 km from donors [6-9].

Objects of researches. Served as objects of researches - a working collection of seeds of summer rapeseed: the grade (*Brassica napus*) with a reporterny gene 2GUS35S115x3GUS received from transgene plants of 2015, grade rapeseed (*Brassica napus*), mustard Sarepta grades of (*Brassica juncea*), rape

of a grade of (*Brassica campestris*) of the Russian selection are received from the All-Russian Research Institute of oil-bearing crops of V.S. Pustovoyt; grades Gedemin and the Viking were received from RUP "NAN Scientific and Practical Center of Belarus for Agriculture". Also wild rape and shepherd's bag (*Capsella bursa-pasroris*). Designs with a target gene 2GUS35S115x3GUS pSS cloned in a binary agrobacteriemic vector based on a commercial vector of pCambia2300, were received from Institute of Molecular Biology and Biochemistry of Aytkhozhin of MAUN RK.

Methods of researches.

Receiving explant of rapeseed for the subsequent transformation. Seeds of rapeseed were sterilized by serial washing in 70% an aqueous solution of hypochlorite sodium sodium/chlorate of five water, 70% alcohol, distilled water (x3). The sterilized seeds were sowed on the environment ½ MS bezgormonalny and are germinated within 7 days. In 7 days hypocotyls and kotiledona separately were sheared off and incubated for 2 days on the MS environment with hormone 2,4D (1 mg/l).

Agrobacteriemic transformation of hypocotyls. Carried out an inoculation with the diluted suspension of agrobacteria (0,8 lakes e. at OD600), pSS containing a binary vector with a target gene 2GUS35S115x3GUS within 10 minutes and a kokultivation on the MS environment with hormone 2,4D (1 mg/l) 2 days. Then hypocotyls transferred to the MS environment with hormone 2,4D (1 mg/l) and tsifotaksimy (500 mg/l) and 14 days with the subsequent transfer on the MS environment with BAP hormones (3 mg/l) and zeatiny (2 mg/l), tsifotaksimy (500 mg/l) and Kanamycinum (40 mg/l) incubated. The incubation on this environment was carried out prior to the beginning of a morphgenesis and an embryogenesis and formation of plants. At formation of plants transferred to the MS environment with BAP hormone (0,05 mg/l), tsifotaksimy (500 mg/l), Kanamycinum (40 mg/l). For acceleration of body height of plants transferred to the MS environment (1% sucrose) with IMK hormone (5 mg/l), tsifotaksimy (250 mg/l) and Kanamycinum (40 mg/l).

Agrobacteriemic transformation of kotiledon. Carried out an inoculation with the diluted suspension of agrobacteria (0,8 lakes e. at OD600) containing a binary vector of pSS with a target gene 2GUS35S115x3GUS within 10 minutes and a kokultivation on the MS environment with hormone 2,4D (1 mg/l) 2 days. Then transferred and incubated on the MS environment with BAP hormone addition (4,5 mg/l) and a tsifotaksima (500 mg/l) within 6-8 weeks, with replacement of the environment each 7-10 days before morfo-and an embryogenesis. Then transferred to the MS environment with BAP hormone addition (0,05 mg/l), and Kanamycinum (40 mg/l) and incubated a tsifotaksim (500 mg/l) before formation of plants. For acceleration of body height of a plant transferred to the MS environment (1% of sucrose), IMK hormone (5 mg/l), tsifotaksimy (250 mg/l) and Kanamycinum (40 mg/l) [13, 14].

In a research used a reference medium of MS (Murashige and Skoog, 1962) [11].

Check of an insert and expression of an expression of a GUS gene. The expression of GUS of a gene was checked by method the developed Jefferson [9].

The transformed cages were incubated in the histochemical buffer (0.1 M the phosphatic buffer, 0.1 M ferricyanide, 0.1% the Triton of H-100, 10.0 mm of EDTA, 20% a methanol, 1.0 mM 5-bromo-3-indolyl-glucoronide (X-gluc, Clontech)) at a temperature of 37^0C within 24 clocks. After that tests were washed out in 70% ethanol before achievement of the complete transparence. The expression of a gene of GUS is estimated visually on intensity of coloring of fabric at blue color. For check of an expression of a GUS gene fabrics from leaves and stalks of plants were taken [11].

Receiving seeds from the transgene plants which are grown up in controlled conditions. Transgene regenerant of in vitro with a reporterny gene of GUS were transferred to a soil in controlled conditions at a temperature of 25^0C, the illumination of 4 thousand luxury, humidities of 50%, the light period of 16 clocks in days before receiving seeds.

Crops and care of plants in field conditions. Crops of rapeseed, a rape and mustard field conditions were carried out in Almaty region to the terms corresponding to area conditions on depth of 2 cm with the subsequent rolling.

For synchronization of blossoming and larger probability of repollination seeds were sowed in the following order: the first sowed rapeseed, in two weeks of rape and mustard. The experimental sites with crops were systematically weeded and processed against wreckers the cruciferous .

Crops in field conditions of plants of rapeseed, a rape and mustard together with the received seeds in 2015 having the reporterny GUS gen. Seeds from eight plants having a GUS gene expression were

sowed in natural field conditions of Almaty region together with seeds cultural (rapeseed, rape and and mustard) relatives.

Crops were carried out on 29.04.2015. For blossoming synchronization the first were sowed rapeseed, then in two weeks were sowed a rape and mustard. Rapeseed seeds with a reporterny gene were sowed in the center of a circle. Rapeseed seeds from the center were sowed, beginning from distance in 0,5 m. Crops of plants were made evenly on all area of a circle with the given radiuses. Seeds of rapeseed, a rape and mustard as potential recipients, were sowed is focused on parts of the world (The North, the South, the East, the West, the Northeast, the Sevoro-West, the Southeast and the Southwest). Rape, mustard and rape were sown by 10 meter rays. 11 replications of Chris rapeseed and mustard Rocket, 10 replications of Golden rape. The scheme of crops is submitted in the figure 1.

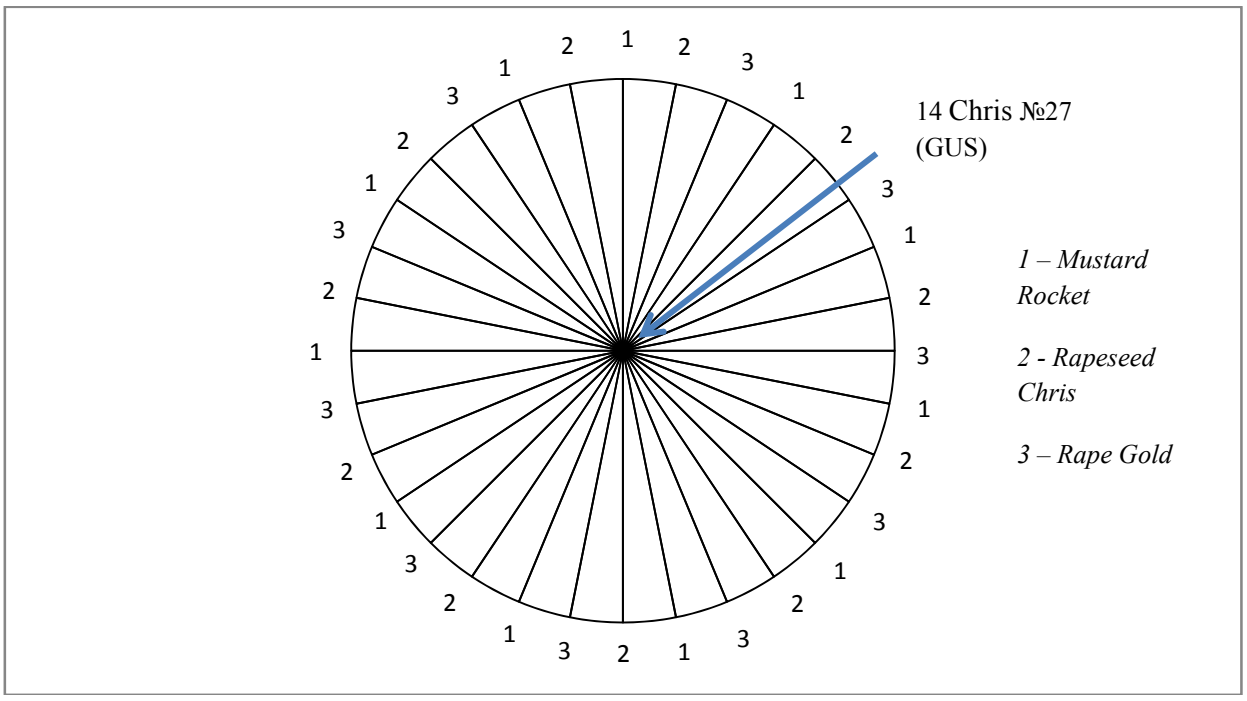


Figure 1 – The scheme of landing of plants on the experimental sites in Almaty region in 2015

Climate in the territory of the experimental site sharply continental. Winters cold and short, summer periods hot and droughty. Long summer. Average temperatures in July are +22 … +25 degrees. For all calendar year about 250 mm of rainfall drop out. In the area the quite strong winds [gismeteo.ru] blow.

In close proximity with the experimental site there were 10 bee colonies (the North – 1 km), 8 bee colonies (the South – 500 m), 5 bee colonies (the West – 1 km).

Harvesting according to the given scheme and selection of collected seeds on mediums with Kanamycinum. The seed collection was carried out at the following time: rape and mustard - 07.21.2015, rapeseed - 07.29.2015. In 2015 harvesting took place according to the following scheme:

1. Seeds of rapeseed, a rape and mustard were selected through each meter on 5 plants from each beam, carried out marking similarly with rape.

Seeds of each collected plant were threshed and located in paper packages of the above-stated marking, then from each bag took 30 seeds and placed on the selection MS environment with concentration Kanamycinum 70 mg/l and put the corresponding marking and then placed on a prorashchivaniye in the sveto-cultural room on the light mode 16/8 (day/night) at a temperature 25ºC and humidities of 50%.

Selection of total DNA from plants [10]. Selection of DNA from plants was carried out with a standard method STAV. Vegetable fabric was placed in a test tube like Eppendorf with a capacity of 1,5 ml; added 700 µl the extraction buffer; added 20 µl RNA elements and mixed, then incubated on a water bath at 60ºC within 10 minutes; added 700 µl chloroform and mixed 2-3 seconds. Contents were

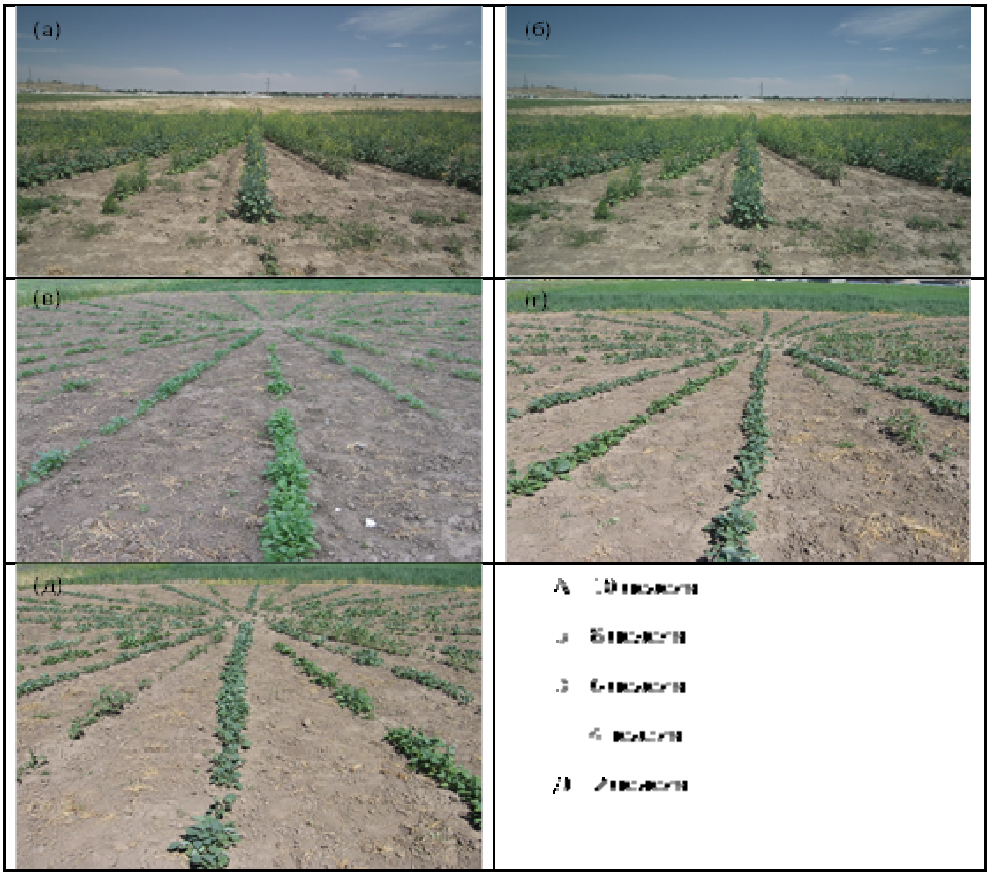


Figure 2 – The state of the field in Uzynagash at different time intervals:
А – 10 week, Б – 8 week, В - 6 week, Г – 4 week, Д – 2 week

centrifuged within 10 minutes at ambient temperature and 14000 rpm. Then a supernatant transferred to other test tube and added 300 µl isopropanol, mixed, centrifuged within 10 minutes at ambient temperature and 14000 rpm and deleting supernatant liquid.

The deposit was washed out by 70% ethanol twice, as follows: added 800 µl 70% of ethanol, mixed 1 second, centrifuged 5 minutes at ambient temperature on 14000 rpm. Deleted over sedimentary liquid, dried a deposit at ambient temperature of 10 - 15 minutes.

Added to the dried-up deposit 50 µl the deionized distilled water, 150 µl 4M of NaCl, 600 µl 70% of ethanol, mixed and put in the deep freeze on - 70ºC for 20 minutes, then centrifuged 10 minutes at ambient temperature and 14000 rpm, washed out 70% ethanol, deleted supernatant liquid and dried a deposit at ambient temperature of 10-15 minutes, added 30 µl the deionized water, mixed 1 sec., checked a spectrophotometer and left quality of DNA in the deep freeze on storages at - 200C.

Amplification of DNA by means of the polymerase chain reaction (PCR) [11]. For carrying out the PCR-analysis prepared a reaction mixture of 20 мкл the following structure: 2 мкл the 10th the buffer for a Taq-polymerase, 0,2 мкл 2,5mm the mixes dNTP, on 0,2 мкл mixes of primers, concentration 50 пмоль, 0,2 мкл Taq-polymerases, 16,2 мкл waters.

Exemplars carried out through three corresponding temperature schedules specified in table 1.

Table 1 – Temperature modes of PCR

Stage	Name of a stage	Temperature	Duration
Stage 1	Initial denaturation	94°	5 min., 1 cycle
Stage 2	Denaturation	The Denaturation - 94°C, annealing of primers at 57°C, lengthenings of a chain a polymerase at 72°C	The Denaturation – 30 sec., annealing of primers – 30 sec., lengthenings of a chain a polymerase – 1 min. x 30 cycles
Stage 3	Final polymerization	72°C, then cooling up to 4°C	5 minutes

Products of amplification divided in the elektroforezny camera 1,2% the TAE agarous gel the buffer with addition bromic an etidiya.

Data analysis. Frequency of transfer of a transgene from the transgene site to the corresponding not transgene plants were calculated by division of number of transgene plants on this site on total of the tested seeds on this site and multiplication on total of the seeds which showed a positive take after the analysis of PCR:

$$\text{Frequency transfer of a transgene} = \frac{\text{Quantity of the transformed plants on this site/meter}}{\text{Total of plants on this site/meter}} \times \text{The Common index of percent of transfer of a transgene after the PCR-analysis}$$

Generalization and assessment of results of researches.

Agrobacteriemic transformation of explant of colza a design with a target gene 2GUS35S115x3GUS. According to literary data for *Brassic napus* the revitalization system is adjusted on different fabrics of plants: the microspores [12], hypocotyls [13-15], seven-shares [16, 17], plastids and protoplasts received from sheet disks and kotiledon [18].

Promoter 35S is one of the most widely used, the very strong constitutive promoter responsible for a transcription of all genome of CaMV. It is well-known thanks to its use in transformation of plants. It causes high levels of an expression of genes in plants of bichromatic plants. 35S promoter was called CaMV 35S promoter ("promoter 35S") as the coefficient of a sedimentation of a virus transcript which expression, naturally, is caused by this promoter makes 35S. It was found in the early eighties by Chua and the staff of the University of Rockefeller. The CaMV 35S promoter which is present at many GM-plants is emitted from cauliflower mosaic virus DNA (Cauliflower mosaic virus (CaMV)).

In this experiment by us it was transformed by a target gene of GUS under 35S promoter in a binary vector of pSS - 195 kotiledon and 230 hypocotyls of a grade Chris, 288 kotiledon and 270 hypocotyls of a grade the Viking, 250 kotiledon and 206 hypocotyls of a grade Gedemin. Quantity of the transformed explant and an induction of a morphgenesis and an embryogenesis it is presented in table 2.

Table 2 – Quantity of eksplant and plants

Types of explant	The Grade	Transformed explant	Morphogenesis	Transgene regenerate
Hypocotyls	Chris	230	209	5
	A viking	270	156	7
	Gedemin	206	108	4
Seed leaves	Chris	195	68	3
	A viking	288	144	5
	Gedemin	250	64	2

Apparently from the table 2, the most morfogenny and embriogenny appeared hypocotyls from 50 to 90% of explant, then, as cotyledons from 25 to 50%. At a stage of three sheets regenerant were cloned and a final exit of plants to the transformed explant made 3,4 – 3,7% for hypocotyls and 2,4 – 2,8% for kotiledon.

In the figure 3 the appearance of explant at an embryogenesis stage – after 7 weeks is presented from the moment of an incubation and also transgene plants received on the 12th week after transformation.

Check of an insert and expression of a GUS gene. The received regenerant (table 2) were checked for a gene expression by GUS method the developed Jefferson (1989). As showed the analysis, the gene of GUS was successfully introduced in a genome of hypocotyls of rapeseed of a grade Chris (figure 3). The expression of a gene of GUS was high, judging by visual assessment. Level of an expression could be estimated, observing intensity of coloring.

Receiving seeds from the transgene plants which are grown up in controlled conditions. Thirteen transgene GUS of plants of a grade Chris were transferred to a soil in controlled conditions (figure 5). From 13 plants adapted in a soil 8 which proceeded to be cultivated before receiving seeds.

a b

Figure 3 – Appearance of eksplant after 7 weeks from the moment of an inoculation with agrobacteria (A) and regenerant of 12 weeks received later after an inoculation with agrobacteria (B)

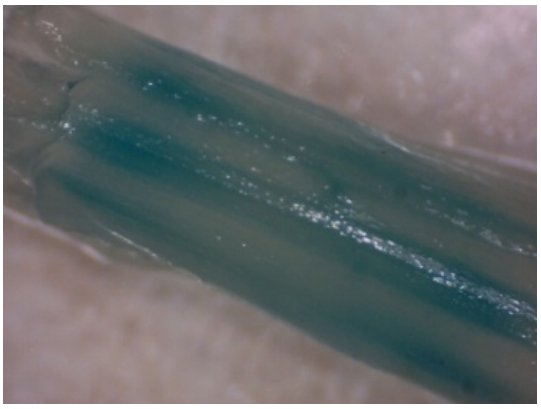


Figure 4 – Expression reporter of a gene of GUS in transgene regenerant of rapeseed of a grade Chris

Figure 5 – Transgene regenerant Chris with a target gene of GUS replaced in a soil in controlled conditions

Seeds of the received transgene plants, were sowed in natural field conditions of Almaty region together with seeds cultural (rapeseed, a rape and mustard) relatives. For blossoming synchronization the first were sowed rapeseed, then in two weeks were sowed a rape and mustard. Rapeseed seeds with a reporterny gene were sowed in the center of a circle. Seeds of rapeseed, a rape and mustard as potential recipients, were sowed is focused on parts of the world.

Harvesting according to the given scheme and selection of collected seeds on mediums with Kanamycinum. In 2015 it was collected exemplars (1 exemplar – seeds from one plant with unique marking): rapeseed – 360, a rape – 322, mustard – 312 (table 3).

Table 3 – Quantity of the exemplars collected from the experimental sites

Kind of plant	2015 год
Rapeseed	360
Rape	322
Mustard	312

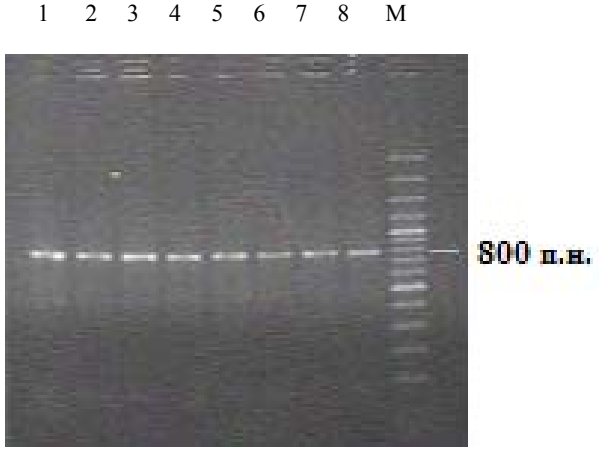
Exemplars of plants which were not tested on the selection environment during the experiment were incinerated.

Definition on presence of an insert and an expression of a transgene of seeds of colza, the surepitsa and mustard gathered during the experiment.

GM of a plant receive by different methods of transformation. Usually for transfer use a plasmid which contains a gene which work gives to a plant the given properties, promoter which regulates inclusion of this gene, terminator of a transcription which contains the selection gene of resistance to an antibiotic to Kanamycinum. Kanamycinum is often used as the selection marker for transgene plants.

For identification of the transformed cages it is necessary to be able to find the stranger DNA integrating into genomic DNA of a plant. All this the reporters of genes which allow or to make selection of the transformed cages demands application, or to estimate activity of the enzyme coded by them. In this work the main stages of screening of this culture on the selection environment are considered and optimized. The way of screening on the selection environment with Kanamycinum is offered. It is picked up optimum concentration for seeds of rapeseed of 70 mg/l, and for seeds of mustard and a rape of 50 mg/l. Thus, the molecular and biological analysis showed that not all survivors when processing by plant Kanamycinum with an insert of genes of GUS in a genome.

Seeds of the plants which passed a test on the selection environment were couched, was emitted DNA for the subsequent definition of an insert. The design under 35S promoter therefore for definition of an insert in estimated plants recipients the following primers for definition of presence of the sequence of this promoter were taken was used for rapeseed transformation: direct - 5-ACTCTGAAAACGGGTCGATA-3', inverse 5-CATCAATCCACTTGCTTTGA-3', at these sequences of primers length of PCR of a product equaled 800 couples of nucleotides.



1 exemplars of rapeseed taken from distance of 10 meters from the center of a circle, 2 - the rapeseed exemplars taken from distance of 9 meters from the center of a circle, 3 - the rapeseed exemplars taken from distance of 6 meters from the center of a circle, 4 - the rapeseed exemplars taken from distance of 3 meters from the center of a circle, 5,6 - the rapeseed exemplars taken from distance of 1 meters from the center of a circle, 7, 8 – monitoring (GUS gene), M – a marker.

Figure 6 – Results of an electrophoresis in 1,2% - number agarous gel of the DNA products of rapeseed (NE direction) received by the PCR method containing the sequence 35S of promoter (exemplars from the field)

In the figure 5 the fact of transfer of a gene of GUS from the rapeseed transformed to routine grades is shown.

In 2015 screening on Kanamycinum of 312 exemplars of a rape, 322 exemplars of mustard and 360 exemplars of rapeseed from the experimental site in 2015 is carried out. From 312 exemplars of a rape underwent screening on the selection environment with Kanamycinum 122 exemplars. Further PCR of these exemplars with the primers specified earlier therefore 38 plants showed a positive take on presence of the sequence 35S of promoter was carried out. From 322 exemplars of mustard underwent screening on Kanamycinum of 129 exemplars which were checked for PCR similarly with exemplars of a rape, from them 63 exemplars showed a positive take on presence of the sequence 35S of promoter. 147 plants drove out of 360 exemplars of rapeseed after screening on the selection environment, 78 of them showed existence of an insert of GUS after PCR (table 4).

To define a possibility of transfer of transgenes (%) cases of transfer of transgenes as equals distances from the center of a circle with GM-rapeseed were considered. For determination of probability of transfer of transgenes the quantity of the transformed exemplars on this site/meter was divided into total of exemplars on this site/meter.

Table 4 – Definition of the repollinated exemplars 2015 with transgene rapeseed by screening methods on the selection environments and PCR of the analysis

Type of screening on repollination	Rape	Mustard	Rapeseed
Models in total	312	322	360
After screening on the selection environment	122	129	147
Percentage index of transfer of a transgene after screening on the selection environment	39,2	39,9	40,8
After carrying out PCR of the analysis	38	63	78
The common index of percent of transfer of a transgene after the PCR-analysis	12,4	19,7	21,7

Schematical representation of frequency of transfer of a transgene at exemplars from the field of 2015 is shown in the figure 7. It is shown that with increase in distance from the center of a circle the frequency of transfer of a transgene decreases. The trendliniya which shows decrease in frequency of transfer, with increase in distance also demonstrates to it.

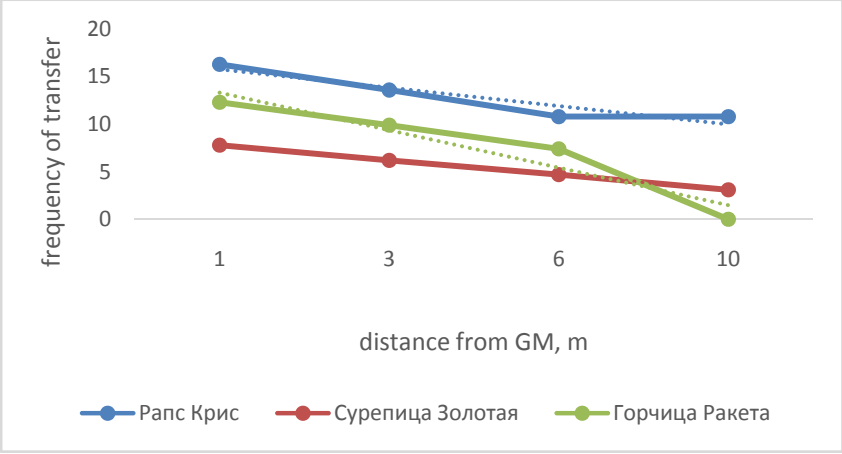


Figure 7 – Frequency of transfer of a transgene at exemplars from the field of 2015 From gold rape GM-rapeseed, mustard the Rocket and to rapeseed Chris

For determination of frequency of transfer of transgenes the possibility of transfer of transgenes on this site/meter was multiplied by the common indicator of transfer of a transgene after PCR – the analysis.

Judging by emergence of events in all parts of the world, without the choice of a dominance of a determinate direction, it is possible to tell that an important role in the course of transfer of a transgene is played by such factors as a wind and insects. It is also possible to judge it from emergence of the isolated and random cases of transfer of transgenes.

In this work in field conditions the opportunity of transfer of transgenes inside between types of the *Brassicaceae* family is shown. There was an exponential decline with increasing distance from the central donor. These results will be coordinated with the results of researches which are carried out worldwide and discussed in the literary review.

For the purpose of improvement of quality of indexes and receiving wider pool of data it is recommended to make an experiment in other areas of the Republic of Kazakhstan and also to increase the scale/area of the experimental site.

Conclusion. In course of execution of the project agrotransformation of hypocotyls and kotiledon of rapeseed by designs with a target gene 2GUS35S115x3GUS cloned in a binary agrobacteriemic vector by pSS based on a commercial vector of pCambia2300 was carried out. Regenerant of rapeseed of three grades were received: Chris, the Viking and Gedemin who were checked for presence of an insert. Check showed presence of an insert at 13 transgene regenerant of a grade Chris from which at transfer in a soil in controlled conditions nine adapted. From seeds of thirteen plants received from regenerant with a GUS gene expression 8 plants which seeds after a prorashchivaniye showed positive test for a GUS gene expression were received.

The received transgene seeds as donors were sowed together with seeds of potential plants of recipients, rape, mustard, rapeseed, a rape of a wild and shepherd's bag on the experimental sites Almaty regions.

The crop according to the given scheme was reaped and screening on the selection environment and PCR the analysis on presence of the sequence 35S of promoter, all exemplars of plants of recipients of a rape and mustard, the Almaty experimental site is carried out.

Results of three-year experiments showed the frequency of possible transfer of genes, high up to 21,7%, for distance to 10 meters from transgene rapeseed to grades of rapeseed *(Brassica napus)* and up to 12,4% of possible crossing with his relatives – mustard *(Brássica juncea)* and a rape *(Brassica rapa)*. At the same time, apart to three meters the possibility of crossing with grades and relatives is practically influenced by neither features of year of cultivation, nor a cultivation zone. In too time, perhaps high-quality distinction influencing the free repollination, the bound to blossoming terms and also morphological features of flowers.

Thus results of experiments in open space the Almaty regions showed that transgene rapeseed is freely crossed to not transgene grades and the close relatives of the *Brassicaceae* family *(Brássica juncea, Brassica rapa, Brassica campestris)*. For prevention of cross repollination gene-modified grades need to be sowed separately from routine grades of rapeseed and its close relatives. Besides it is necessary to carry out monitoring of grades of rapeseed and relatives on existence of transgenes at cultivation the inorayonnykh of grades with use of the modern methods.

А. К. Едилова, Д. В. Волков, М. Х. Шамекова, К. Ж. Жамбакин

РМК «Өсімдіктердің биологиясы және биотехнологиясы институты» ҚР БҒМ ҒК,
Алматы, Қазақстан

ГЕНЕТИКАЛЫҚ МОДИФИЦИРЛЕНГЕН РАПС ЛИНИЯЛАРЫНАН ТРАНСГЕНДЕРДІҢ ТАРАЛУ МОНИТОРИНГІ

Аннотация. Біздің республикамызда агроөнеркәсіптік кешенді дамыту үшін аграрлық индустрияда негізгі басымдық болуы керек заманауи және жоғарлы әсерлі технологияларды қолдану қажет. Осы технологиялардың бірі өсімдіктердің генетикалық инженериясы болып табылады. Генетикалық модифицирленген дақылдарды жасап шығару және оларды өсіру белгілі бір қауіпті төндіреді, көбінесе экологиялық және агротехникалық. трансгендердің модифицирленбеген сұрыптарға және олардың жабайы түрлеріне тозаңдану есебінен таралудың әлеуетті мүмкіндікері бар. Тозаңның ауысуы өсімдіктердің географиялық орналасқан жері мен жақын маңдағы жабайы түрлерге өте қатты тәуелді. Қазақстандық экожүйеде рапстың көптеген жабайы түрлері бар және олар алмасып тозаңдану мүмкіндігіне қолайлы әсерін тигізеді. Осыған байланысты жабайы флора мен фауна алуантүрлілігінің төмендеу мүмкіндігі бар. Сонымен қатар агротехникалық қатерлер орны болу мүмкін, олар екпе сұрыптардың алуантүрлілігінің төмендеуі, мақсатсыз белгілердің және қасиеттердің өзгеруі, арамшөптердің пайда болуы. Ұсынылған жұмыс барысында Қазақстанда

бірінші рет ашық ортада генетикалық модифицирленген рапстан рапс сұрыптарына және олардың жабайы түрлеріне бөгде гендердің тасымалдануының практикалық мониторингі жүргізілген.

Түйін сөздер: рапс, сарепт қыша сұрыпы, қышабас сұрыпы, генетикалық трансформация, гендердің тасымалдануы, ген экспрессиясы.

А. К. Едилова, Д. В. Волков, М. Х. Шамекова, К. Ж. Жамбакин

РГП «Институт Биологии и биотехнологии растений» МОН РК, Алматы, Казахстан

МОНИТОРИНГ РАСПРОСТРАНЕНИЯ ТРАНСГЕНОВ ОТ ГЕНЕТИЧЕСКИ МОДИФИЦИРОВАННОЙ ЛИНИИ РАПСА

Аннотация. Использование современных и высокоэффективных технологий в аграрной индустрии должно стать главным приоритетом для развития агропромышленного комплекса нашей республики. Одним из таких технологий является генетическая инженерия растений. Создание и выращивание генетически модифицированных культур создает определенные риски, главным образом экологические и агротехнические. Поскольку существует потенциальная возможность переноса трансгенов к не модифицированным сортам и диким сородичам за счет переопыления. Трансфер пыльцы сильно зависит от географического местоположения растений и нахождения вблизи диких сородичей. В казахстанской экосистеме у рапса есть большое количество сородичей, что благоприятно сказывается на возможности перекрестного опыления. В связи с этим возможно снижение в биоразнообразии дикой флоры и фауны. Также могут иметь место такие агротехнические риски, как снижение биоразнообразия культурных сортов, изменение нецелевых признаков и свойств, появление супер сорняков. В ходе представленной научной работы был проведен первый в Казахстане практический мониторинг переноса чужеродных генов от генетически модифицированного рапса к сортам рапса и его сородичам в открытой среде.

Ключевые слова: рапс, горчица сарептская, сурепица, генетическая трансформация, перенос генов, экспрессия гена.

Information about authors:

Yedilova A. K., junior scientific elaborator, RSE "Institute of Plant Biology and Biotechnology" CS MES RK, Almaty, Kazakhstan; edil_aigul@mail.ru; https://orcid.org/0000-0002-6733-0878

Volkov D. V., senior scientific elaborator, RSE "Institute of Plant Biology and Biotechnology" CS MES RK, Almaty, Kazakhstan; spiritdem@mail.ru; https://orcid.org/0000-0001-8055-6516

Shamekova M. H., Leading Researcher, Deputy General Director of the RSE "Institute of Plant Biology and Biotechnology" CS MES RK, Almaty, Kazakhstan; shamekov@gmail.com; https://orcid.org/0000-0002-2353-6460

Zhambakin K. Zh., Academician of NAS RK, General Director of the RSE "Institute of Plant Biology and Biotechnology" CS MES RK, Almaty, Kazakhstan; zhambaki@mail.ru; https://orcid.org/0000-0002-9821-9814

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S. M. Adekenov, E. M. Gabdullin, I. A. Khabarov, B. B. Bekeev, Z. K. Shaushekov

JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan.
E-mail: phyto_pio@mail.ru

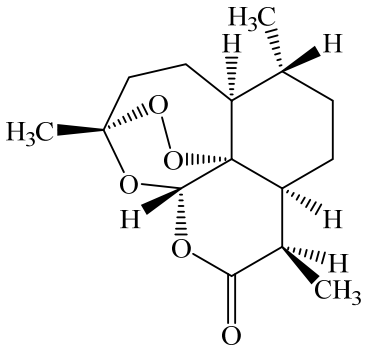
SPREADING OF *ARTEMISIA ANNUA* L. AND ITS CONTENT OF ARTEMISININ

Abstract. This article presents the results of study resources and the assessment of the raw material base of the industrial source of the antimalarial drug "Artemisinin" derived from *Artemisia annua L* in the Almaty region of the Republic of Kazakhstan. Phytocenotic characteristic of the communities was carried out, the operational stock and the possible volume of annual raw materials harvesting of *Artemisia annua L* were determined.

The content of pharmacologically active sesquiterpene lactone artemisinin in the raw material of *Artemisia annua L* from different coenopopulations was discussed. It also provides recommendations for the exploitation of the natural reserves of *Artemisia annua L.*

Key words: *Artemisia annua L.*, coenopopulation, operating stock, raw materials, CO_2-extraction, sesquiterpene lactone, artemisinin.

Introduction. *Artemisia annua* L. (one-year warmwood) is the main source of raw materials for the production of the antimalarial drug artemisinin, developed on the basis of the sesquiterpene lactone with the same name (**1**) [1].



Artemisinin (**1**)

The World Health Organization (WHO) estimates that amount of artemisinin to provide at least 120 million treatments is 96,000 kg. At the same time, around 500 million cases of malaria are reported every year around the world [2].

The main suppliers of artemisinin in the world are Chinese and Indian companies, such as: Maysar Herbals (Haryana, India), KPC Pharmaceuticals (Kungming, China), Xi'an Lyphar Biotech Co., Ltd. (Xian, China), Guangzhou Quanao Chemical Co., Ltd. (Guangzhou, China), Nanjing Zelang Medical Technology Co., Ltd. (Nanking, China), Kerui nanhai (Chongqing, China) [3]. Despite the ongoing cultivation of *Artemisia annua L*. [4] and obtaining one-year species with artemisinin content up to 2% with regard to air-dry raw materials [5], as well as developing a semi-synthetic method for producing

artemisinin, pharmaceutical companies are still dependent on harvesting plant materials in nature due to the high cost of these methods [6].

In the Republic of Kazakhstan, the habitat of *Artemisia annua L* passes through a narrow strip of South and South-East Kazakhstan: the Zaisan depression, the valleys of the Chu, Sarysu, Syrdarya rivers, the Prikaratau piedmont plain, the foothills of the Dzungarian, Ili and Kyrgyz Alatau [7, 8]. Reconnaissance surveys of one-year-old wormwood thickets were conducted earlier [9] in the Almaty region of the Republic of Kazakhstan.

The purpose of the research is to identify and evaluate the raw material base of *Artemisia annua L* in the Almaty region for the preservation and balanced use of renewable plant materials, as well as to determine the content of sesquiterpene lactone artemisinin in coenopopulation different of different places of growth.

Materials and methods. Object of study - natural populations of *Artemisia annua L.* in the Almaty region of the Republic of Kazakhstan (figure 2).

Artemisia annua L. is a widespread cosmopolitan plant, which grows on sandy places, gardens and in settlements. The stalks of the *Artemisia annua L* reach a height of 30-100 cm, erect. Stem leaves are short; lower leaves sessile twice pinnate; periston-cut ovoid segments. The leaves are alternate, broadly ovate shape, 2.5–10 cm long and 2.5–4 cm wide, with 2-3 segments on each side. Petioles of lateral segments widely bordered. End of nibs quickly acuminate. The flowers are yellow. Baskets on drooping thin legs 1-3 mm long, hemispherical, form a common loose, wide densely leafy paniculate inflorescence; naked wrapper, linear filmy leaves. Edge flowers in a thread-like basket; median - glass and tubular. The fruit is an oblong flat achene without a crest, it blooms in July - August. The fruits ripen in August - September. The longevity of populations of *Artemisia annua L* ranges from 1 to 7-9 years, after which the species is displaced [10].

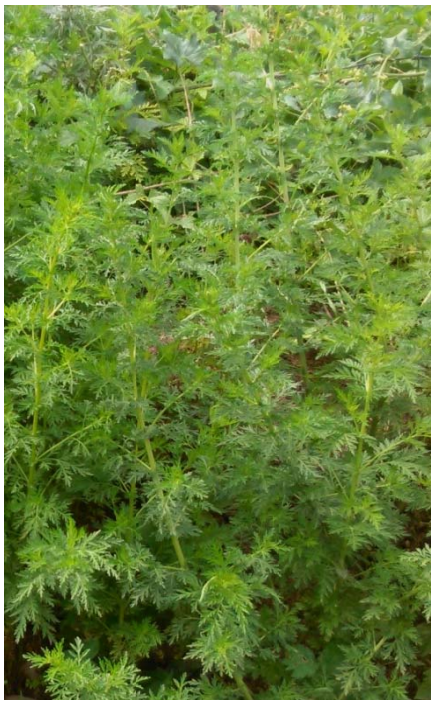


Figure 2 – *Artemisia annua* L. on territory of Almaty region

Traditional methods of geobotanical [11-13] and resource research were used during carrying out the work [14].

Supercritical CO2-extraction was carried out at the USFE-5/2 installation (production GORO-engineering, Russia). Carbon dioxide food GOST 8050-64 was used As the extractant.

Extraction of raw material (weight in all experiments was 100 g) was carried out at a pressure of 25 MPa, extraction time 3 hours and a temperature of 60 ° C.

The quantitative content of artemisinin in the extracts was determined by HPLC on an Agilent 1260 chromatograph (USA) compared to an external standard, under the following conditions: Zorbax SB-C18 sorbent column, 4.6 x 150 mm, particle size 5 μm, acetonitrile-water mobile phase 60: 40, detection at 235 nm, the column temperature is room temperature, the speed of the mobile phase is 0.5 ml/min.

Results and discussion. In August 2018 we made route-reconnaissance survey and found coenopopulations in the village Uzynagash Zhambyl district, near the village of Shilikbay Zhambyl district, near the village of Sayan Karasai, near the village of Kainar Karasai, village Kaskelen Karasai in the neighborhood Akshi village of Enbekshikazakh district, in the vicinity of the village of Avat, Enbekshikazakh district, village of Turgen of the Enbekshikazakh district and in the vicinity of the village of Enbek Alm Atinsky region of Enbekshikazakh district with a total length of 300 km. As a result of the expeditionary work in the surveyed area, 10 fishing arrays of Artemisia annua L were identified (table 1).

Table 1 – Productivity and raw material reserves of the aboveground mass of the generative organs *Artemisia annua* L. in Almaty region

Location of coenopopulation	Square	Plant density, pcs/m^2	Model plant weight, g	Productivity (air dry weight)		Operating stock of air-dry raw materials, t	Volume of possible annual procurement of air-dry raw materials, t
				g/м^2	c/hectare		
2 km from vill. Uzynagash Zhambyl district	2	1,2±0,03	14,75±0,1	17,7±0,5	1,7±0,05	0,34	0,14
Vicinity round village Shilikbai of Zhambyl distric	1,5	3,4±0,05	36,9±2,3	125,5±4,6	12,5±0,4	1,88	0,75
Vicinity round village Shilikbai of Zhambyl distric	1,7	3,2±0,04	35,7±2,2	114,2±3,7	11,4±0,3	1,94	0,78
Vicinity round village Sayan Karasay district	2,2	2,7±0,03	36,8±4,1	99,4±3,2	9,9±0.3	2,18	0,87
Vicinity round village Kainar Karasay district	0,9	2,2±0,02	24,8±3,2	54,5±3,1	5,4±0,3	0,49	0,19
Village Kaskelen Karasay district	1,2	2,7±0,04	34,5±2,6	93,1±3,3	9,3±0,3	1,12	0,45
Village Akshi of Enbekshikazakh district	1	1,1±0,02	14,1±0,2	15,5±1,3	1,5±0,1	0,15	0,006
Village Avat, Enbekshikazakh district	1,1	2,1±0,01	25,5±0,9	53,5±2,9	5,3±0,2	0,58	0,23
Village Turgen Enbekshikazakhskogo area	1,3	2,9±0,03	30,9±2,1	89,6±3,2	8,9±0,3	1,16	0,46
Vicinity round village Enbek Enbekshikazah area	2,5	2,3±0,03	24,2±1,4	55,6±3,3	5,5±0,3	1,38	0,55
Total	15,4					11,22	4,48

Coenopopulation 1 (C3 1) is located 2 km from the village. Uzynagach, Zhambyl district, 43º22'16,74 " N, 76º98'52,79 " E, forming a weedy community along the edge of the field. Co-dominants: *Cichorium intybus* L., *Agropyron cristatum* (L.) Beauv. First tier 85-130 см - *Artemisia annua* L., *Cannabis ruderalis* Janisch., *Urtica dioica* L.; second 40-80 см - *Cichorium intybus* L., *Acroptilon repens* (L.) DC., *Lactuca tatarica* (L.) C.A.Mey.; third 25-40 см - *Agropyron cristatum* (L.) Beauv., *Achillea nobilis* L.; fourth - *Trifolium pratense* L., *Plantago lanceolata* L., *Malva pusilla* Sm. The height of *Artemisia* annua L ranges from 90 to 135 cm, the number of commodity individuals is 1.2 ± 0.03 pcs/m^2. The area of thickets is 2 hectares, the operating stock is estimated at 3.4 centners, of which the volume of possible blanks is 1.4 centners.

Coenopopulation 2 (CP 2) 43º13'44,16" N, 76º22'14,46" E. Thicket number 2 is found near by village Shilikbay Zhambyl district. The thicket was located on the edge of an abandoned field, with a total area of 1.5 hectares. Co-dominants: *Lactuca tatarica* (L.) C.A.Mey., *Achillea nobilis* L., *Cirsium arvense* (L.) Scop. Ярусность не выражена. Types of tiers are not pronounced. The average height of specimens of the *Artemisia* annua L was 111.7 ± 2.4 cm, diameter 51.1 ± 1.2 cm. The number of commercial

specimens per 1 m^2 was 3.4 ± 0.05 pieces. The operational stock of raw materials on an area of 1.5 hectares of CP amounted to 18.8 centners, of which the harvesting can be carried out at a level of 7.5 centners.

Coenopopulation 3 (CP 3) 43º14'48,17" N, 76º24'16,53" E. is located 400 meters from the thickets number 2 and covers an area of 1.7 hectares. The vegetation is growing on a hill side. In this community, 2 tiers are expressed: the first tier (110cm): dominants - *Artemisia annua* L. second tire (till 55 cm) - *Bromopsis inermis* (Leyss.) Holub., *Lactuca tatarica* (L.) C.A.Mey., *Tripleurospermum inodorum* (L.) Sch. Bip. The number of commodity plants per 1 m^2 was 3.2 ± 0.04 pieces, with an average height of plants of wormwood 106.9 ± 3.1 cm and a diameter of 39.5 ± 0.7 cm. c, the amount of possible harvest - 7.8 c.

Coenopopulation 4 (CP 4) 43º17'54,50" N, 76º44'90,21" E. was discovered near the Sayan village of the Karasai district and covers an area of 2.2 hectares, located on abandoned fields. Co-dominants: *Glycyrrhiza uralensis* Fisch., *Arctium tomentosum* Mill.. Marked 2 tiers: upper tier 80 cm and higher - *Artemisia annua* L.; *Arctium tomentosum* Mill.; bottom 30-50 cm - *Glycyrrhiza uralensis* Fisch., *Polygonum aviculare* L. The yield was 9.9 centners per hectare. The operational stock of air-dry raw materials is 21.8 centners, the volume of possible harvest is estimated at 8.7 centners.

Coenopopulation 5 (CP 5) 43º16'19,64" N, 76º44'53,00" E. grows in the vicinity of the village Kainar of the Karasai district and covers an area of 0.9 hectares, located on abandoned fields. Edificator in the community *Artemisia annua* L., Co-dominants: *Cannabis ruderalis* Janisch., *Onopordum acanthium* L. in high tier (80-130 cm) and *Xanthium strumarium* L., *Achillea millefolium* L. in bottom tier (20-35 cm). The average plant height was 125.4 ± 3.1 cm, diameter - 21.6 ± 0.8 cm. The operational stock was 4.9 centner of air-dry raw material, of which up to 1.9 centner can be harvested.

Coenopopulation 6 (CP 6) 43º21'62,71" N, 76º69'23,08" E. was found 2 km from the village. Kaskelen of Karasay district towards Almaty with a total area of 1.2 hectares. The number of commodity plants is 2.7 ± 0.04 pcs/m^2. The yield was 93.1 g/m^2, the operational stock of raw materials was estimated at 11.2 centners, the amount of possible raw material harvesting was 4.5 centners.

Coenopopulation 7 (CP 7) 43º50'92,64" N, 77º65'50,18" E. grows in the vicinity of the village. Akshi of Enbekshikazakh district, and covers an area of 1 hectar. The height of Artemisia annua L in the CP was 140.4 ± 4.0 cm, diameter 12.6 ± 0.3 cm. Co-dominants - *Artemisia vulgaris* L., *Cirsium vulgare* (Savi) Ten. The presence of tiers is not marked. the operational stock of raw materials was estimated at 1.5 centners, the amount of possible raw material harvesting was 0.6 centners.

Coenopopulation 8 (CP 8) 43º40'48,1"N, 77º29'76,03" E. is located in the vicinity of the village of Avat of the Enbekshikazakh district on the edge of a corn field on an area of 1.1 hectares, the operational reserve is estimated at 5.8 centners, of which 2.3 centners can be harvested annually. Co-dominants *Xanthium strumarium* L., *Cannabis ruderalis* L. The average height of wormwood in the CP is 130.0 ± 3.1 cm, diameter - 34.2 ± 0.9 cm.

Coenopopulation 9 (CP 9) is located in the vicinity of the village of Turgen, Enbekshikazakh district 43º41'11,62"N, 77º61'14,19" E. on an abandoned field of 1.3 hectares, the operational reserve is estimated at 11.6 centners, of which 4.6 cent can be harvested annually. Edificator *Artemisia annua* L., Co-dominants *Xanthium strumarium* L., *Polygonum aviculare* L. The average height of wormwood in the CP is 129.3 ± 3.6 cm, diameter - 35.8 ± 0.7 cm.

Coenopopulation 10 (CP 10) was marked near the village of Enbek Enbekshikazakh district 43º40'48,1"N, 77º29'76,03" E. 43º47'46,69" N, 77º45'27,44" E. in an abandoned field, the total area was 2.5 hectares, the operational reserve is estimated at 13.8 centners, of which 5.5 cent units can be harvested annually. Edificator *Artemisia annua* L., Co-dominants - *Cichorium intybus* L., *Polygonum aviculare* L. The average height of thicket in the CP is 117.4 ± 2.9 cm, diameter - 25.6 ± 0.8 cm.

Thus, according to the results of resource studies on the territory of the Almaty region, 10 *Artemisia annua L.* coenopopulations were found, the total operating stock was 112.2 centners, of which the annual harvesting volume was 44.8 centners (figure 3).

The most promising for the procurement of raw materials is the CP 4 with an operating stock of 21.8 c, but, due to the increased economic activity, we can see a noticeable decrease in the raw material stocks of *Artemisia annua L.* in the Almaty region of the Republic of Kazakhstan. In the event of an increase in the demand for raw materials of *Artemisia annua L.*, cultivation is recommended under conditions acceptable to growing, since one-year wormwood successfully goes through all phases of growth and gives a high yield of above-ground mass in Kazakhstan [15].

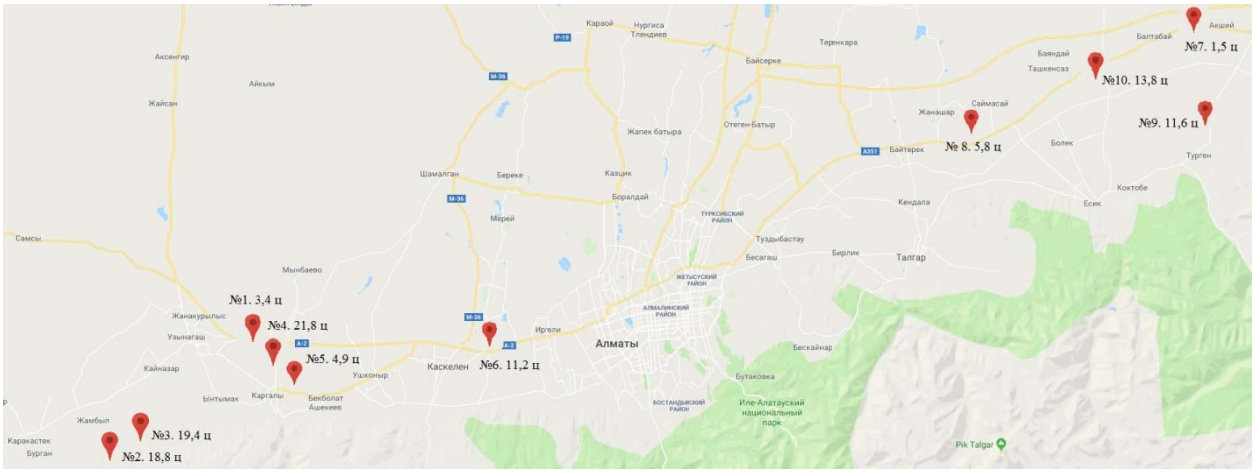


Figure 3 – Map of Artemisia annua L raw materials on the territory of Almaty region

– Marker designation of sites for the collection of raw materials.

To determine promising coenopopulations in terms of the content of the target substance artemisinin (1), we conducted studies to determine the optimal modes of supercritical fluid extraction of *Artemisia annua L.* collected in 10 coenopopulations to obtain an extract with quantitative content of artemisinin (**1**).

The results of supercritical fluid extraction and quantification of artemisinin are shown in table 2, which shows the average values for 3 experiments.

Table 2 – Comparison of the output of CO_2-extract of wormwood annual and the volume of the possible production of artemesinin (1) from the place of collection of raw materials

Place of collection	Output of extract, %	Content of Artemesinin, % (g)	Volume of artemisinin production, kg/year
neighborhood of the village Avat	7,2	5,48 (0,40)	0,92
neighborhood of the village Turgen	6,5	9,44 (0,62)	2,85
neighborhood of the village Enbek	7,6	9,48 (0,72)	3,96
neighborhood of the village Sayan	5,2	13,30 (0,70)	6,09
neighborhood of the village Kainar	4,33	17,47 (0,76)	1,44
neighborhood of the village Kaskelen	7,5	17,92 (1,34)	6,03
neighborhood of the village Akshi	6,4	8,10 (0,52)	0,99
neighborhood of the village Uzunagash	10,0	0,80 (0,08)	0,11
neighborhood of the village Shilkibay	5,0	3,03 (0,15)	1,13
neighborhood of the village Shilkibay (2 km away from first thicket)	6,5	1,36 (0,10)	0,78

As can be seen from table 2, the content of artemisinin (1) varies from 0.1% (neighborhood of Shilikbay) to 1.34% (neighborhood of Kaskelen), depending on the place of collection, therefore promising in terms of industrial production of artemisinin (1) are coenopopulations of *Artemisia annua L.* in the vicinity of Kaskelen village with artemisinin content up to 1.34%, Sayan village - up to 0.7% and Enbek village - up to 0.72%, which is 6.03 kg per target substance (1), 6.09, kg and 3.96 kg respectively.

Conclusion. On the territory of the Almaty region in the Republic of Kazakhstan promising for industrial workpieces in terms of the amount of raw material harvested are thickets of *Artemisia annua L.* in the vicinity of the Shilikbai and Sayan settlements (coenopopulations 2, 3, 4). In general, the total operational stock of air-dry raw wormwood in the surveyed cenopopulations was 11.22 tons, with a possible annual harvest of 4.48 tons, while the average content of artemisinin in air-dry raw materials is 0.26%, which is on the target substance is 8.0 kg of artemisinin. The total area for collecting air-dry raw

wormwood was 15.4 hectares. At the same time, according to the content of artemisinin in raw materials, the most promising are coenopopulations in the vicinity of the villages of Kaskelen, Sayan, Enbek (1.34%, 0.7% and 0.72%, respectively) with the possibility of total annual procurement of air-dry raw wormwood in an annual amount of 1 , 87 tons, while the average content of artemisinin in air-dry raw materials is 0.92%, which in terms of the target substance is an average of 16.0 kg of artemisinin. That is why, *Artemisia annua L.* with rational use of the identified thickets in the Almaty region is provided with a raw material base and its operational reserves in the vicinity of the villages of Kaskelen, Sayan and Enbek are the basis of the industrial production of the antimalarial drug «Artemizinin».

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С. М. Әдекенов, Е. М. Ғабдуллин, И. А. Хабаров, Б. Б. Бекеев, З. Қ. Шәушеков

«Фитохимия» халықаралық ғылыми-өндірістік холдингі» АҚ, Қарағанды, Қазақстан

БІРЖЫЛДЫҚ ЖУСАННЫҢ (*ARTEMISIA ANNUA* L.) ТАРАЛУЫ ЖӘНЕ ОНЫҢ ҚҰРАМЫНДАҒЫ АРТЕМИЗИНИН

Аннотация. Мақалада безгекке қарсы «Артемизинин» препаратының өнеркәсіптік көзі болып табылатын біржылдық жусанның (*Artemisia annua* L.) Қазақстан Республикасы Алматы облысындағы шикізат қорына баға беріліп, оның ресурстарын зерттеу нәтижелері келтірілген. Біржылдық жусан өсімдік бірлестіктеріне фитоценоздық сипаттама берілді, оны пайдалану қоры және шикізатын жыл сайын дайындаудың ықтимал көлемі белгіленді.

Әртүрлі ценопопуляциялардағы біржылдық жусан шикізатының құрамындағы фармакологиялық белсенді артемизинин сесквитерпенді лактонының мөлшері талқыланады. Біржылдық жусанның табиғи қорларын пайдалану бойынша ұсынымдар берілді.

Түйін сөздер: *Artemisia annua* L., ценопопуляция, пайдалану қоры, шикізат, CO_2-экстракциялау, сесквитерпенді лактон, артемизинин.

С. М. Адекенов, Е. М. Габдуллин, И. А. Хабаров, Б. Б. Бекеев, З. К. Шаушеков

АО «Международный научно-производственный холдинг «Фитохимия», Караганда, Казахстан

РАСПРОСТРАНЕНИЕ ПОЛЫНИ ОДНОЛЕТНЕЙ (*ARTEMISIA ANNUA* L.) И СОДЕРЖАНИЕ АРТЕМИЗИНИНА

Аннотация. В статье приводятся результаты изучения ресурсов и оценка сырьевой базы промышленного источника антималярийного препарата «Артемизинин» полыни однолетней (*Artemisia annua* L.) в Алматинской области Республики Казахстан. Проведена фитоценотическая характеристика сообществ, определен эксплуатационный запас и возможный объем ежегодных заготовок сырья полыни однолетней.

Обсуждается содержание фармакологически активного сесквитерпенового лактона артемизинина в сырье полыни однолетней из разных ценопопуляций. Приведены рекомендации по эксплуатации природных запасов полыни однолетней.

Ключевые слова: *Artemisia annua* L., ценопопуляция, эксплуатационный запас, сырье, CO_2-экстракция, сесквитерпеновый лактон, артемизинин.

Information about authors:

Adekenov S. M., JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan; phyto_pio@mail.ru; https://orcid.org/0000-0001-7588-6174

Gabdullin E. M., JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan; phyto_pio@mail.ru; https://orcid.org/0000-0002-6444-444X

Khabarov I. A., JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan; phyto_pio@mail.ru; https://orcid.org/0000-0002-6727-8870

Bekeev B. B., JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan; phyto_pio@mail.ru; https://orcid.org/0000-0003-2100-7626

Shaushekov Z. K., JSC «International research-production holding «Phytochemistry», Karaganda, Kazakhstan; phyto_pio@mail.ru; https://orcid.org/0000-0002-3162-2748

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K. Kh. Zhumatov, A. I. Kydyrmanov, M. Kh. Sayatov

LLP «SPC Microbiology and Virology», Almaty, Kazakhstan.
E-mail: Kainar60@yahoo.com, kydyrmanov@yandex.kz, sayatov37@mail.ru

INFLUENZA A/H9 VIRUSES – IMPORTANT INFECTIOUS PATHOGENS OF WILD BIRDS, MAMMALS AND HUMAN

Abstract. Influenza occupies one of the first places among infectious diseases in terms of the number of biological species involved in the infectious process, and is characterized by global spreading and great economic and social significance. The ubiquitous and uncontrolled circulation of influenza A viruses is primarily due to their unique variability, which is based on both point mutations characteristic of RNA-containing viruses and recombination and reassortment of genes. The review article describes the structural features, sources of isolation and the current classification of influenza pathogens. The main groups of influenza viruses that infect humans, mammals and birds are characterized. The latest literature data on various issues of the structure, ecology, pathogenicity and evolutionary variability of influenza A/H9 viruses of various species origin are summarized. Information is provided on the evolutionary variability of viruses of this group circulating in avifauna, populations of mammals and human. The conclusion is done about the importance of influenza A (H9N2) viruses as a donor in the processes of reassortation and exchanging genetic information between influenza Aviruses of various subtypes and the emergence of new, epidemically relevant variants. The need to control circulation of influenza A (H9N2) viruses in order to prevent contact of infected poultry with people and possible appearance of epidemic strains is emphasized.

Key words: influenza virus, A/H9 subtype, bird, genome, variability, phylogenesis, hemagglutinin, antigenic drift.

Influenza occupies one of the first places among infectious diseases in terms of the number of biological species involved in the infectious process, and is characterized by global spreading and great economic and social significance [1].

Influenza viruses belong to the Orthomyxoviridae family, and are divided into genera: Influenza virus A, B, C, D, as well as *Quaranjavirus, Thogotovirus* and *Isavirus*; the last two infect leporids and salmon [2]. *Quaranjavirus* representatives circulate both among invertebrates (ticks) and vertebrates (aquatic birds) hosts [3].

Influenza A viruses are widespread in the environment and affect humans, some mammals and birds.

The global and uncontrolled spread of influenza A viruses takes place primarily due to their unique variability, which is based on point mutations that are characteristic of RNA-containing viruses and recombination and reassortment of genes. Their genome consists of eight segments encoding the synthesis of surface glycoproteins HA and neuraminidase (NA), M1 and M2 matrix polypeptides, NS1 and NS2 non-structural proteins, nucleocapsid (NP), polymerases (PB1, PB2, PA) and F2 protein. The most variable structural components of the virion are surface antigens, HA and NA, which play an important role in the initial stages of cell infection, since it is against them that protective antibodies are formed in the host organism.

The classification of influenza A viruses is based on antigenic differences of NA and NA, detected in serological reactions using specific sera, or in BLAST analysis of sequenced genes [4]. The subtype affiliation of all currently isolated influenza A viruses is determined by a combination of known HA and NA subtypes - H1N1, H3N2, H5N1, H7N7, and others, in avifauna, at least 55 variants were isolated [5, 6].

The most recently identified subtypes of NA and NA, are represented in influenza A (H17N10) and A (H18N11) viruses isolated from bats in Central America [7]. Due to the absence of hemagglutinating and neuraminidase activity in these viruses, some authors suggest labeling their surface glycoproteins as "HA-like" and "NA-like", that is "HL17NL10" and "HL18NL11", respectively [8].

In the last century, representatives of the H1N1 subtype caused a devastating pandemic of 1918, which killed more than 40 million of people around the world. The pandemics of 1957 (H2N2) and 1968 (H3N2) caused the death of hundreds of thousands of people [9].

The natural reservoir of influenza A viruses are wild birds, mainly related to waterfowl [10, 11]. If the interspecies barrier between birds and mammals is overcome, the influenza A pathogen, after initial adaptation for a rather long period, may acquire the ability to infect a new species, and later circulate in this ecological niche for many decades as an endemic pathogen. Currently such endemic infections include swine, eqine and canine influenza, most cases of human influenza. In addition, low pathogenic influenza viruses can cause sporadic, localized epizootics among minks, seals, whales [12]. It should be noted that avian flu is a potentially zoonotic infection that affects poultry and can be transmitted to humans, causing mostly self-limited respiratory diseases. In some cases, they can lead to multiple organ malfunctions resulting in death, especially in immunocompromised patients.

Influenza A(H9N2) virus has been isolated for the first time from wild birds and turkey in USA in 1966 [13]. It is the most propagated subtype among poultry all over the world. During two last decades H9N2 viruses were found in wild birds, poultry, swine, horses, weasels, mink, ferrets and humans [14-19]. In poultry it usually manifests in form of slight clinical signs (e.g. breathing malfunction, drop of egg production and loss of body mass). Lethal cases occur mainly during mixt infections with bacteria and other viruses [20]. The agent also cause temporary immunosuppression which may worsen another coinside or secondary infections [21]. All H9N2 viruses are considered low pathogenic avian influenza viruses based on the lack ofmortality in the standardized in vivo pathotyping test in specific pathogen-free (SPF) chickens [22].

In humans, H9N2 most often causes mild respiratory disease, but sometimes lethalitycases are observed. Direct transmission of H9N2 from birds to humans has rarely been reported, but serological studies have shown that the prevalence of H9N2 infection in humans is higher than the number of confirmed cases [23-27]. It is noteworthy that all highly pathogenic avian influenza viruses that cause fatal infections in humans (for example, H5N1, H7N9 and H10N8) and registered in the last two decades have acquired gene segments from H9N2 [28-30]. One of the most likely places of origin for such reassortants can be the live poultry markets, which are widespread in the countries of Southeast Asia.For example, M. Hu [31] investigated 618 biological samples collected in 24 markets in Nanchang district (China) in December 2013 and January 2014. Of the 201 samples that were positive in real-time PCR, 20.9% (42/201) contained different HA subtypes. At the same time, in 50% of mixed infections (21/42), the presence of HA subtypes H9 and H10 is shown, with the detection of HA H5 in some cases. According to the authors, this indicates that the H10N8 virus was caused by the reassortment of representatives of the H9 and H10 subtypes. In the same time period, three cases of human infection with the H10N8 virus were reported in Nanchang, one of which was fatal [32].

The evolution of the H9N2 virus in recent decades in poultry has led to diversification into several genotypes. Some have disappeared, while others are still evolving. In 1999, Guan et al. [33] based on the HA gene sequences, grouped H9N2 viruses from Europe, Asia and Africa into several different genotypes represented by their prototype strains: A/quail/Hong Kong/G1/97 (G1-like), A/duck/Hong Kong/Y280/9 (Y280-like), A/chicken/Beijing/1/94 (BJ94-like) and A/chicken/Korea/38349-P96323/96 (Korea-like). Later, Fusaro et al. [34] as a result of phylogenetic analysis of all gene segments of H9N2 viruses isolated in Asia and Europe from 1998 to 2010, revealed four monophyletic groups (A, B, C, D) and the presence of reassortment between them.

The H9N2 virus, along with other avian influenza viruses, is subject to genetic changes affecting the virulence, pathogenicity and specificity of the host. Antigenic drift caused by the absence of the mechanism for correcting viral RNA polymerase in influenza A virus causes high genetic variability due to point mutations in the nucleotide sequence of the genome [35].These mutations ultimately lead to amino acid substitutions in structural proteins and surface glycoproteins HA and NA are particularly interesting in

this regard. Over time, changes in them are summarized in serologically determined antigenic differences between isolates [42, 36, 37].

At the same time, influenza A virus has a segmented genome, which allows their reassortment in the event that two differentviruses infect a single host cell resulting in generation of progeny with genes from both parents. This process is called antigenic shift, as a result of which pathogens of human influenza pandemics can occur. Ultimately, reassortment of gene segments provides the possibility of the rapid emergence of new viruses with unique phenotypic characteristics [42].

It is believed that avian influenza viruses easily infect other organisms, but rarely reproduce well in changing conditions in order to maintain the infection and subsequently become endemic to them [42, 38]. The transition to a new host is facilitated by the fact that they use the surface protein HA to attach to sialic acid as part of the receptor on the surface of the host cell. Sialic acid is the final sugar of *N*- and *O*-linked glycoproteins that are present in most host cell receptors in birds and mammals, which allows viruses to use this universal structure. There are many types of sialic acid, and the relative affinity of HA varies depending on its type, which is one of the factors of host specificity. The majority of influenza A viruses interact with receptors containing α-2,3-linked sialic acid (α-2,3-SA) found in the respiratory and gastrointestinal tracts of birds [35, 42, 43]. In most people, the upper respiratory tract receptors contain α-2,6-SA, with which pathogens adapted to humans form a stronger connection. Many currently circulating isolates of the H9N2 G1 and Y280 lines have mutations that lead to a high affinity for the α-2,6-SA receptor [21, 37, 42, 39]. These changes in HA viruses of the G1 and Y280 lines increase the likelihood of their transmission to humans or other mammals without any additional modification [21]. In turn, the ability of serotype H9N2 viruses to infect people without changing the binding affinity for the receptor increases the likelihood of genetic reassortment between avian and human influenza viruses. In addition, a study of the type and prevalence of various conformations of sialic acid receptors showed that poultry of some species have receptors in the respiratorytract with both α-2,6-SA and α-2,3-SA molecules [42]. These include quails, turkeys and pheasants, which are often found in the live poultry markets, where the H9N2 viruses can thus be transmitted to other species, including humans [40]. Monitoring of avian markets with a high frequency of detection of influenza A viruses of many subtypes is of particular interest, as close contact between people and birds provides ample opportunities for their zoonotic transmission [41].

It was previously shown that influenza A viruses adapted to birds contain glutamine (*Q*) at position 226 of HA, while pathogens that infect humans carry leucine (*L*). Analysis of the amino acid sequence variations of the H9N2 viruses from the GenBank database showed that almost all avian, human and porcine viruses at position 228 contain glycine, which is characteristic of binding to receptors of birds with α-2,3-SA. In position 226, with rare exceptions, only *Q* or *L* was found. Thus, all H9N2 viruses from North America and Korea had *Q*. Representatives of the Y280 and G1 lines possessed *Q* until 2000, but already after 2000 most of them carried *L*at this locus [42]. It is believed that the presence of *L* at position 226 is a factor contributing to the transition of viruses from birds to humans. The reason for the change for *L* in this position in poultry viruses is unclear, but a similar modification is seen in a significant percentage of Chinese avian H7N9 viruses and in an even larger proportion of human H7N9 viruses [43]. The effect of the selective pressure of the human immune system on infectious viruses with an L preference in this position is assumed. Thus, 91.3% of the H9N2 isolates isolated from 1998 to 2016 were characterized by the presence of 226L [49].

Another potential source of antigenic drift in avian H9N2 viruses is vaccination, carried out in many countries where this pathogen is endemic in poultry. Vaccine-induced antibodies exert strong immunological pressure, promoting the appearance of various viruses. Thus, vaccination against H9N2 viruses in Korea reduced their genetic diversity, effectively excluding one of the two lines from the circulation (clade A). As a result of this genetically distinct from vaccine strainco-circulating clade B increased its antigenic diversity and became dominant [44].

Reassortingof gene segments is often observed between endemic H9N2influenza viruses. The mapping of phylogenetic relationships of H9N2 isolates from chickens revealed three main variants. Genotype A, common in the 1990s, was replaced with H better adapted to poultry, and dominating until the mid-2000s. Then in 2007, it was replaced by genotype S viruses, which included G1-like segments of PB2, M and the genetic basis of F/98-like viruses (A/chicken/Shanghai/F/1998) [45].

The genotype S is characterized by increased infectivity, isolation rate, titers, preference for the 2,6-linked sialic acid receptor prevalent in humans and large economic losses, it was he who donated to the internal genes of the H5 and H7 viruses [52, 46-48]. The 2013 A/H7N9 influenza outbreak causative agent in China had all six internal genes derived from the H9N2 viruses, and this new virus line infected both birds and humans [50].

Phylogenetic analysis indicated a distinct genetic diversity of H9N2 viruses and the presence of at least four lines of viruses adapted to domestic birds. When comparing human viruses and poultry viruses, it turned out that all human viruses sequenced belong to the Y280 or G1 lines. No human cases caused by wild bird viruses, or Korean and European lines, have been reported. At the same time, Y280 viruses compared with the G1 line were recorded more often, it is not clear, however, whether this reflected their increased zoonotic potential; perhaps the reason lies in greater isolation rate. The last G1 virus was isolated from humans in 2011, while the Y280 viruses are registered in 2017 [49].

Placed in GenBank and GISAID 24 sequences of the human influenza virus H9N2, which until recently had been available, allowed for comparative genetic analysis. As mentioned earlier, most human viruses contain *L* at position 226 HA, which corresponds to human-adapted viruses. Other adaptation markers are identified in the PB2 and PB1 polymerase genes. The marker in position 627 PB2 is one of the most well characterized; most strains of birds contain glutamic acid in this site, and adapted human viruses - *L*. One of the selective advantages of *L* in this position is increased polymerase activity at low temperature. At a higher temperature typical for birds, glutamic acid at position 627 performs better. Human virus replication mainly occurs in the upper respiratory tract, where the temperature is lower, and *L* provides a more efficient polymerase activity. When analyzing avian and human isolates of the H9N2 influenza virus in PB2 protein, 4 positions were found, where human isolates had the highest percentage of adaptive changes compared to avian viruses. It should be noted that all adaptive mutations characteristic for human viruses are found in at least some avian strains. Over 11% of avian isolates had valine at position 588, which is considered an adaptive amino acid in humans. This change is also associated with polymerase activity [50]. Although the percentage of most of these human-adapted markers appears to be low in viruses in poultry populations, their presence seems to increase the likelihood of viruses that can be transmitted to humans.

In the Republic of Kazakhstan, ecological-virological studies of avifauna were first undertaken in 1979 at the Institute of Microbiology and Virology of the Academy of Sciences of the Kazakh SSR. Since then, up to now, important data have been obtained on various aspects of influenza in wild and domestic birds, and extensive research experience has been gained using the latest molecular genetic research methods. Over the past period, many influenza A viruses have been isolated with various combinations of surface glycoproteins, but no influenza A (H9N2) viruses have been identified [51-57]. In 2014, during the screening of biological materials collected in North-Kazakhstan oblast from wild waterfowl, three viruses of influenza A/H9 were detected by the staff of the laboratory of the ecology of viruses of the LLP «SPC Microbiology and Virology». At present, they are carried out on their full genomic sequencing with a target for a detailed study of phylogenetic characteristics.

In general, literature data indicate the importance of influenza A (H9N2) viruses as a donor in the process of reassorting and exchanging genetic information between influenza A viruses of various subtypes and the emergence of new, epidemically relevant variants. There is an obvious need to limit its distribution among poultry and further transferring to humans and other species, for which vaccination programs, biosafety at poultry farms, and control of live poultry markets are necessary.

Қ. Х. Жұматов, А. И. Қыдырманов, М. Х. Саятов

«Микробиологияжәне вирусология ҒЗО» ЖШС, Алматы, Қазақстан

А/Н 9 ТОБЫНДАҒЫ ВИРУСТАР – ЖАБАЙЫ ҚҰСТАР, СҮТҚОРЕКТІЛЕР МЕН АДАМДАРДЫҢ ӨЗЕКТІ ИНФЕКЦИЯЛЫҚ АГЕНТТЕРІ

Аннотация. Тұмау, экономикалық және әлеуметтік маңызы бар ғаламдық таралумен сипатталатын инфекциялық індеттердің ішінде биологиялық түрінің көптігіне байланысты алғашқы орындардың біріне ие. Тұмау А вирусының жер-жердегі және бақыланбайтын айналымы, ең алдымен олардың РНҚ-бар вирустарға тән нақты мутациялар негізіндегі түрленгіштігінде, сонымен қатар гендердің рекомбинациясы және реас-

сортациясымен түсіндіріледі. Шолымдық мақалада тұмау қоздырғыштарының бөліну көздерімен заманауй жіктелуінің құрылымдық ерекшеліктері сипатталады. Шығу тегі әр-түрлі тұмау A/H9 вирустарының құрылымы, экологиясы, патогендігі және эволюциялық өзгергіштігі жөнінде әртүрлі сұрақтарды қамтитын әдебиеттердің соңғы деректері қамтылған. Жабайы орнитофаунада, сүтқоректі жануарлар популяциясымен тұрғындар арасында айналымда болатын аталған топтағы вирустардың эволюциялық өзгергіштігі жөнінде мәліметтер келтіріледі. Түртармақтары әртүрлі тұмау А вирустары және пайда болған жаңа, эпидемиялық өзекті нұсқалардың арасында генетикалық ақпараттың алмасуымен реассортация кезеңіндегі донор ретінде тұмау (H9N2) вирустарының маңыздылығына қорытынды жасалады. Зақымдалған жануарлардың адаммен байланысуын және эпидемиялық штамдардың пайда болу мүмкіндігін болдырмау мақсатында тұмау А (H9N2) вирусының айналымын қадағалау қажеттілігіне мән береді.

Түйін сөздер: тұмау вирусы, A/H9 түртармақ, құс, геном, өзгергіштік, филогенез, гемагглютинин, антигендік дрейф.

К. Х. Жуматов, А. И. Кыдырманов, М. Х. Саятов

ТОО «НПЦ микробиологии и вирусологии», Алматы, Казахстан

ВИРУСЫ ГРИППА A/H9 – АКТУАЛЬНЫЕ ИНФЕКЦИОННЫЕ АГЕНТЫ ДИКИХ ПТИЦ, МЛЕКОПИТАЮЩИХ ЖИВОТНЫХ И ЧЕЛОВЕКА

Аннотация. Грипп занимает одно из первых мест среди инфекционных болезней по количеству биологических видов, вовлекаемых в инфекционный процесс, характеризуется глобальным распространением и большой экономической и социальной значимостью. Повсеместная и неконтролируемаяциркуляция вирусов гриппа А объясняется, прежде всего, их уникальной вариабельностью, в основе которой лежат как точечные мутации, характерные для РНК-содержащих вирусов, так и рекомбинации и реассортации генов. В обзорной статье описываются структурные особенности, источники выделения и современная классификация возбудителей гриппа. Обобщены последние данные литературы по различным вопросам строения, экологии, патогенности и эволюционной изменчивости вирусов гриппа A/H9 различного видового происхождения. Приводятся сведения об эволюционной изменчивости вирусов этой группы циркулирующих в дикой орнитофауне, популяциях млекопитающих животных и среди населения. Делается вывод о важности вирусов гриппа А (H9N2) как донора в процессах реассортации и обмена генетической информацией между возбудителями гриппа А различных подтипов и возникновения новых, эпидемически актуальных вариантов. Подчеркивается необходимость контроля циркуляции вирусов гриппа А (H9N2) с целью предотвращения контактов инфицированного поголовья с людьми и возможного появления эпидемических штаммов.

Ключевые слова: вирус гриппа, подтип A/H9, птица, геном, изменчивость, филогенез, гемагглютинин, антигенный дрейф.

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S. A. Aitkeldiyeva, E. R. Faizulina, O. N. Auezova, L. G. Tatarkina, G. A. Spankulova

LLP "Scientific Production Center of Microbiology and Virology", Almaty, Kazakhstan.
E-mail: sa.kz@list.ru, ecomicrolab@gmail.com

ISOLATION AND STUDY OF THERMOTOLERANT OIL-OXIDIZING MICROORGANISMS

Abstract. Climatic conditions limit the effectiveness of the use of the most known remediation methods in regions with hot climates. In the oil-producing regions of Kazakhstan, the climate is characterized by seasonal and daily temperature differences, high rates of water evaporation, salinity and low soil moisture. In this regard, the problem of the development and application of technologies adapted to the above conditions is relevant for Kazakhstan and other countries. Thermotolerant hydrocarbon-oxidizing microorganisms, adapted to extreme climatic conditions, are capable of oxidizing petroleum hydrocarbons at elevated temperatures.

The purpose of the research was isolation and selection of cultures of thermotolerant oil-oxidizing microorganisms, as well as the study of their activity.

From the contaminated soil of the Zhanatalap field (Atyrau region), 72 cultures were isolated by the method of enrichment cultures. Among them 15 cultures showing good and moderate growth at 35^{o}C were selected, 7 cultures – at 40^{o}C and 12 cultures – at 50^{o}C. Their oil oxidizing activity was studied. It was shown that during the cultivation of isolates in a liquid mineral medium with oil, the degree of its destruction at 35^{o}C was 18.7-52.0%, at 40^{o}C – 22.7-31.5%, and at 50^{o}C – 17.7-33.8 %.

Keywords: oil, oil pollution, thermotolerant oil-oxidizing microorganisms, oil destruction.

Numerous disturbances of the ecological balance in nature ultimately lead to environmental disasters. Currently, among the various man-made disturbances of nature, one of the most serious and difficult to repair is oil pollution. Oil and its components (aromatic, naphthenic and paraffinic hydrocarbons) are among the most dangerous pollutants entering the soil in the processes of extraction, transportation, processing and storage. Increasing environmental pollution with oil and petroleum products leads to serious disturbances in natural ecosystems, biological balance and biodiversity. In areas of oil production, the anthropogenic impact on land resources is increasing, which leads to the emergence of man-made changes in the state of the soil. Oil and petroleum products cause almost complete depression of the functional activity of flora and fauna, adversely affecting the links of the biological chain [1, 2]. In the oil-producing regions of Kazakhstan, environmental problems are aggravated by the intensive development of the gas and oil refining industry, which has a negative impact on public health. Allergic diseases such as dermatitis, bronchial asthma and the like are widespread [3].

According to estimates by the United States Environmental Protection Agency (EPA USA), the volume of contaminated soil by oil and oil products exceeds 1 billion cubic meters. Only in the EU there are more than one and a half million polluted areas, for the cleaning of which more than 85 billion euros are needed [4, 5]. In Kazakhstan, in the areas of oil production, the presence of more than 200 thousand hectares of oil-contaminated land has been established [6].

The main risk of pollution by oil and oil products are the regions where the deposits are located and oil is being produced. About 60% of the world's oil reserves are located in countries with hot climates. Temperature conditions are the limiting factor in the remediation of oil-polluted soils and suggest a careful approach to the choice of methods for cleaning contaminated land [7, 8].

One of the main problems of remediation of territories in a hot climate is the fact that high temperatures reduce the viscosity of oil and, thus, accelerate its diffusion deep into the soil. In addition, the evaporation of light fractions of oil at elevated temperatures leads to air pollution by toxic products, while the remaining non-volatile components with high molecular weight form films that are poorly biodegradable. At the same time, elevated average daily temperatures are responsible for the rapid evaporation of water from the soil and from the surface of water reservoirs, which leads to their salinization [9].

A significant contribution to the process of biological destruction of oil is made by hydrocarbon-oxidizing microorganisms, which are a permanent component of soil biocenoses [10]. Promising remediation agents for oil-polluted areas in regions with high temperatures are thermotolerant microorganisms that are resistant and adapted to the lack of water in the soil and the elevated salt content in the area being treated.

Depending on the temperature, bacterial activity and rates of biodegradation may vary seasonally. The effect of temperature on the growth of microorganisms is due to its effect on the rate of chemical reactions in the cell and the state of cellular macromolecules (membrane viscosity, protein conformation, etc.).

In relation to temperature, microorganisms are divided into the following groups: psychrophilic (minimum – about 0^{o}C, maximum – below 20^{o}C); psychroactive / psychrotrophic (minimum – about 0^{o}C, optimum and maximum – above 20^{o}C); mesophilic (minimum – above 0^{o}C, maximum – up to 45^{o}C); thermophilic (maximum above 45^{o}C).

Thermophilic microorganisms, in turn, depending on the temperature range, are divided into 5 groups:

1. Thermotolerant (minimum - + 10^{o}C; optimum - + 35-40^{o}C, as in mesophiles; maximum - + 55-60^{o}C);

2. Facultative thermophiles (minimum - below + 20^{o}C; maximum - + 55-65^{o}C);

3. Obligate thermophiles (minimum - + 40^{o}C; optimum - adjacent to the upper limit (+ 65-70^{o}C); maximum - above + 70^{o}C);

4. Extreme thermophiles (minimum - above + 40^{o}C; optimum - + 70-75^{o}C; maximum - above + 90^{o}C);

5. Hyperthermophiles (minimum - about + 70^{o}C; optimum - above + 80^{o}C; maximum - above + 100^{o}C) [11].

The enzymes used by thermotolerant bacteria to destroy hydrocarbons operate at higher temperatures than the enzymes of common mesophilic destructors. Therefore, thermotolerant microorganisms can and should be used in the remediation of oil-contaminated soils and waters under conditions of high ambient temperatures. However, the diversity of thermotolerant bacteria, their metabolic pathways of degradation and transformation of hydrocarbons are poorly studied.

In this connection, the isolation and study of thermotolerant microorganisms-destructors of petroleum hydrocarbons is current.

The purpose of this work was isolation and selection of cultures of thermotolerant oil-oxidizing microorganisms, as well as the study of their activity.

Materials and methods. The isolation of new thermotolerant oil-oxidizing microorganisms was carried out by the method of enrichment cultures. In Erlenmeyer flasks with 200 ml of Voroshilova-Dianova (VD) mineral medium, 20 g of oil-contaminated soil and 10 ml of Zhanatalap field oil were added. The flasks were placed in thermostatic shakers at temperatures of 35^{o}C, 40^{o}C, 50^{o}C. After 14 days, the first passage was conducted on a fresh medium with oil, another 14 days later - the second passage.

Isolation of oil-oxidizing microorganisms was carried out by seeding the culture liquid in Petri dishes with nutrient agar. Grown up individual colonies were seeded with streak plating to check purity. Pure cultures were re-seeded on slant nutrient agar.

The ability of the isolated cultures to grow on oil was studied in a liquid mineral VD medium. 5 ml of the cell suspension of each strain studied and 1 ml of Zhanatalap oil (Atyrau region) were added in flasks with 100 ml of medium. The flasks were incubated in thermostatic shakers (120 rpm) at appropriate temperatures for 7 days. The destruction of oil was judged visually by the change in oil slick and biomass accumulation.

Quantitative oil consumption was determined by gravimetric [12], and the component composition – by gas chromatographic methods [13]. In flasks with 100 ml of mineral medium, 2% of oil was added.

Then 5 ml of suspension of the studied cultures was added. Cultivation was carried out in thermostatic shakers at appropriate temperatures for 14 days. The residual oil was extracted with chloroform.

All experiments were performed in 3 replicates.

Statistical processing of the research results was carried out according to generally accepted criteria of variation statistical analysis with the calculation of average values (M), arithmetic average error (m) using the computer package Microsoft Excel, 2010. The statistical significance of differences in average values was estimated using the standard method [14]. The differences with $p < 0.05$ were considered statistically significant.

Results and discussion. Oil-oxidizing microorganisms growing at elevated temperatures were isolated from oil-contaminated soils of Western Kazakhstan by the method of enrichment cultures. In total, 34 cultures were isolated from the initial enrichment cultures and two subsequent passages at a temperature of 35°C, 24 isolates – at 40°C, and 14 isolates – at 50°C. Bacterial cultures differed in shape, size, and surface of colonies. Non-pigmented colonies were met mostly.

Selected cultures were tested for the ability to grow in a liquid mineral medium in the presence of 1% oil (table). Their growth was evaluated visually by changes in the oil slick and biomass accumulation.

The number of thermotolerant microorganism cultures growing in mineral medium with oil

Temperature	Total cultures	Growth intensity	
		moderate	good
35 °C	34	10	4
40 °C	24	7	–
50 °C	14	4	8

At 35°C, 4 cultures showed good growth in oil. At the same time, there was no oil film on the surface of the medium, the oil itself was either converted into a homogeneous emulsion, or was in the form of small suspended particles. There was a significant increase in biomass. 10 cultures showed moderate growth. The remaining isolates showed no significant activity.

At 40°C, none of the studied cultures showed good growth. 7 cultures grew moderately in these conditions. A suspension of small particles of oil with biomass was observed in the culture liquid; oil on the surface of the medium was partially preserved as a thin film.

At 50°C from the 14 tested cultures, 8 showed a good growth, 4 cultures showed moderate growth and only 2 cultures grew poorly.

Thus, 15 cultures that showed good and moderate growth at 35°C, 7 cultures at 40°C and 12 cultures at 50°C were selected for further research.

Studying the ability of selected cultures of thermotolerant oil-oxidizing microorganisms to utilize oil at 35°C showed that when they grew in a liquid mineral medium with oil, the degree of its destruction was 18.7-52.0% (figure 1). In most of the cultures tested, oil utilization did not exceed 28%. Three cultures consumed over 35% of oil. The most active were the cultures of P1-35-14 and P2-35-9. When incubated, the destruction of oil was more than 50%.

At 40°C, in most of the studied cultures, the degree of oil destruction was 22.7-25.3% (figure 2). Only in two isolates IP-40-4 and P1-40-8 it exceeded 30%.

At 50°C, the destruction of oil was about the same. The three most active isolates IP-50-3/1, P2-50-5 and P2-50-2 utilized 29.4-33.8% of oil (figure 3). Abiotic losses of oil were 10.1% and 10.8% at 40°C and 50°C, respectively.

Gas chromatographic analysis of oil after cultivation of selected strains of microorganisms showed that, during the experiment, at all temperatures studied, reactions occur, as a result of which the content of the main components of oil changes. According to the data obtained in the experimental samples, a decrease in the number of n-alkanes occurred. Also it was noted a decrease in basic aromatic hydrocarbons. Figure 4 shows the chromatograms of the oil of the control and the test sample after 14 days of cultivation with culture P2-35-9.

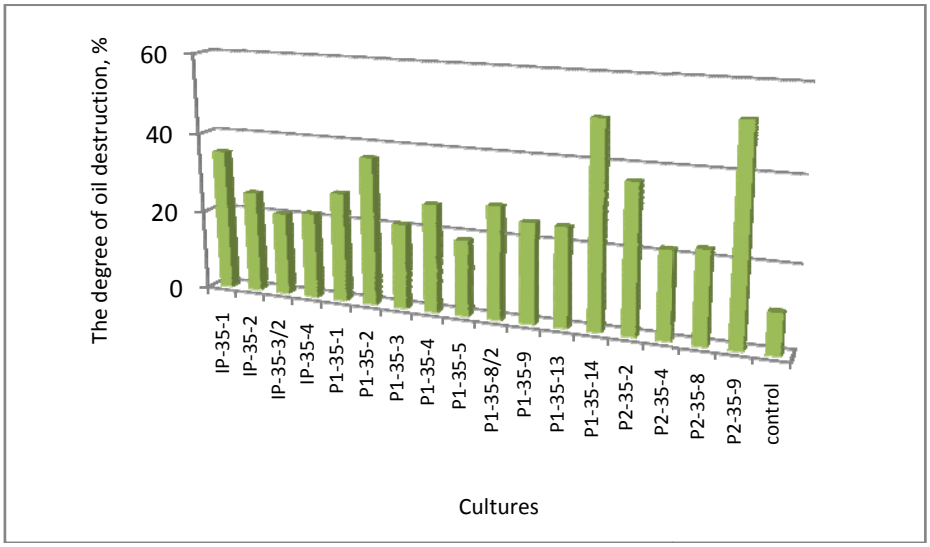


Figure 1 – The destruction of oil by new cultures of thermotolerant oil-oxidizing microorganisms at 35°C

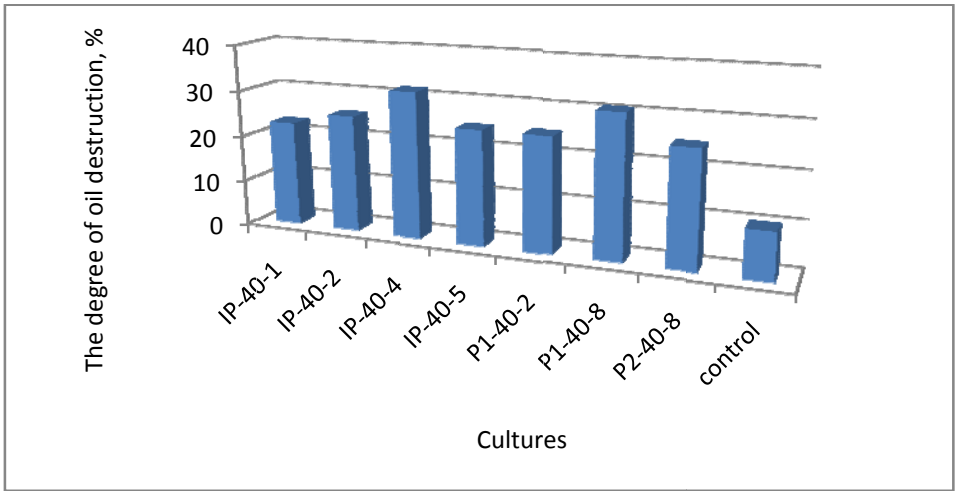


Figure 2 – The destruction of oil by new cultures of thermotolerant oil-oxidizing microorganisms at 40°C

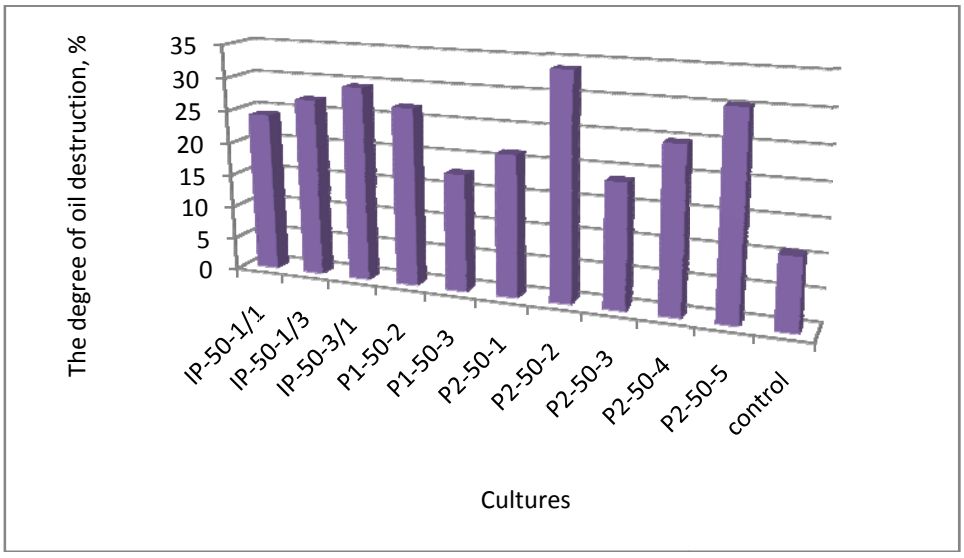
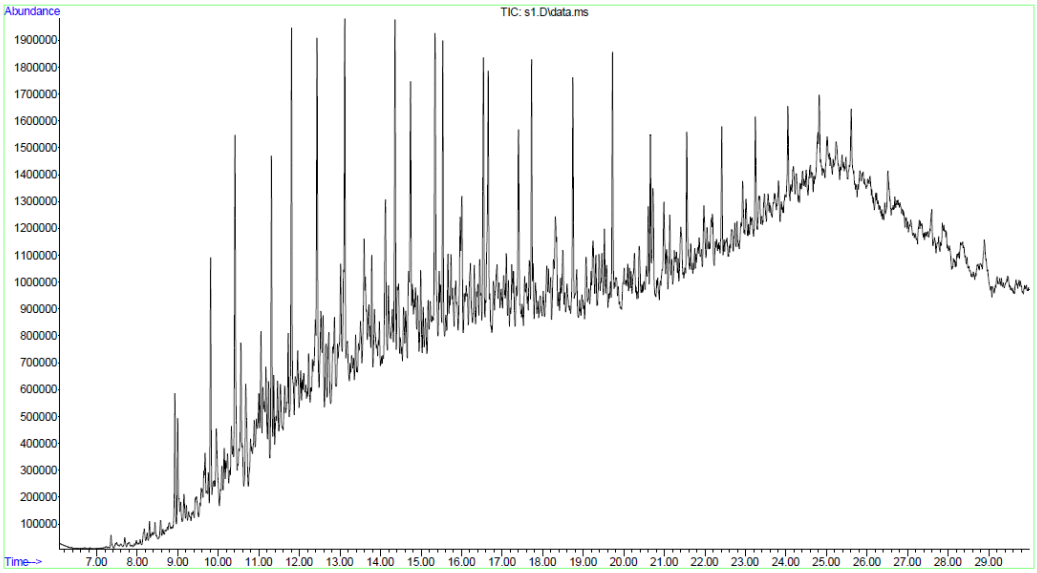
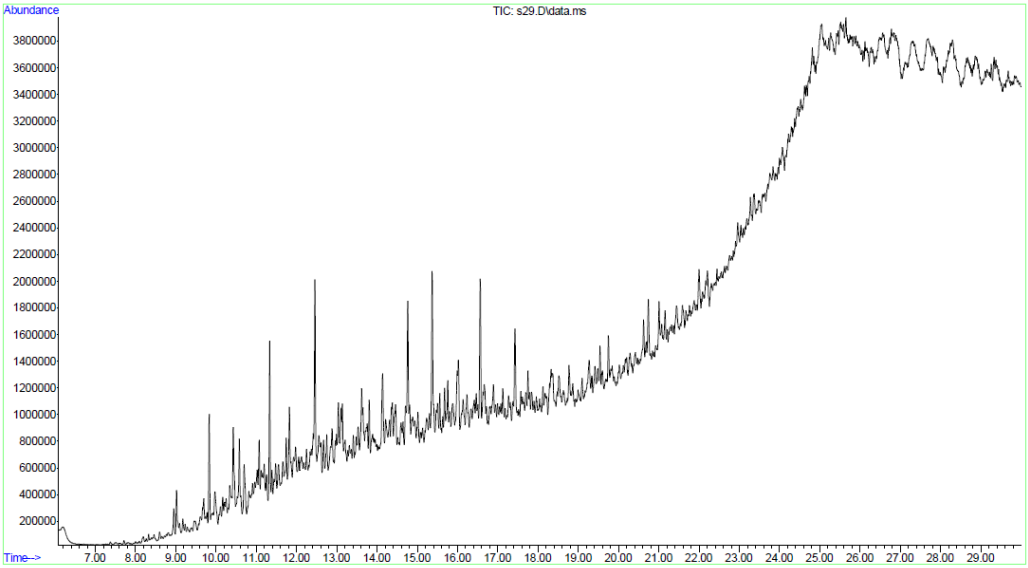


Figure 3 – The destruction of oil by new cultures of thermotolerant oil-oxidizing microorganisms at 50°C



a



b

Рисунок 4 – Chromatogram of the total content of petroleum hydrocarbons
in the control (a) and after cultivation of the strain P2-35-9 (b)

Thus, temperature plays a vital role in the bioremediation of oil pollution. This effect is due to its effect on the metabolic rate of bacteria. Temperature affects both the physical state of the hydrocarbons present in the contaminated area and the microorganisms present in the soil. Research related to the search and study of thermotolerant microorganisms-destructors of oil, is very actual, because they are promising agents for remediation of oil-polluted areas in regions with a predominance of elevated temperatures.

From oil-polluted soils of Western Kazakhstan, thermotolerant oil-oxidizing microorganisms have been isolated. Their oil oxidizing activity was studied. It was shown that during the cultivation of isolates in a liquid mineral medium with oil, the degree of its destruction at 35^{o}C was 18.7-52.0%, at 40^{o}C – 22.7-31.5%, and at 50^{o}C – 17.7-33.8 %.

All selected active thermotolerant strains of oil-oxidizing microorganisms can be further used as part of a consortium for cleaning oil-contaminated soils in regions with a hot arid climate.

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С. А. Айткельдиева, Э. Р. Файзулина,
О. Н. Ауэзова, Л. Г. Татаркина, Г. А. Спанкулова

ЖШС «Микробиология және вирусология ғылыми-өндірістік орталығы», Алматы, Қазақстан

ТЕРМОТОЛЕРАНТТЫ МҰНАЙТОТЫҚТЫРҒЫШ МИКРООРГАНИЗМДЕРДІ БӨЛІП АЛУ ЖӘНЕ ЗЕРТТЕУ

Аннотация. Климаттық жағдайлар ыстық ауа райлы аймақтарда көпшілікке танымал ремедиациялық әдістерідің тиімділігін шектейді. Қазақстанның мұнай өндіретін аймақтарында климат маусымдық және тәуліктік температура айырмашылығымен, судың буланuының жоғары деңгейімен, тұзданuымен және топырақтың төмен ылғалдығымен сипатталады. Осыған байланысты жоғарыда аталған жағдайларға бейімделген технологияларды әзірлеу және қолдану мәселесі Қазақстан мен алыс шет елдер үшін өзекті болып табылады. Төтенше климаттық жағдайларға бейімделген термотолерантты көмірсутектотықтырғыш микроорганизмдер жоғары температурада көмірсутектерді тотықтыруға қабілетті.

Зерттеудің мақсаты термотолерантты мұнайтотықтырғыш микроорганизмдердің культураларын бөліп алу және іріктеу, сондай-ақ олардың белсенділігін зерттеу болып табылады.

Жаңаталап (Атырау облысы) кен орнының ластанған топырағынан жинақтау әдісі арқылы 72 изолят бөлініп алынды. Олардың ішінен жақсы және қалыпты өсуін көрсеткен 35°С температурада 15 культура, 40°С температурада 7 культура және 50°С температурада 12 культура іріктеліп алынды. Олардың мұнайды тотықтыру белсенділігі зерттелді. Изоляттарды сұйық минералды қоректік ортада мұнаймен бірге өсіру кезінде олардың ыдырату деңгейі 35°С температурада 18.7-52.0%, 40°С - 22.7-31.5% , ал 50 °С - 17.7-33.8 % құрады.

Түйін сөздер: мұнай, мұнайлы ластаушылар, термотолерантты мұнайтотықтырғыш микроорганизмдер, мұнайды ыдырату.

С. А. Айткельдиева, Э. Р. Файзулина,
О. Н. Ауэзова, Л. Г. Татаркина, Г. А. Спанкулова

ТОО «Научно-производственный центр микробиологии и вирусологии», Алматы, Казахстан

ВЫДЕЛЕНИЕ И ИЗУЧЕНИЕ ТЕРМОТОЛЕРАНТНЫХ НЕФТЕОКИСЛЯЮЩИХ МИКРООРГАНИЗМОВ

Аннотация. Климатические условия ограничивают эффективность применения большинства известных ремедиационных методов в регионах с жарким климатом. В нефтедобывающих регионах Казахстана климат характеризуется сезонными и суточными перепадами температур, высокими темпами испарения воды, засоленностью и низкой влажностью грунта. В связи с этим проблема разработки и применения технологий, адаптированных к вышеперечисленным условиям, является актуальной для Казахстана и дальнего зарубежья. Термотолерантные углеводородокисляющие микроорганизмы, адаптированные к экстремальным климатическим условиям, способны окислять углеводороды нефти при повышенных температурах.

Целью исследований было выделение и отбор культур термотолерантных нефтеокисляющих микроорганизмов, а также изучение их активности.

Из нефтезагрязненной почвы месторождения Жанаталап (Атырауская область) методом накопительных культур выделено 72 изолята. Из них отобрано 15 культур, показавших хороший и умеренный рост при 35^{o}С, 7 культур – при 40 ^{o}С и 12 культур – при 50^{o}С. Изучена их нефтеокисляющая активность. Показано, что при культивировании изолятов в жидкой минеральной среде с нефтью степень ее деструкции при 35^{o}С составляла 18,7-52,0%, при 40^{o}С – 22,7-31,5%, а при 50^{o}С – 17,7-33,8%.

Ключевые слова: нефть, нефтяное загрязнение, термотолерантные нефтеокисляющие микроорганизмы, деструкция нефти

Information about authors:

Svetlana A. Aitkeldiyeva, Doctor of biological sciences, Chief researcher, LLP "SPC of Microbiology and Virology", Almaty, Kazakhstan; sa.kz@list.ru, ecomicrolab@gmail.com; https://orcid.org/0000-0003-3903-1675

Elmira R. Faizulina, Candidate of biological sciences (PhD), Leading researcher, LLP "SPC of Microbiology and Virology", Almaty, Kazakhstan; elmira_f@mail.ru, ecomicrolab@gmail.com; https://orcid.org/0000-0002-5769-1741

Olga N. Auezova, Researcher, LLP "SPC of Microbiology and Virology", Almaty, Kazakhstan; auezova.o@list.ru; https://orcid.org/0000-0003-2317-5113

Larissa G. Tatarkina, Researcher,LLP "SPC of Microbiology and Virology", Almaty, Kazakhstan; tatalora@mail.ru; https://orcid.org/0000-0002-1375-3744

Gulzhan A. Spankulova, Researcher, LLP "SPC of Microbiology and Virology", Almaty, Kazakhstan; gulzhan_aspan@mail.ru; https://orcid.org/0000-0002-0363-2690

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G. Zh. Medeuova

Kazakh state women's pedagogical university, Almaty, Kazakhstan.
E-mail: medeuova.galiya96gmail.com

OPTIMIZATION OF PHOTOSYNTHETIC ACTIVITY AND YIELDING CAPACITY OF RICE CULTIVARS DEPENDING ON METHODS OF APPLICATION OF NITROGENOUS FERTILIZERS AND SEED APPLICATION RATES

Structural abstract. In case of application of increasing rates of mineral amendments, in particular of nitrogen fertilizers in medium-grown cultivars, ***the first effect*** of increasing of grain yield enhancement has been observed at a rate of N120P90-120 kg/ha of rate of application. In the circumstances, in agrocoenosis of medium-grown rice-cultivars cenotic mutual influence has not been conductive to reduction of net photosynthesis of photosynthesis (Ph.n.pr., g/m^2 per day). At high-yielding seedings, in case of application of optimal rate (N160-180R 120 kg/ha) of fertilizers, large CA, FP, Ubiol are formed in medium-grown cultivars. However, the level of average net productivity of photosynthesis (Ph.n.pr., g/m^{2}per day), in particular after heading phase it has not decreased. This effected the formation of high crop yield of grain (72-78 c/ha) that is ***the second effect*** of increasing of grain yield enhancement of rice cultivars. At high-yielding seedings of narrow-leaved cultivars with vertical phylotaxy of Kuban 3, Krasnodar 424, Aru, the highest yielding capacity has been obtained in case of application of 25-33% of annual rate of nitrogenous fertilizers before seeding, and 67-75% in the form of two fertilizations at crop stages 6-7 and 8-9. At seedings of large-leaved cultivar of Marzhan, Aral 202, Togusken 1, the largest grain yield has been formed upon application of 60-70% of annual rate of nitrogenous fertilizers before seeding, and application of other 30-40% in the form of fertilization at crop stage 6-7.

Key words: rice, cultivars, methods of application of mineral fertilizers, optimization of photosynthetic activity, formation of optimal leaf area and the largest grain yield.

Nitrogenous fertilizers promotes a significant increase in crop area (CA) of rice croppers [Hill Jt et al.,2001, 491-500; Tuong T.P., et al., 2000, 3-18; Zhailybay K.N., 2018, 63-70; Zhailybay K.N., 2018, 103-109; Olzhabayeva A.O., 2018, 9-20]. Provided that, leading role in grain formation belongs to upper, in particular upper leaves 2-5 of main stem, and stem shoots, length and width of leaf blades [Lizandr A.A., 391-397]. In connection therewith, the effect of methods of application of optimal rate of nitrogenous fertilizer - N180 kg / ha (compared to P120 kg / ha) and seed application rates on assimilative apparatus formation and rice grain yield have been researched. Cultivars of rice varieties varying in architectonics: Kuban 3, medium-grown, with narrow vertical phylotaxy; Marzhan is medium-grown, large-leaved. Plot area in dummy experiments is 5 m^2, at large-plot experiments - 100-120 m^2, replication of experiment - four times, agrotechnics is universal for Kyzylordin region (Kazakhstan) [Sistem of agroculral., 380-410]. Research of effect of optimal rate of nitrogenous fertilizer (N160-180 kg/ha of rate of application) against phosphate fertilizer (P 120 kg/ha of rate of application) has been carried out according to the following pattern:

Block 1. ***N180P120 kg/ha of rate of application,*** the annual rate of fertilizers has been applied before seeding.

Block 2 -*N180P120 kg/ha,* 70% of the annual rate of nitrogenous fertilizer (N120 kg/ha) have been applied before seeding, the remaining 30%, or N60 in the form of fertilizations at crop stage 6-7;

Block 3 -*N180P120 kg/ha,* 50% of the annual rate of nitrogenous fertilizer (N90) and two fertilizations, 25% each, have been applied before seeding: N45 at crop stage 4-5 and N45 - at crop stage 6-8 - method developed by the laboratory of mineral nutrition of Institute of Botanics of the Academy of Sciences of the Republic of Kazakhstan [Gostenko G.P.,12-36; Starkova A.V.,9-12];

Block 4 -*N180R120 kg/ha,* 1/3 (33% or N90) of the annual rate of nitrogenous fertilizer and two fertilizations have been applied before seeding: N90 at crop stage 6-7 (at the beginning of 3^d phase of organogenesis), and N30 - at stem elongation phase (8-9 leaves) - method developed by Laboratory of Plant Physiology of Kazakh Research and Development Institute of rice [Ramazanova S.B.,18-20];

Block 5 -*N180R120 kg/ha,* 25% (N45) of the annual rate of nitrogenous fertilizer and two fertilizations have been applied before seeding: 50% (N90) at crop stage 3-6, and 25% (N45) - at crop stage 8-9 - method developed by Russian Research and Development Institute of rice [Aliyezhin Ye.P.,25-27].

Background - phosphate fertilizer (P120 kg/ha of rate of application) have been applied before seeding. At large-plot and farm scale trials, blocks 4 and 5 are combined, as effect of these variations turned out to be the same.

At dummy experiments, rice seeds have been sown manually using narrow-rowed method in the steps of markers in quantities of 100, 300, 500, 700, 900 pcs/m^2 and covered with soil. At large-plot experiments, seeds have been sown by drill-machine SZ-3.6 in the following norms: Marzhan cultivar - 130 kg/ha (3 million of viable grains), 230 (6 million), 280 (7.5 million), 320 kg/ha (9.5 million of seeds); Kuban 3 cultivar - 100 kg/ha (3 million), 200 (6 million), 250 (7.5 million), 300 kg/ha (9.5 million of viable grains). Crop area has been determined using method of V.V.Anikiev, F.F. Kutuzov, usability of

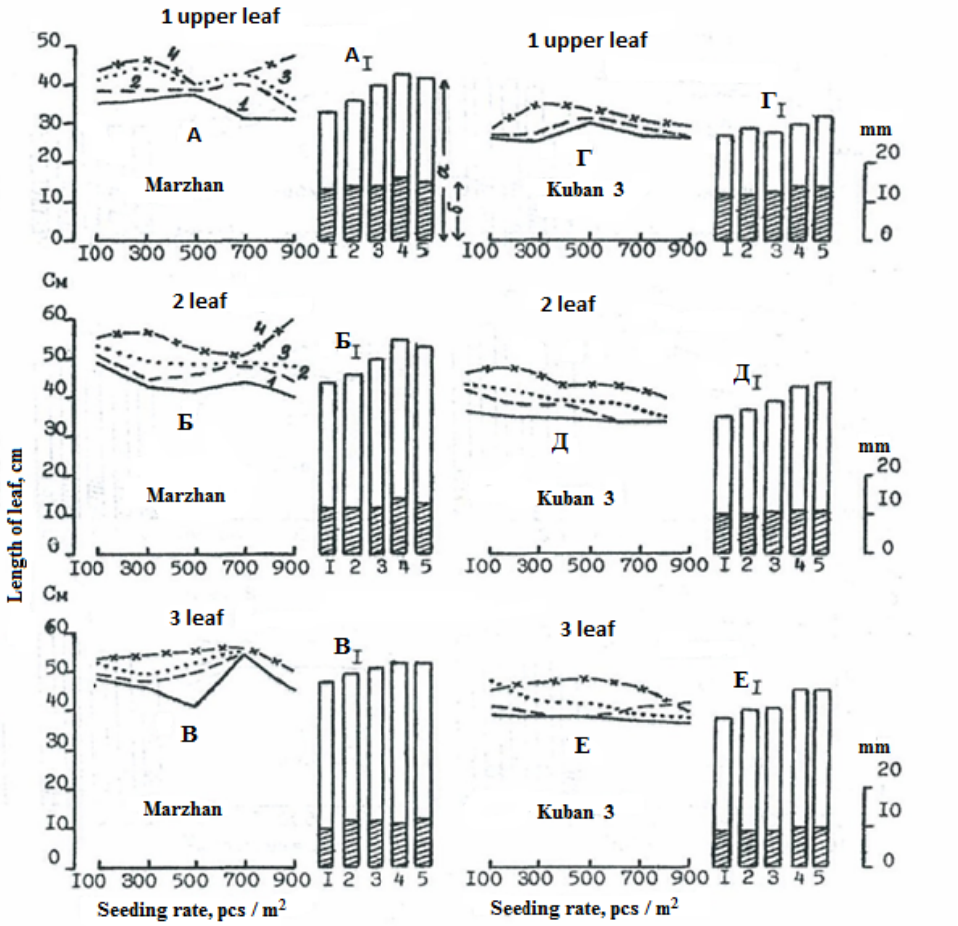

Figure 1 – Change of length and width of main stem leaves of Marzhan and Kuban 3 cultivars depending on seeding rate of seeds (А, Б, В, Г, Д, Е) and methods of nitrogenous fertilizer application ($А_1$, $Б_1$, $В_1$, $Г_1$, $Д_1$, $Е_1$).
_Block 1; _ _ _ _Block 2; . . . . . Block 3; _ x_x_x_Block 4.
1, 2, 3, 4, 5 - Blocks with relative numbers; a - length, and b - width of leaf
(averaged values by block - methods of nitrogenous fertilizer application)

which has been checked by experience [Anikiev V.V.,375-377]. Agrotechnics is universal for PreAral zone. Change of degree of density of rice croppers in agrocoenosis and methods of nitrogenous fertilizer application has a significant impact on formation and size of assimilative apparatus (figures 1-7).

Marzhan cultivar in Block 1 (application of full rate of nitrogenous fertilizer before seeding) have length of the first leaf (from top) of main stem that increases in case of seeding of 500 pcs/m^2 of seeds, and it reduces with seeding overcrowding. In Block 1, the length of main stem flag of Marzhan cultivar is 30.5-36.9 cm, the width is 1.25-1.43 cm depending on population (of the 2nd, in consequence, the length of 2nd and 3rd leaves of main stem is more than the flag but the width is smaller. In case of split application of nitrogenous fertilizer (Blocks 2, 3, 4, 5), the length and width of leaves increase, the largest of their values is noted in Block 4 (*figure 1,* А$_1$, Б$_1$, В$_1$). Thus, in the Block 4, the length of flag is 41.0-45.8 cm, the width is 1.50 -1.70 cm, the 2nd leaf, respectively, - 52.0-63.2, and 1.2-1.6 cm, the 3rd - 51.0-55.2 and 1.0-1.4 cm (figure 1).

Sizes (length and width) of leaves of the average stem shoot is less than those of leaves of main stem. Provided that, dependency of length and width change of stem shoot leaves depending on grain seeding rate and methods of nitrogenous fertilization are similar to the leaves of main stem (figure 2; А$_2$, А$_3$, Б$_2$, Б$_3$, В$_2$, В$_3$).

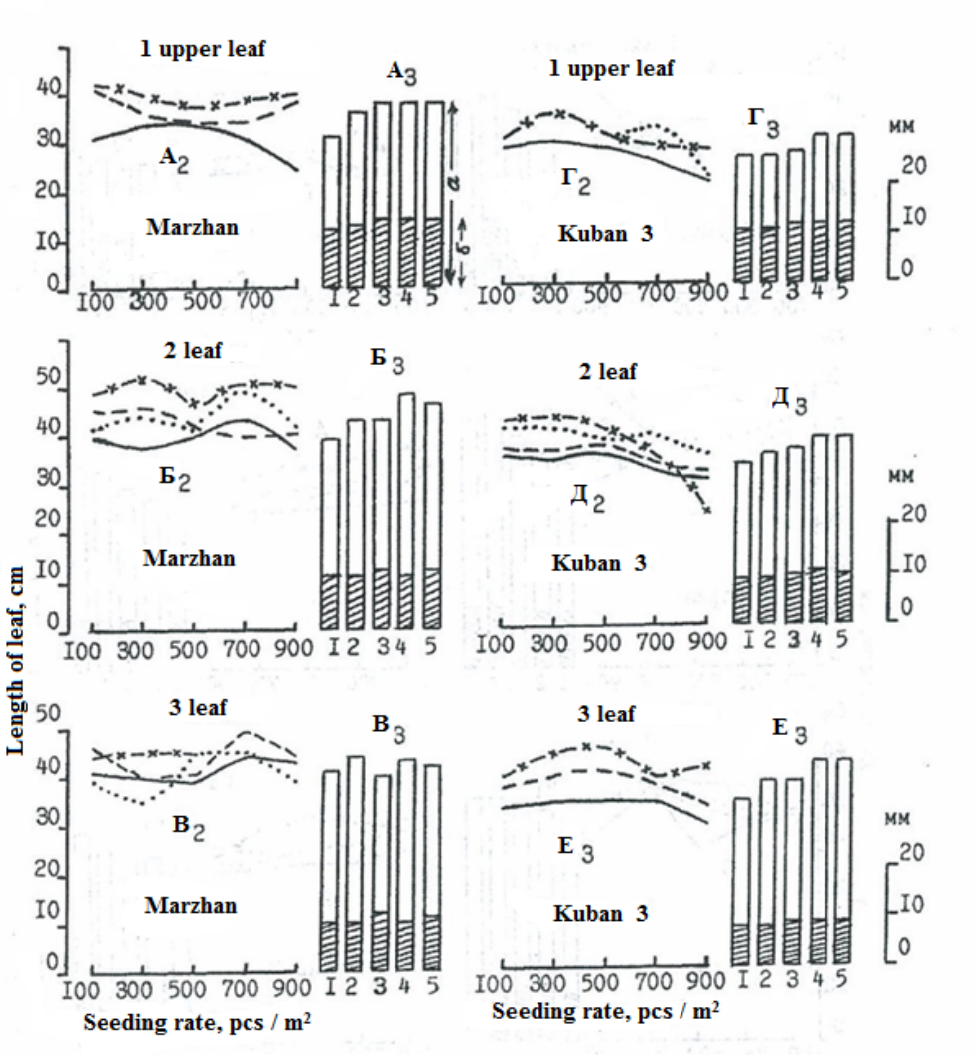

Figure 2 – Change of length and width of stem shoot leaves of Marzhan and Kuban 3 cultivars depending on seed application rate (А$_2$, Б$_2$, В$_2$, Г$_2$, Д$_2$, Е$_2$) and methods of nitrogenous fertilizer application (А$_3$, Б$_3$, В$_3$, Г$_3$, Д$_3$, Е$_3$).
_Block 1; _ _ _ _Block 2; . . . . . Block 3; _ x_x_x_ Block 4.
1, 2, 3, 4, 5 - Blocks with relative numbers; a - length, and b - width of leaf
(averaged values by block - methods of nitrogenous fertilizer application)

In case of application of full rate of nitrogenous fertilizer before seeding (Block 1), the area (cm^2) of main stem flag of Marzhan cultivar increases gradually depending on seeding rate reaching a maximum at high-yielding seedings (seeding of 500 pcs/m^2 of seeds), and then decreases with overcrowding. Area of the 2nd and the 3rd leaves also increases, maximum is reached with seeding of 700 pcs/m^2 of seeds, and at heavy seedings (seeding of 900 pcs/m^2 of seeds) decreases (figure 3; $А_4$, $Б_4$, $В_4$).

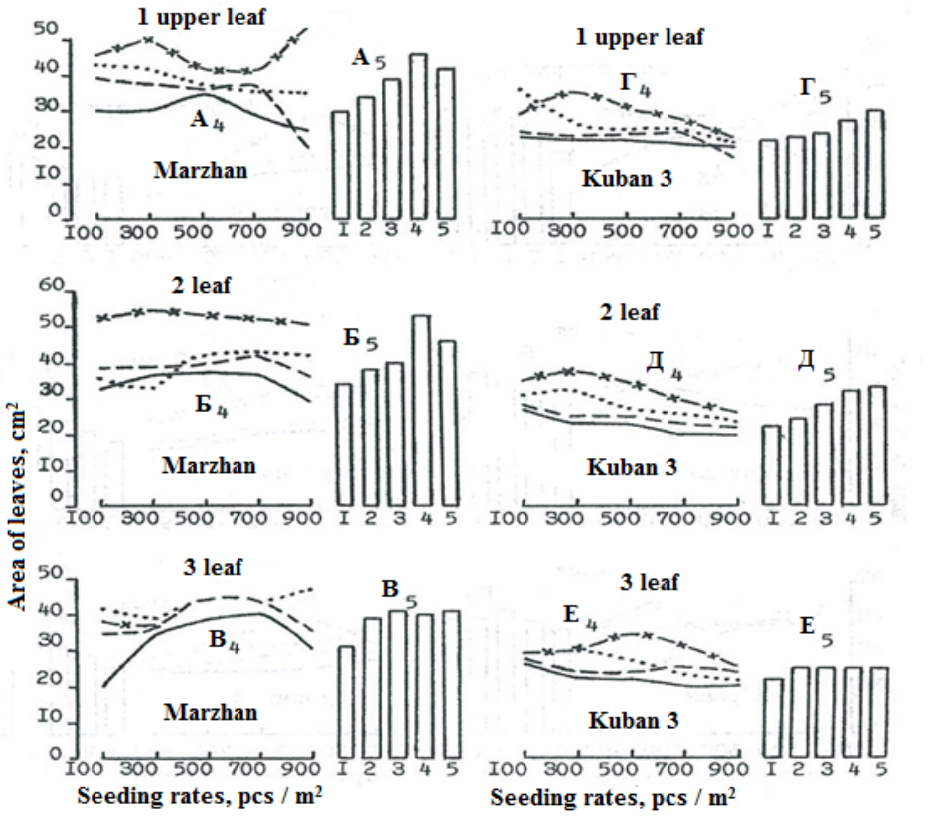

Figure 3 – Change of cropper (cm^2) area of main stem of Marzhan and Kuban 3 cultivars depending on seed application rates ($А_4$, $Б_4$, $В_4$, $Г_4$, $Д_4$, $Е_4$), methods of nitrogenous fertilizer application ($А_5$, $Б_5$, $В_5$, $Г_5$, $Д_5$, $Е_5$).
_____Block 1; _ _ _ _Block 2; . . . . .Block 3; _ x_x_x_ Block 4.
1, 2, 3, 4, 5 - Blocks with relative numbers; a - length, and b - width of leaf
(averaged values by block - methods of nitrogenous fertilizer application)

In case of split application of nitrogenous fertilizer (Blocks 2, 3, 4, 5), increasing in crop area is principally observed at thinned out (seeding of 100 pcs/m^2 of seeds) and moderate (300 pcs/m^2 of seeds) seedings (figure 3; $А_4$). Averaged according to seeding rates, the area of flag and bracing leaves of the main stem were the largest in Block 4, and the 3rd leaf - in Blocks 3, 4, 5 (figure 3; $А_5$, $Б_5$, $В_5$). Similar dependency of crop area change has been observed related to stem shoots (figure 4; $А_6$, $А_7$, $Б_6$, $Б_7$, $В_6$, $В_7$).

Formation of assimilative apparatus of leaves of **Kuban 3 rice cultivar** differs from Marzhan cultivar. Thus, in Block 1 the length of main stem leaves on a practical level has been unchanged depending on seed application rate. Provided that, the length of the 2nd leaf is more than the 1st, the 3rd is more than the 2nd but the width. In case of split application of nitrogenousfertilizer (Blocks 2-5), the length of the flag and the 2nd leaf of main stem increases with seeding of 300 pcs/m^2, the 3rd - with seeding of 500 pcs/m^2, and then it gradually decreases. Overall length and width of leaves are noted in Blocks 4.5 (figure 1; Г, Д, Е).

Leaf sizes of mid stem shoot of Kuban 3 cultivar are less than those of main stem leaves. Provided that, dependency of change of length and width of stem shoot leaves depending on seeding rate are similar to those of leaves of main stem (figure 2; $Г_2$, $Д_2$, $Е_2$). Kuban 3 cultivar crop area of main stem and stem shoots in Block 1 is larger with seeding of 100 pcs/m^2 of seeds, then it gradually decreases with overcrowding of seedings. In case of split application of nitrogenous fertilizer (Blocks 2-5), in particular, in

Block 4, area of flag and the 2nd leaves of main stem is more with seeding of 300 pcs/m^2 of seeds, and the 3rd leave - with seeding of 500 pcs/m^2 of seeds, then it gradually decreased (figure 3; Г$_4$, Д$_4$, Е$_4$). Areas of stem shoot flag is more in Blocks 4.5; the 2nd and the 3rd leaves - in Blocks 3, 4, 5 (figure 4; Г$_6$, Г$_7$, Д$_6$, Д$_7$, Е$_6$, Е$_7$).

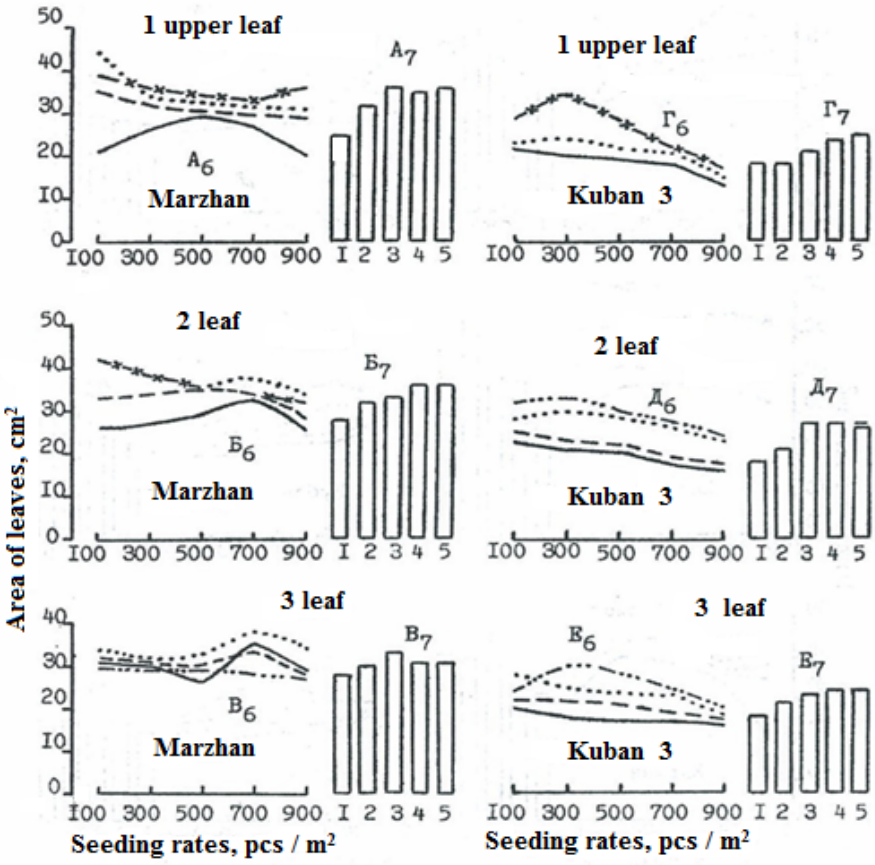

Figure 4 – Change of length and width of stem shoot leaves of Marzhan and Kuban 3 cultivars depending on seed application rate (А$_6$, Б$_6$, В$_6$, Г$_6$, Д$_6$, Е$_6$) and methods of nitrogenous fertilizer application (А$_7$, Б$_7$, В$_7$, Г$_7$, Д$_7$, Е$_7$)

Particulars of assimilative apparatus formation of Kuban 3 and Marzhan cultivars have had definitive impact on formation of grain yield structure elements. Thus, number of spikelets in main stem head and stem shoots significantly decreases with overcrowding of seedings (figure 5; Ж, З, И, К). The biggest number of spikelets in main stem head and stem shoots of Kuban 3 cultivar are noted in Blocks 4.5 (figure 5; И$_1$, К$_1$). Other dependency is observed in Marzhan cultivar. Thus, larger number of spikelets on main head is noted in Blocks 2, 4, 5. With increasing of rate and number of fertilizations (Blocks 4.5), the number of stem shoots, length, width and size of crop area increase, but this does not lead to increase in number of spikelets on main head compared with Block 2, and it decreases on stem shoot head. The biggest number of spikelets on stem shoot head of Marzhan cultivar is noted in Block 2 (figure 5; З$_1$).

As a consequence of this, grain yield of Kuban 3 cultivar in Block 1 increases with overcrowding of seedings. In case of split application of nitrogenous fertilizer (Blocks 2-5), the yield is increased, however, the highest level has been noted at high-yielding seedings (seeding of 500, 700 pcs/m^2 of seeds) and in Blocks 3, 4, 5 (figure 6; И$_2$, И$_3$). Marzhan cultivar has turned out to be the most yielding at high-yielding seedings (seeding of 500, 700 pcs/m^2 of seeds), and upon application of 60-70% of annual rate of nitrogenous fertilizer before seeding, and 30-40% - in the form of fertilization at crop stage 6-7 (figure 6; Ж$_2$, Ж$_3$). This is confirmed by results of large-spot experiments. Thus, the largest grain output yield of Kuban 3 cultivar was being formed when seeding of 7.5 million of viable seeds, and application of 25-33% of annual rate of nitrogenous fertilizer before seeding, and 67-75% in the form of fertilization at crop stages 6-7 and 8-9 (Block 4, figure 6; К$_2$, К$_3$), and Marzhan cultivar - in Block 2 (figure 6; З$_2$, З$_3$).

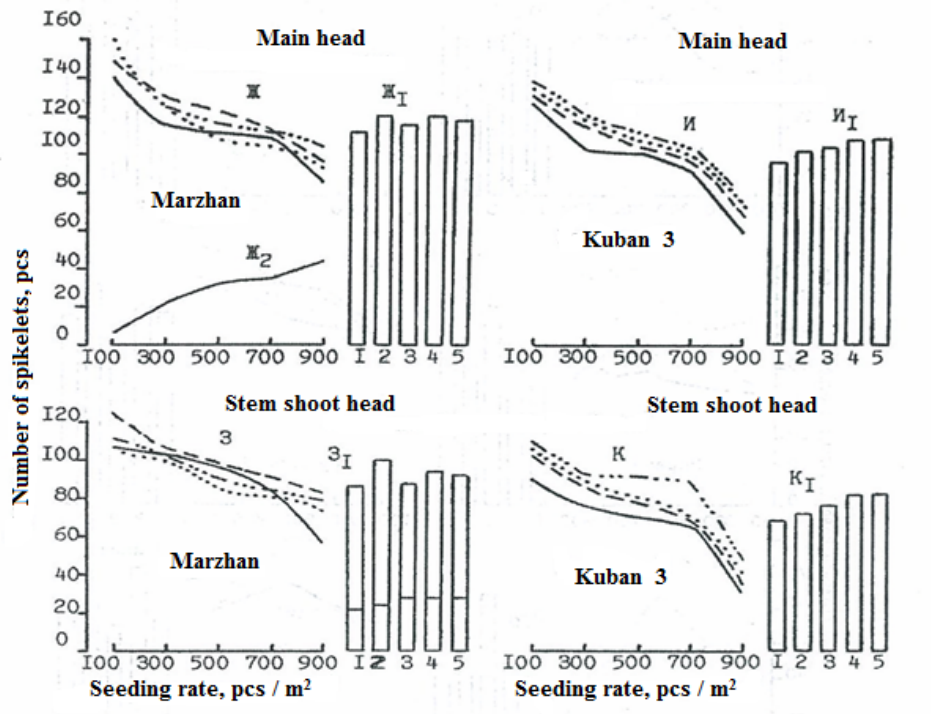

Figure 5 – Change of number of spikelets on main stem heads and stem shoots of Marzhan and Kuban 3 cultivars depending on seed application rate (Ж, З, И, К) and methods of nitrogenous fertilizer application.
Designations: _____Block 1; - - - - -Block 2; . . . . .Block 3; - . . .- . . .- Block 4;
Figures specify numbers of Blocks 1, 2, 3, 4, 5 (each block has averaged number of spikelets)

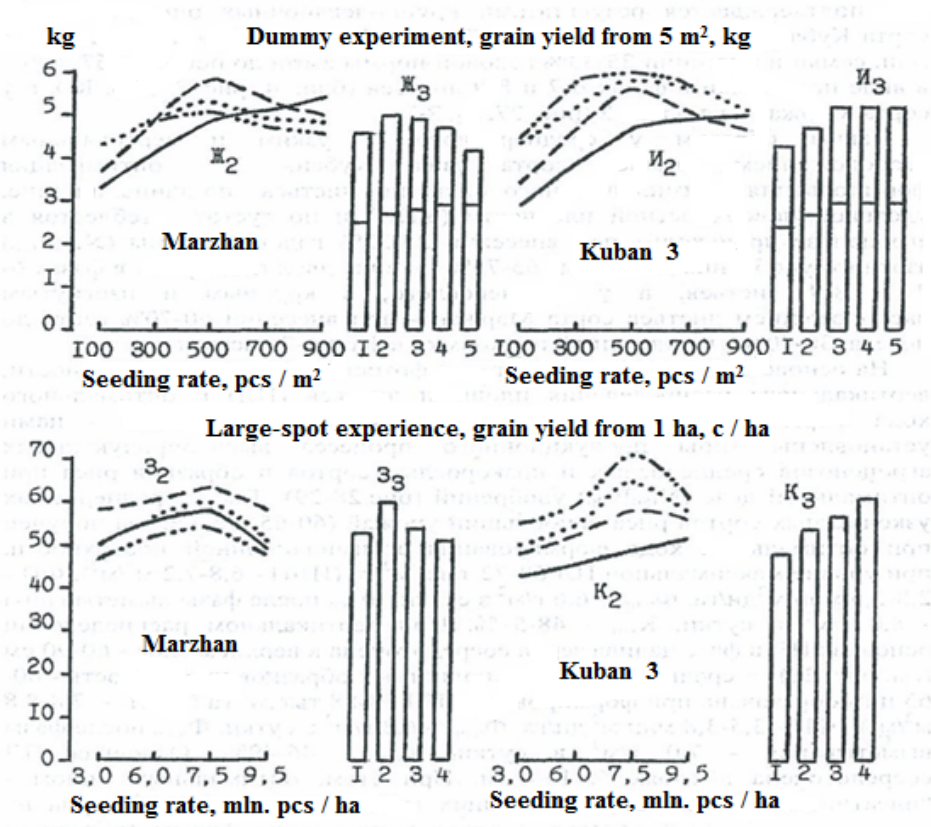

Figure 6 – Yield of Marzhan and Kuban 3 rice cultivars depending on seed application rate ($Ж_2$, $И_2$, $З_2$, $К_2$), and methods of nitrogenous fertilizer application ($Ж_3$, $И_3$, $З_3$, $К_3$) (designations are the same as in figure 5)

Thus, in medium-grown Kuban 3 rice cultivar with narrow and vertical phylotaxy, the optimization of formation of assimilative apparatus – leaves in length, width and area, as well as degree of density of yielding stem in agrocoenosis occurs upon application of 25-33% of annual rate (N180P120 kg/ha) of nitrogenous fertilizer before seeding, 65-75% - in the form of two fertilizations at crop stages 6-7 and 8-9, and in medium-grown, large-leaved Marzhan cultivar - upon application of 60-70% of nitrogen before seeding, 30-40% - in the form of single fertilization at crop stage 6-8, and when performing all technological processes in due time and qualitatively. On the basis of interconnection of photosynthetic activity indicators, vertical allocation of crop area (CA) and optimal progress of formation of assimilative apparatus - leaves, we have established types of productive process of high-producing agrocoenosis of medium-grown and low-grown cultivars, and rice exponents at optimal rate (N180P120 kg/ha) of fertilizers. Thus, the largest grain yield of medium-grown, narrow-leaved rice cultivars (65-75 c/ha) has been received at optimal progress of formation of assimilative surface at maximum level of CA - 68-72 thous. m^2/ha (LAI, - 6.8-7.2 m^2/m^2), FP - 2.8-3.5 million of m^2 days/ha, Ph.n.pr. - 6.6 g/m^2/day (average for the vegetation period), Ph.n.pr. - average after heading phase - 8.0 g/m^2/day, EEP - 48-51% (figure 7).

In case of vertical allocation, the main CA at grain filling phase is concentrated in upper layer - 60-90 cm. Yield of medium-grown large-leaved cultivars and rice exponents equal to 62-73 kg/ha has been established in the course of formation of CA 78-88 thousand of m^2/ha (LAI, 7.8 - 8.8 m^2/m^2), FP 3.5-3.8 million m^2days/ha upon average for the vegetation period of Ph.n.pr. - 6.3 g/m^2/day, Ph.n.pr. after heading phase - 7.0 g/m^2/day, EEP - 46-49%. The main CA is concentrated in layers 50-100 cm (figure 7).

In case of application of heavy rate (N240R 180 kg/ha) of fertilizers for rice seedings of Kuban 3 cultivator, vast crop area is formed (CA) - 82.0-86.8 thousand of m^2/ha, and for seedings of Krasnodar-skiy 424, Marzhan, Aral 202 cultivars - level of CA reaches 90.8 thousand of m^2/ha, photosynthetic potential (PP) - 3.85-4.02 million of m^2 days/ha, however, net productivity of photosynthesis (Ph.n.pr. g/m^2/day) decreases. In such agrocoenosis, leaves of rice cultivars shade each other reciprocally, adverse, negative coenotic interactions increase that leads to reduction in grain yields (figure 7).

Therefore, the main cause of reduction in yields upon application of heavy rate (N240R 180 kg/ha) of fertilizers is forming of adverse agrocoenosis architectonics and decrease in net productivity of photosynthesis (Ph.n.pr, g/m^2/day). In such agrocoenosis, leaf area index (LAI, 8-10 m^2/m^2), powerful photosynthetic potential (PP, 4.02 million of m^2days/ha) and heavy yield of biomass (Ubiol, c/ha) are formed. In the above seedings, the main part of crop area (CA) in vertical direction is located in relatively low layers - 30-60 cm. In such cases, the leaves of joining rice croppers shade each other reciprocally resulting in significant reduction in intensity value and net productivity of photosynthesis that leads to a decrease in synthesis of organic substances (assimilates) by these leaves. In addition, upon application of heavy rate (N240P180 kg/ha) of fertilizers, at seedings rice grow high (135-145 cm) and lodge earlier at grain filling phase resulting in increasing of number of feeble and fistular grains. In such cases, huge total biomass is formed but grain yield and its quality decrease.

High productiveness of agrocoenosis of rice cultivars is connected to a certain extent with vertically location of leaves, and in spacing. *Inconditions of the Kazakh PreAral, location of main crop area in 60-90 cm layers of medium-grown cultivars is positive, as it improves agrocoenosis architectonics. Such seedings absorb more photosynthetic active radiation (PAR), grain yield and its quality increase shortly. Interconnections of photosynthetic activity indicators of rice cultivars improve varying in height, architectonics and early ripening (figure 7).*

Study results show (figure 7) that net productivity of photosynthesis (Ph.n.pr., g/m^2/day) of rice croppers is a complex integrated physiological process. Therefore, Ph.n.pr. has complex functional interdependence with leaf area index (LAI, m^2/m^2), photosynthetic potential (PP, million of m^2 days/ha), growth and development of rice croppers during vegetation period, huge total biomass formation (Ubiol). These indicators and processes are subject to significant impact of environmental (temperature, soil conditions, its salinity, salinity of agricultural and underground water) and technological and agri-environmental (land-clearing, rates, methods, time of fertilizer application, spacing and degree of density of croppers in seedings, etc.) factors. With a favorable agricultural background (application of N160-180P120 kg/ha of fertilizers), optimum level of crop area (CA, thousand of m^2/ha), photosynthetic potential (PP, mln. of m^2 days/ha) and total biomass (Ubiol) are formed. In such circumstances, high level of net productivity of photosynthesis (Ph.n.pr., g/m^2 day) contributes to a shortly increase in grain yield and its quality improvement (figure 7).

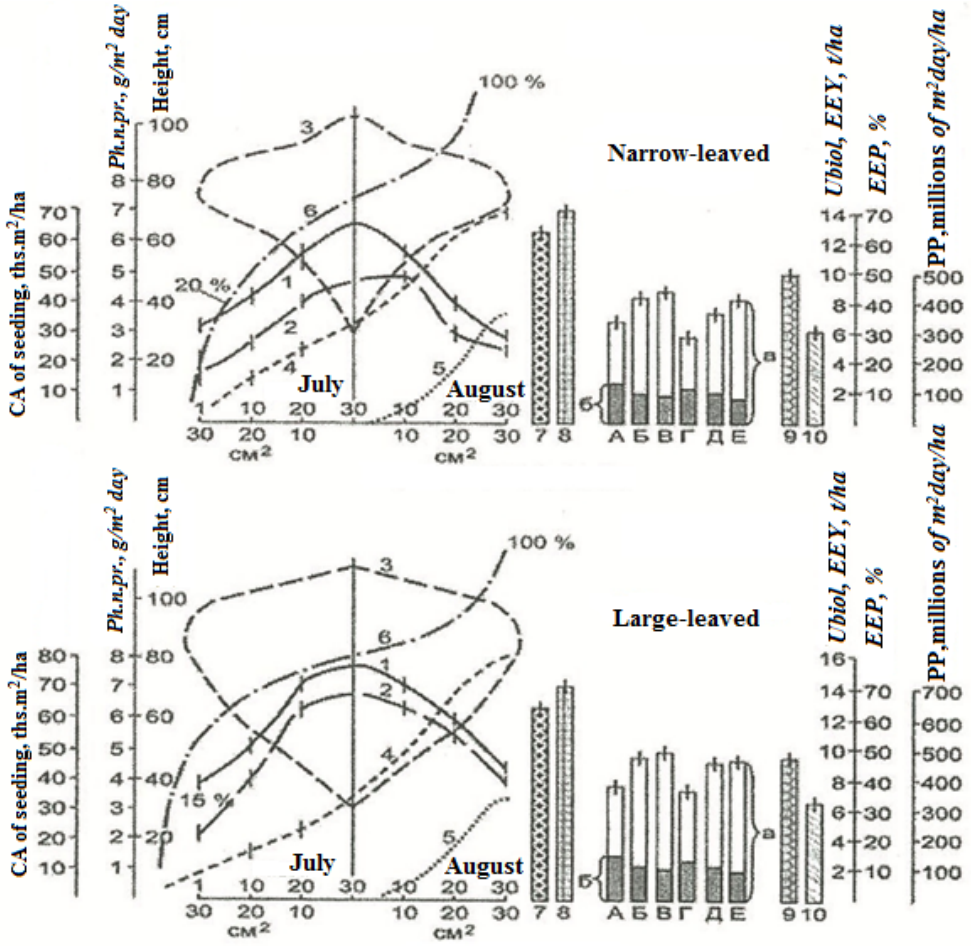

Figure 7 – Typesofphotosyntheticactivityofmedium-grown narrow-leaved and large-leaved rice cultivars at high-producing agrocoenosis and optimal rate of mineral fertilizers.
Designations: 1 - intensity value of crop area formation (CA, thousands of m^2/ha); 2 - intensity value of photosynthetic potential formation (PP, thousand of m^2days/ha); 3 - location of crop area in height at grain filling stage (CA, cm^2); 4 - formation of biomass (Ubiol, t/ha); 5 - grain yield formation (EEY, t/ha); 6 - change of lighting intensity inside the seeding; 7 - average net productivity of photosynthesis for the vegetation period (Ph.n.pr., g/m^2/day); 8 - average Ph.n.pr. after heading phase (Ph.n.pr., g/m^2/day); 9 - economical effectiveness of photosynthesis (EEP,%): 10 - grain yield, t/ha.;
А, Б, В – length (cm), width (mm) of the flag, length (a, cm), width (b, mm) of the 2nd and 3rd main stem leaves;
Г, Д, Е – length (a, cm), width (b, mm) of the flag, length (a, cm), width (b, mm) of the 2nd and 3rd stem shoot leaves

To improve grain yield of rice cultivars, it is necessary to increase net productivity of photosynthesis (Ph.n.pr., g/m^2 day). Study results show [2, 3] that at high-producing agrocoenosis, and in case of application of N120R120 kg / ha fertilizer rate at seedings of Kuban 3, Aru, Marzhan, Aral 202, Togusken 1 rice cultivars, level of average Ph.n.pr. (g/m^2 day) for the vegetation period does not decrease that contributed to formation of a sufficiently heavy grain yield (e.g., at seedings of Kuban 3 cultivar, 58.1 c/ha of grain has been obtained, Marzhan - 53.4-61.5 c/ha, Aral 202-50.1 c/ha,- Togusken 1-52.6 c/ha). Therefore, **the first effect** of grain yield increasing has been noted in case of N120P120 kg/ha rate of fertilizer application, as no adverse coenotic interinfluences in agrocoenosis have been observed, level of Ph.n.pr. indicator is high, and they do not come into conflict with CA, PP, total biomass (Ubiol) indicators.

At high-producing agrocoenosis and in case of N180P120 kg / ha rate of fertilizer application at seedings of Kuban 3, Aru cultivars, and in case of application of N160-180P120 kg/ha at seedings of Marzan, Aral 202, Togusken 1, negative coenotic interinfluences are increased. Nevertheless, level of net productivity of photosynthesis (Ph.n.pr., g/m^2/day) has been turned out to be sufficiently high (not lower than 6.5 g/m^2/day), as great amount of photosynthetically active radiation had impact on agrocoenosis (PAR) - 2.5-3.2 billion of kcal/ha. Due to better architectonics of high-producing agrocoenosis of

mentioned cultivars, 80-90% of PAR are absorbed by seedings resulting in heavy yield formation (Kuban 3 cultivar - 78.0 c/ha, Marzhan cultivar - 70.1-72.8 c/ha). This is the **second effect** of heavy yield formation in case of application of optimal (N150-180R 120 kg/ha) rate of fertilizers (figure 7).

At densedagrocoenosis (seeding of 900 pcs/m^2 of seeds), and when application of heavy rate (N240P180 kg/ha) of fertilizer, high CA, PP and total biomass (Ubiol) are formed in cultivars above mentioned, but this has led to a decrease in net productivity of photosynthesis (Ph.n.pr., g/m^2 day), coefficient of economical efficiency of photosynthesis (EEP, %). At such seedings, rice croppers grew high (135-145 cm), however, the main part of crop area (CA) was located in vertical direction relatively lower than 30-50 cm layers, and leaves were shaded reciprocally, and adverse coenotic interinfluences increased. As a consequence of this, although huge total biomass was formed but grain yield decreased.

Under production conditions, formation of high-producing agrocoenosis and CA, PP, total biomass (Ubiol), Ph.n.pr. and EEP relative to these seedings of medium-grown narrow-leaved Kuban 3, Krasnodarskiy 424, Aru cultivars with vertical phylotaxy has been obtained in case of seeding of 7.5 million of viable grains (250 kg/ha), and in case of N180R 120 kg/ha rate of fertilizer application.

Under production conditions, formation of high-producing agrocoenosis and photosynthetic activity indicators relative to these seedings of medium-grown large-leaved Marzhan, Togusken 1, Aral 202 cultivars has been obtained in case of seeding of 7.5 million of viable grains (280 kg/ha), and in case of N160-180P120 kg / ha rate of fertilizer application.

So, *optimum morphotype of croppers forming maximum grain yield at high-yielding seedings has turned out to be obtaining of type (exponents) of rice with relatively large flag, with longer 2nd, 3rd and 4th leaves, relatively short the 5th leaves. Orientation of leaves in spacing: flag - horizontal after heading phase, the 2nd and 3rd leaves - vertical, the 4th and the 5th leaves - with increasing angle of deflection (figure 7). This is the optimal type of production process of agrocoenosis of medium-grown narrow-leaved and large-leaved cultivars and exponents of rice in Kazakhstan PreAral conditions conducive to formation of the heaviest grain yield.*

According to the results of experimental studies, the following conclusions have been formed:

1. In case of application of optimum (N180P120 kg/ha) rate of fertilizers at high-yielding seedings, low-grown, short and narrow-leaved cultivators, and medium-grown but early ripening rice exponents formed relatively smaller crop area (CA, thousand of m^2/ha), photosynthetic potential (PP, million of m^2 days/ha), total biomass (Ubiol, c/ha). Therefore, when application of heavy (N240P120-180 kg/ha) rate of fertilizers, CA, PP, Ubiol indicators of above mentioned cultivars and rice exponents increased resulting in formation of the heaviest grain yield.

2. When application of optimal (N160-180P120 kg/ha) rate at high-producing agrocoenosis, medium-grown cultivars (Kuban 3, Krasnodarskiy 424, Marzhan, Aral 202, Togusken 1) formed the heaviest grain yield, and when application of heavy (N240P120-180 kg/ha) rate, grain yields decreased.

3. At high-yielding seedings, and when application of optimal (N160-180P120 kg/ha) rate of fertilizers, medium-grown cultivars formed large CA, PP and Ubiol, and net productivity value of photosynthesis (Ph.n.pr., g/m^2/day) did not decrease but was at relatively high level. This had an impact on formation of heavier grain yield of medium-grown cultivars (Kuban 3, Krasnodarskiy 424, Marzhan, Aral 202, Togusken 1) compared to tiny, low-grown and medium-grown but early-ripening cultivars and rice exponents. In making an assessment of rice cultivars in breeding nursery, relatively high level of Ph.n.pr. in process of formation of larger CA, PP and Ubiol is positive event, i.e. refers to good indicators.

4. In case of application of increasing rates of mineral amendments, in particular of nitrogen fertilizers in medium-grown cultivars, ***the first effect*** of increasing of grain yield enhancement has been observed at a rate of N120P90-120 kg/ha of rate of application. In the circumstances, in agrocoenosis of medium-grown ricecultivars cenotic mutual influence has not been conductive to reduction of net photosynthesis of photosynthesis (Ph.n.pr., g/m^2 per day).

5. At high-yielding seedings, in case of optimal (N160-180P120 kg/ha) rate application, large CA, PP, Ubiol are formed in medium-grown cultivators, however, level of net productivity of photosynthesis (Pn.n.pr., g/m^2day), in particular after heading phase, did not decrease. This effected the formation of high crop yield of grain (72-78 c/ha) that is ***the second effect*** of increasing of grain yield enhancement of rice cultivars.

Ғ. Ж. Медеуова

Қазақ мемлекеттік қыздар педагогикалық университеті, Алматы, Қазақстан

АЗОТ ТЫҢАЙТҚЫШЫН ЕНГІЗУ ТӘСІЛДЕРІНЕ ЖӘНЕ ТҰҚЫМ СЕБУ НОРМАСЫНА БАЙЛАНЫСТЫ КҮРІШ СОРТТАРЫНЫҢ ФОТОСИНТЕТИКАЛЫҚ ҚЫЗМЕТІНІҢ ОПТИМИЗАЦИЯЛАНУЫ ЖӘНЕ ДӘН ӨНІМІНІҢ ҚАЛЫПТАСУЫ

Аннотация. Әртүрлі дозадағы минеральды, әсіресе азот тыңайтқыштарын енгізу тәсілдеріне байланысты дән өнімі артуының **бірінші эффекті** азот тыңайтқышын N120P90-120 кг/га мөлшерінде берілгенде байқалады. Мұндай жағдайда орта бойлы күріш сорттары агроценозында ценотикалық өзара әсерлесу Фотосинтездің таза өнімділігін (Фт.ө., г/м^{2}тәулік) төмендетпейді. Жоғары өнімді егістерде минеральды тыңайтқыштардың оптимальды дозасын (N160-180P120 кг/га) енгізгенде орта бойлы сорттар жоғары деңгейде жапырақ алаңы (ЖА, мың м^2/га), фотосинтетикалық потенциал (ФП, млн. м^{2}тәулік/га), биомасса (Өбиол) қалыптастырады. Бірақ, фотосинтездің таза өнімділігінің (Фт.ө., г/м^{2}тәулік) орташа деңгейі және масақтану фазасынан кейінгі орташа мөлшері төмендемейді. Бұл өте жоғары дән өнімінің (72-78 ц/га) құралуына әсер етті, және бұл жоғары дән өнімі қалыптасуының **екінші эффекті.** Орта бойлы, тік жапырақты Кубань 3, Краснодарский 424, Ару сорттарының жоғары өнімді егістігіне азот тыңайтқышының жылдық нормасының 25-33%-ын себу алдында, 67-75%-ын екі рет: 6-7 және 8-9 жапырақты кезеңде үстеме қоректендіру ретінде берілгенде ең жоғары дән өнімі алынды. Ірі жапырақты Маржан, Арал 202, Түгіскен сорттарының жоғары өнімді егісіне азот тыңайтқышының жылдық нормасының 60-70%-ын себу алдында, 30-40%-ын үстеме қоректендіру ретінде 6-7 жапырақты кезеңде берілгенде ең жоғары өнім алынды.

Түйін сөздер: күріш, сорттар, минеральды тыңайтқыштарды енгізу тәсілдері, фотосинтетикалық қызметін оңтайландыру, жапырақтардың оптимальды мөлшерінің және ең жоғары дін өнімінің қалыптасуы.

Г. Ж. Медеуова

Казахский государственный женский педагогический университет, Алматы, Казахстан

ОПТИМИЗАЦИЯ ФОТОСИНТЕТИЧЕСКОЙ ДЕЯТЕЛЬНОСТИ И ФОРМИРОВАНИЕ ВЫСОКОЙ УРОЖАЙНОСТИ СОРТОВ РИСА В ЗАВИСИМОСТИ ОТ СПОСОБОВ ВНЕСЕНИЯ АЗОТНЫХ УДОБРЕНИЙ И НОРМЫ ВЫСЕВА СЕМЯН

Аннотация. При внесений возрастающих доз минеральных, особенно азотных удобрений у среднерослых сортов ***первый эффект*** повышения урожайности зерна наблюдалось при дозе N120P90-120 кг/га д.в. В этих условиях в агроценозах среднерослых сортов риса ценотическое взаимовлияние не способствовало снижению чистой продуктивности фотосинтез (Фч.пр., г/м^{2}сутки). На высокопродуктивных посевах при внесении оптимальной дозы (N160-180P120 кг/га) удобрений у среднерослых сортов формируются большая ПЛ,ФП, Убиол. Однако уровень средней чистой продуктивности фотосинтеза (Фч.пр., г/м^{2}сут.), особенно после фазы выметывания не снижалось. Это оказало влияние на формирование высокой урожайности зерна (72-78 ц/га), что является ***вторым эффектом*** повышения урожайности зерна у сортов риса. На высокопродуктивных посевах узколистных, с вертикальным расположением листьев сортов Кубань 3, Краснодарский 424, Ару наибольшая урожайность получено при внесений 25-33% годовой нормы азотных удобрений до посева и 67-75% в виде двух подкормок в фазах 6-7 и 8-9 листьев. На посевах крупнолистного сорта Маржан, Арал 202, Тогускен 1 наибольший урожай зерна сформировано при внесении 60-70% годовой нормы азотного удобрения до посева и внесении остальных – 30-40% в виде подкормки в фазе 6-7 листьев.

Ключевые слова: рис, сорта, способы внесения минеральных удобрений, оптимизация фотосинтетической деятельности, формирование оптимальной площади листьев и наибольщей урожайности зерна.

Information about author:

Medeuova Galiya Jumakanovna, Candidate of Agricultural Sciences, Acting Professor; Kazakh state women's pedagogical university, Almaty, Kazakhstan; medeuova.galiya96gmail.com

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S. Nurashov[1], A. Jiyenbekov[2], E. Sametova[1]

[1]«Institute of Botany and phytointroduction», Almaty, Kazakhsatan,
[2]Al-Farabi Kazakh national university, Almaty, Kazakhsatan.
E-mail: nurashs@mail.ru, zh-ai-ek@mail.ru, elyasam@mail.ru

BIODIVERSITY OF BLUE-GREEN (*Cyanophyta*) ALGAE OF ALAKOL LAKE AND ITS SYSTEMATICS

Abstract. In Kazakhstan there are many specially protected natural territories: nurseries, national parks, reserves, sanctuaries, wildlife areas, natural monuments, botanical gardens established for the preservation of biological diversity of the state. In many of those areas the scientists-florists conducted scientific research related to the inventory of vascular plants. Despite the substantial interest for the study of flora, the research into their diversity in various nature communities are insufficient, especially the flora of water reservoirs. The algae of water reservoirs remain studied to a small extent. Nevertheless recently we have conducted the study of algae flora in the specially protected natural territories of various regions of Kazakhstan.Earlier we published systematics and species diversity of diatoms of Lake Alakol.In the article, the authors provide research data's for the first time investigate of the algal flora of Alakol lake, which flows through 15 rivers (The Urzhar, the Katynsu, the Emelkuisa, the Yrgaity, the Zhamanty, the Zhamanotkel, the Tastu etc.). The found seaweeds were divided into: 1-systematic division, 1-clas, 5-orders, 9-families, 22-species and species belonging to 11-genures. Biodiversity of specially established types of seaweed has developed and modern taxonomy has been created. In the studied lake of the algae are found cosmopolitan species in different areas Most of the species listed here are of the plankton bacterial species and some species are of benthos.

Key words: algae, plankton, benthos, systematics, lake Alakol.

Introduction. Lake Alakol is a saline drainage lake located on the Balkhash-Alakol lowland, which is located on the border of the Almaty and East Kazakhstan regions, in the eastern part of the Balkhash-Alakol Basin.More than 15 tributaries flow into the lake, of which the main are the rivers Urzhar, Katynsu, Emelkysa, Ygrajty, Zhamanty, Zhamanotkel, Tasty.The area of the lake (with islands) is 2696 square kilometers. The volume of water is 58.56 cubic km. Length-104 km. Width-52 km. Average depth-22 m. The greatest depth is 54 m.The length of the coastline is 348 km.Together with the lakes Sasykkol, Uyaly, Zhalanashkol and others, smaller, forms the Alakol lake system.In the center of Alakol there are islands: Ulken, Kishkeni Araltobe, Belkuduk, etc. The climate of the coast is sharply continental. A complex wind regime is observed above the lake. The maximum wind speed over the northern parts of the lake reaches 40-50 m/s, over the southeastern and central 50-60 m/s. The most active winds in the autumn-winter period, when the wave height can be up to 2-2,5 m.

The duration of freeze-up is about 2 months (February-March). The largest thickness of ice is 0.8 m (in February). Melting ice-April-early May. The water temperature reaches +7+ 15^0C in late May. Mineralization of water in the water varies from 1.2 to 11.6 g/l. The composition of water is chloride-sodium and chloride-sulfate-sodium. In the waters of Lake Alakol, the high content of fluorine and bromine.In 1994, the Parliament of Kazakhstan ratified the Convention on Biological Diversity, thus affirming its desire to preserve the unique richness of nature. A real step towards the implementation of these documents was the creation in 1998 of the Alakol State Reserve(http://almatyregion-tour.kz).

In 2013-2015 we studied the algae flora of one of the barely studied high mountainous reservoir - the Rakhmanovskoye lake in the Katon Karagay state National natural park of the East Kazakhstan oblast for

he purposes of identification of their species diversity. As a result of research the algae composition of the lake Rakhmanovskoye was determined in which there are 249 species, varieties and forms of algae referred to four types 10 phyla, 25 orders, 45 families and 71 genera. Cyanoprokaryota-14, Chlorophyta-63, Bacillariophyta -1 7 1 , Charopyta – 1 [1-3].

The Lake Markakol is a large water reservoir of Altay located in the mountainous gap (at the altitude of 1500 m above the sea level) in the territory of Markakol state natural reserve. The Markakol hollow is surrounded by the mountain peaks of Kurchumskiy and Azutau. As a result of algae related research in Markakol lake there were discovered 129 types of algae, referred to 3 orders: Bacillariophyta - 85, Chlorophvta -41, Cyanoprokaryota - 3. The basis of algae flora of Markakol lake create the diatomic algae (Bacillariophyta) represented by 85 species from 28 genera, 18 families, 12 orders and 3 phyla [4-9].

In 2013 we conducted algae research from rivers of Zhongar Alatau of Almaty region. As a result of processing algae samples in 2013 for Baskan river in the Zhongar Alatau of the State national natural park of the Almaty region there were discovered 37 species and types of algae referred to 3 orders: diatomic - 32, the green ones -3 and blue-green ones - 2. The basis of Baskan river is created by diatomic algae (Bacillariophyta), represented by 32 speices from 11 genuses, 7 families, 6 orders and 2 phyla. The genuses of Navicula (9), Cymbella (4), Gomphonema (4), Synedra (3), Fragilaria (3) are characterized as being most abundant in genuses [10-13].

The Big Chubachye Lake is the largest of the lakes of the State National Natural Park “Burabay” in the North of Kazakhstan. The average depth of the lake is 11.1 m, the maximal 33.3 m. At the lake there is a number of small islands. The lake is drain free. The water is used for the purposes for drinking potable water, for water supply for cattle and for various economic needs of Burab settlement. As a result of processing of collected samples of alg from the considered drain water reservoir in 2012-20 there were discovered 146 species and types of alg from diatomic division - 117 species, the green ones 11, the blue-green ones - 10; euglena - 2; dinophyta charophyta algae - 3 species [14-16].

Material and methods. The material of this article is elected 2016-2017. During the summer expedition time a species was collected from different points of the Alakol lake.Along the collection of algae, meteorological conditions of the water, air and water temperature were determined. The water depth is determined by the Sekki disk, water ph- universal indicator paper. The water temperature showed the sample at 22°C, and the water was Ph-7.5.In the course of the work, commonly known classical methods of hydrobotanics and algae were used (Jiyenbekov et al.). To determined of phytoplankton samples is a specific examination by M. Gollerbach and B. N. Polyansky, also by the method of N. P. Masiuk and others use Apshtain netting with diameter 45 cm is filtered by plankton grid number 76.The collected material was fixed there in 4% solution of formalin and 96% etanol [17-19]. During harvesting, the algae type, color, colony, etc. p. signs are logged. 26 algae samples from plankton, periphyton, and benthos were collected from the lake. Diatomic algae preparations are investigated by heating. Formalin-treated material is coated with glass and heated in the electric cooker. Organic cleaning of algae piglets is carried out by firing in strong acids [20-24].

In the identification of species, light microscope MBI-3 and binoculars were produced using a computer program with the binoculars Motic BA 400 microscope, and the size of the cells was obtained by using an ocular micrometer.

Results and discussion. As a result of processing algae samples collected from Lake Alakol, analysis of algae obtained from the lake was investigated and modern systematic groups were identified. They are as follows:

1-division (*cyanoprokaryota*), 1-klass (*Cyanophyceae*), 5–order (*Nostocales, Oscillatoriales, Chroococcales, Synechococcales, Spirulinales*) [25-26],9-family (*Nostocaceae, Microcoleaceae, Chroococcaceae, Microcystaceae, Gloeotrichiaceae, Merismopediaceae, Aphanizomenonaceae, Oscillatoriaceae, Spirulinaceae*), 11- genius (*Anabaena, Arthrospira, Chroococcus, Gloeocapsa, Gloeotrichia, Merismopedia, Nodularia, Trichodesmium, Oscillatoria, Spirulina, Nostoc*)the species belong to interdisciplinary forms with the following [27-28], 22 - species (Anagnostidis, 2001: 359-375; Berg, 1987: 97-103; Bourrelly, 1966: 551; Bruno, 1994: 369-373; Carmichael, 1990: 87-106; Edwards, 1992: 1165-1175; Gibson, 1982: 463-489; Gromov, 2000: 79) [29-31].

Type of Alakol lake algae

#	Name of species	#	Name of species
1	*Anabaena cylindrica* Lemmermann	12	*Nodulariaharveyana*Th. ex Bornet&Flahault
2	*A. oscillarioides* Bory ex Bornet & Flahault	13	*N. spumigena*Mertens ex Bornet&Flahault
3	*Arthrospirajenneri* Stizenberger ex Gomont	14	*Nostoc linckia* Bornet ex Bornet&Flahault
4	*Chroococcus minutus* (Kützing) Nägeli	15	*N. zetterstedtii* Areschoug ex Bornet&Flahault
5	*C. tenax* (Kirchner) Hieronymus	16	*Oscillatoria princeps* Vaucher ex Gomont
6	*C. turgidus* (Kützing) Nägeli	17	*O. sancta* Kützing ex Gomont
7	*Gloeocapsa turgida* f. *subnuda* (H.)Hollerbach	18	*Spirulina labyrinthiformis* Gomont
8	*G. violacea* Kützing	19	*S. major* Kützing ex Gomont
9	*Gloeotrichia intermedia* (Lemmermann) Geitler	20	*S.subsalsa* Oersted ex Gomont
10	*Merismopedia glauca* (Ehrenberg) Kützing	21	*Trichodesmium lacustre* Klebahn
11	*M. punctata* Meyen	22	*Trichormus variabilis* (Kütz.Bor.&Fl.) Kom. & Anag.

Figure 1 – *Oscillatoria princeps* Vauch

Figuure 2 – *Chroococcus tenax* (Kirch.) Hier

Figuure 3 – *Gloeotrichia intermedia* (Lemm.) Geit

Conclusion. Discussing the results, many water reservoirs, alga flora of river lakes in our country have been studied, including the Caspian Sea, Syrdarya, Ili, Baskan and Sarkand, Shar and Kokpekty rivers and algal flora and algal biological diversity of the Alakol lake were not investigated by the country's algal specialists. One of the main objectives of the UN Conference on Biodiversity Conservation, adopted in 1992 in Rio de Janeiro is to preserve biodiversity in the environment and prevent the disappearance of species. The algal diversity of the lake is the basis for this goal. The Kazakh Fisheries Research Institute and the Zoology Research Institute have not studied of Alakol Lake Algapholics by hydrobiotes and ichthyofauna.

During our special algaeological investigations, several times this scientific expedition was built. Algae samples from the northern, southern and south-western parts of the lake were removed and the second part was mixed with 4% solution of formalin and 96% solution of ethanol. A microscopic analysis was carried out to determine the types obtained in the laboratory and the study revealed the varieties of diatomaceous algae and its modern taxonomy. Moreover, we have seen in the study that the Alcohol content of some parts of Lake Alacol Lake is very rich. But in recent years, it can be seen that anthropogenic impact on the stability of lake ecosystems and biodiversity linked to the transformation of the lake into a tourist destination. In this article, the authors regulate the stability of the lake water biota, which is the wealth of algaflora. Consequently, it saves the gaseous, salinity of the water, Ph-levels, mineral composition, and biotic content.

С. Б. Нурашов[1], А. К. Джиенбеков[2], Э. С. Саметова[1]

[1]РМК «Ботаника және фитоинтродукция институты», Алматы, Қазақстан,
[2]Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан

АЛАКӨЛ КӨЛІНІҢ КӨК-ЖАСЫЛ (*Cyanophyta*) БАЛДЫРЛАРЫНЫҢ АЛУАНТҮРЛІЛІГІ ЖӘНЕ ОНЫҢ СИСТЕМАТИКАСЫ

Аннотация. Қазақстанда көптеген ерекше қорғауға алынған табиғи аймақтар кездеседі: питомниктер, ұлттық саябақтар, қорықтар, жабайы табиғи аймақтар, табиғат ескерткіштері, ботаникалық бақтар мемлекеттің биологиялық әртүрлілігін сақтау үшін құрылған. Осы салалардың көбінде флорист ғалымдар тамырлы өсімдіктерді түгендеуге қатысып, ғылыми зерттеулер жүргізді. Өсімдіктерді зерттеуге үлкен қызығушылық болсада да, әртүрлі табиғатты қорғау қауымдастықтарында олардың алуан түрлілігіне байланысты зерттеулер, әсіресе, су объектілерінің флорасын зерттеу жеткіліксіз. Су балдырларының құрамын зерттеу төменгі деңгейде қалып отыр. Дегенмен альголог ғалымдар Қазақстанның түрлі өңірлерінің ерекше қорғалатын табиғи аумақтарында балдырлар флорасын зерттеу жұмыстарын жүргізді. Осыған дейінгі мақаламызда Алакөл көлінің диатомды балдырларының алуантүрлілігі мен систематикасын жариялаған болатынбыз. Бұл мақалада авторлар 15 өзендер келіп құйатын (Үржар, Қатынсу, Емелқұйса, Ырғайты, Жаманты, Жаманөткель, Тастыт.б) Алакөл көлінің альгофлорасына алғаш рет мәліметтер беріліп отыр. Табылып, анықталған балдырлар 1 бөлімге, 1 класқа, 5 қатарға, 9 тұқымдасқа, 11 туысқа жататын 17 түрлері мен түр аралық формалары екендігі анықталды. Анықталған балдырлар түрлерінің биологиялық сипаттамасы жасалып, заманауи систематикасы жасалынды. Зерттелуші көлден анықталған балдырлардың көпшілігі әртүрлі су айдындарында кеңінен таралған – космополит түрлер болып саналады. Көрсетіліп отырған түрлердің көпшілігі планктондық, аздаған түрлері бентостық түрлерге жатады.

Түйін сөздер: балдырлар, планктон, бентос, систематика, Алакөл көлі.

С. Б. Нурашов[1], А. К. Джиенбеков[2], Э. С. Саметова[1]

[1]РГП «Институт ботаники и фитоинтродукции», Алматы, Казахстан,
[2]Казахский национальный университет им. аль-Фараби, Алматы, Казахстан

БИОРАЗНООБРАЗИЯ СИНЕЗЕЛЕНЫХ (*Cyanophyta*) ВОДОРОСЛЕЙ ОЗЕРА АЛАКОЛЬ И ЕЕ СИСТЕМАТИКИ

Аннотация. В Казахстане существует много особо охраняемых природных территории: питомники, национальные парки, заповедники, районы дикой природы, памятники природы, ботанические сады, созданные для сохранения биологических многообразие растений. Во многих из этих областей ученые-флористы провели научные исследования, связанные с инвентаризаций сосудистых растений. Несмотря на существенные интересы к изучению флоры, исследование их разнообразие в различных природоохранных сообществах является недостаточным, особенно флоры водоемов. Вводоросли в водоемах остаются изученными в незначительной степени. Тем не менее недавно наши специалисты альгологи провели исследование флоры водорослей в особо охраняемых природных территориях различных регионов Казахстана. Ранее нами была опубликована систематика и видовое разнообразие диатомовых водорослей озера Алаколь. В статье авторы впервые приводят данные по изучению альгофлоры 15 рек (Урджар, Катынсу, Эмелькуйса, Ыргайты, Жаманты, Жаманутkель, Тасты и. т. д.) втекающие в озеро Алакол. Список обнаруженных видов водорослей включает: 22 видов, разновидностей и формы водоросли, относящиеся к 11 родам, 9 семейству, 5 порядкам, 1 классам и 1 отделу. Составлен конспект и биологическое описание обнаруженных видов водорослей и проведена современная систематика. Большинство видов водорослей, обнаруженные в исследуемых озерах относятся к космополитным формам, широко распространенным в различных типах водоемов. Подавляющее большинство обнаруженных видов относятся к планктонным, малая часть видов – бентосные.

Ключевые слова: водоросли, планктон, бентос, систематика, озера Алаколь.

Information about authors:

Nurashov Satpai Bakytbaevich, Candidate of Biological Sciences, Head of Mycology and Algology Laboratory of the Institute of Botany and Phytointroduction, «Institute of Botany and phytointroduction», Almaty, Kazakhsatan; nurashs@mail.ru;

Jiyenbekov Aibek Kaplanbekovich, PhD doctoral student of the Faculty of Biology and Biotechnology, al-Farabi Kazakh national university, Almaty, Kazakhsatan; zh-ai-ek@mail.ru; https://orcid.org/0000-0003-1548-926X

Sametova Elmira Sailaukhanovna, Candidate of Biological Sciences, Academic Secretary of the Institute of Botany and Phytointroduction, «Institute of Botany and phytointroduction», Almaty, Kazakhsatan; elyasam@mail.ru; https://orcid.org/0000-0003-1184-1393

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