ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Өсімдіктердің биологиясы және биотехнологиясы институтының

# Х А Б А Р Л А Р Ы

# ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Института биологии и биотехнологии растений

# N E W S

OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
of the Institute of Plant Biology and Biotechnology

## БИОЛОГИЯ ЖӘНЕ МЕДИЦИНА СЕРИЯСЫ

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## СЕРИЯ БИОЛОГИЧЕСКАЯ И МЕДИЦИНСКАЯ

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## SERIES OF BIOLOGICAL AND MEDICAL

**5 (329)**

**ҚЫРКҮЙЕК – ҚАЗАН 2018 ж.**
**СЕНТЯБРЬ – ОКТЯБРЬ 2018 г.**
**SEPTEMBER – OCTOBER 2018**

1963 ЖЫЛДЫҢ ҚАҢТАР АЙЫНАН ШЫҒА БАСТАҒАН
ИЗДАЕТСЯ С ЯНВАРЯ 1963 ГОДА
PUBLISHED SINCE JANUARY 1963

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR

АЛМАТЫ, ҚР ҰҒА
АЛМАТЫ, НАН РК
ALMATY, NAS RK

**«ҚР ҰҒА Хабарлары. Биология және медициналық сериясы».**
**ISSN 2518-1629 (Online),**
**ISSN 2224-5308 (Print)**
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.)
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5546-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18, www:nauka-nanrk.kz / biological-medical.kz

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Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

**«Известия НАН РК. Серия биологическая и медицинская».**
**ISSN 2518-1629 (Online),**
**ISSN 2224-5308 (Print)**
Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5546-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18,
www:nauka-nanrk.kz / biological-medical.kz

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Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

**News of the National Academy of Sciences of the Republic of Kazakhstan. Series of biology and medicine.**
**ISSN 2518-1629 (Online),**
**ISSN 2224-5308 (Print)**
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5546-Ж, issued 01.06.2006

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz / biological-medical.kz

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Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.1**
Volume 5, Number 329 (2018), 5 – 7

UDC 616–006.325.03:612.12-089

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# OUR EXPERIENCE OF THE SURGICAL TREATMENT OF PRIMARY HEART TUMORS

**Abstract.** In this article there has been generalized an clinical experience of the surgical treatment of primary heart tumors for the 33-years of the work of cardiac surgery department of the NSCS named after A. N. Syzganov. The clinical manifestation of the heart tumors and the diagnostic methods were described. The surgical treatment is a basic method of treatment in this pathology. The morphology of primary heart tumors are presented.

**Key words:** primary heart tumors, surgical treatment, heart myxoma, long-term results.

**Introduction.** In the cardiac surgery practice the primary heart tumors are related to rare diseases. According to literary data they are found in 0,01–0,5% of cases from total quantity of heart diseases. Taking into account extremely unfavorable prognosis in the development of this disease and a good long-term result of modern operation, the problem solution of the surgical treatment of heart tumors is extremely relevant.

**The aim of research** – evaluation of the long-term results of the surgical treatment of primary heart tumors.

**Material and methods.** The analysis was based on the results of 99 hospitalized patients since 1983 till 2016. The age of patients varied from 7 years till 67 years (on average – 37,5 years), while 65% were females. The greatest group (93%) was made by patients of working-age from 21 till 54 years. In 82 cases a tumor was located in the left atrium, in 13 patients – in the right atrium, in 2 patients – in the right ventricle, in 1 patient – in the left ventricle and in 1 case – in both atria simultaneously. The NYHA classification was used for evaluation of severity of a functional class that provides the distribution of patients into 4 classes, while there was used the classification of N.D. Strazhesko and Ch.F. Vassilenko that provides the stages of the circulatory disorders. According to data of classification 38 patients were related to IV class, 48 patients – to III class and 13 patients – to II class;the circulatory insufficiency of the I stage was found in 11 patients, II Astage – in 51 patients, II Бstage – in 37 patients that testifies to severity of hospitalized patients [1].

Before hospitalization 12 (12%) patients were on disability, 75 (75%) patients were engaged in a work, 5 (5%) patients were pupils, 8 (8%) patients were retired. These data testify to a necessity of the surgical treatment for faster social rehabilitation of patients [2].

**Results.** 95 patients underwent a surgical treatment. 3 patients died in the hospital at the stage of examination and preparation for operation during the period of the development of these operations in our center.According to data of pathological and anatomical autopsy 2 patients died of an obstruction of the

left atrioventricular orifice with tumor, and 1 patient died due to development of an acute cardiac and pulmonary insufficiency. One patient was discharged from the hospital having refused the offered surgical treatment. The diagnosis of a heart tumor serves as a basis for the surgical removal of a tumor by urgent indications. Operations were performed according to common rules of oncology which means that there was performed a maximum resection of nearby tissues with following closure or plastic repair of the formed defect. In cases when the radical excision of the heart tissue was not possible owing to complex anatomical structure, there was performed an electric coagulation, a maximum resection of a place of tumor [3].

Long term results of the surgical treatment of patients with heart tumors in the term from 3 till 12 years have been studied in 65 patients of 94, discharged from the hospital (69 %). 29 males and 36 females aged from 27 till 59 years were observed.

Evaluation of the long term results was carried out on the basis of clinical and instrumental investigation, including electrocardiography, chest X-ray and EchoCG. In accordance with clinical results, the observed patients were divided into 3 groups: with good, satisfactory and unsatisfactory results. One patient died of developed cardiac and pulmonary insufficiency due to progression of the leiomyosarcoma.

The group with good results included 48 patients with significant improvement of the condition, in which the physical activity did not cause dyspnea, tachycardia and fatigue. They led healthy lives, a working ability was restored, there was a positive dynamics of the objective methods and investigation (ECG, X-ray data, EchoCG).According to their condition the patients were transferred to functional class higher by 2 classes.

The group with satisfactory results included 10 patients, in which, there was an improvement of the condition as well, but it is less expressed than in first group. Usual physical loading caused dyspnea, palpitation, fatigue. They have the signs of the moderate heart decompensation in great blood circulation saved that we had to use periodically the cardiotropic medicines. The positive dynamics of instrumental methods of investigation in patients of this group was less expressed. According to their condition the patients were transferred to functional class higher by 1 class.

The group with unsatisfactory results included 2 patients which did not have any improvement after operation and any positive dynamic on the side of methods of an investigation. According to their condition the patients remained in the same functional class. We have estimated the long term results the following way.

Long term results of the surgical treatment of patients with heart tumors

| Results of operations | Quantity of patients | % |
|---|---|---|
| Good | 52 | 80,0 |
| Satisfactory | 10 | 15,4 |
| Unsatisfactory | 2 | 3,1 |
| Died | 1 | 1,5 |
| **Total** | 65 | **100** |

**Conclusion.** Myxomais the most common form (95,9%) among primary heart tumors being localized predominantly in the left atrium (86%), rare in the right atrium (12 %), where in majority of cases it is attached by fibrous leg to atrial septum in the oval fossa (90%). The diagnosis of heart myxoma is an indication for urgent operation in order to avoid an occlusion of the atrioventricular orifice and fragmentation of a tumor with development of the acute arterial obstruction. Good long term results of the surgical treatment of benign heart tumors 52 (80%) contribute a social rehabilitation of patients and restoration of their working ability. [4].

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## ЖҮРЕКТІҢ БІРІНШІЛІК ІСІКТЕРІН ОТАЛАУ ЕМІНІҢ ТӘЖІРИБЕСІ

**Аннотация.** Мақалада А. Н. Сызганов атындағы Ұлттық Ғылыми Хирургия Орталығы кардиохирургиялық бөлімшесінің 33-жылдық жұмысы барысында жүректің біріншілік ісіктерін хирургиялық жолмен емдеудің клиникалық тәжірибесі жалпыланған. Жүрек ісіктерінің симптоматикасы әрі диагностикалық әдістері сипатталған. Аталған сырқаттың негізгі емдеу жолы – хирургиялық әдіс. Жүректің біріншілік ісіктерінің морфологиясы берілген.

**Түйін сөздер:** жүректің біріншілік ісіктері, оталау емі, жүрек миксомасы, алшақ нәтижелері.

**А. В. Квашнин, И. Е. Сагатов, Н. С. Досмаилов, К. О. Онгарбаев, Ж. Б. Кошкинбаев**

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## НАШ ОПЫТ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ ПЕРВИЧНЫХ ОПУХОЛЕЙ СЕРДЦА

**Аннотация.** В статье обобщен клинический опыт и отдаленные результаты хирургического лечения первичных опухолей сердца за 33-летний период работы кардиохирургического отделения ННЦХ им. А. Н. Сызганова. Хирургический метод является основным в лечении данной патологии. Оценена социальная реабилитация пациентов после удаления миксом сердца в отдаленном периоде.

**Ключевые слова:** первичные опухоли сердца, оперативное лечение, миксома сердца, отдаленные результаты.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.2**
Volume 5, Number 329 (2018), 8 – 15

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# COMPARATIVE ANALYSIS OF FACTORS MOTIVATING TOBACCO USE AMONG ADOLESCENTS IN THE REPUBLIC OF KAZAKHSTAN

**Abstract.** *Objectives.* The prevalence of tobacco use among schoolchildren continues to be a significant societal problem. A comprehensive study of personal and behavioral aspects of children and adolescents, and their impact on smoking is one of the most promising areas to address this issue. This study aimed to examine various conditions promoting the use of tobacco among children and adolescents.

*Methods.* The current study examined 1,715 eligible students, aged 13–15 years (grades 7–9) from the Global Youth Tobacco Survey (GYTS) conducted in Kazakhstan (2014). The GYTS is a school-based survey on tobacco use prevalence and key tobacco control measures among a representative sample. The survey has standardized methodology: a two-stage sample of schools and classes.

*Results.* Survey results indicated that 2.8% of schoolchildren smoked tobacco. Parental smoking (smoking by one or both parents) influenced smoking among their children. Furthermore, smoking youth demonstrated a positive image of tobacco use. Significant motivating factors included 1) helping to feel comfortable at parties, 2) a positive response to an offer to smoke from friends, and 3) hookah smoking.

*Conclusions.* Effective psycho-pedagogical educational technologies/programs are needed that target parents, especially those who smoke, as well as schoolchildren. These programs should be targeted at the family and school levels to develop negatives attitude toward smoking and strengthen care for quitters. Additionally, strong legislative measures to create smoke-free environments and to reduce the availability of tobacco should be enacted.

**Keywords:** tobacco smoking, tobacco use, children, adolescent, behavioral risk factor, motivating factor.

**Background.** The prevalence of tobacco use among schoolchildren continues to be a significant societal problem. Rapid growth in the number of smokers has led to a "rejuvenation" of smoking and a decrease in the age of smoking initiation. Currently, the average age of young smokers is 13 years. Every day, approximately 80–100 thousand young people worldwide become addicted to tobacco [1–5].

The World Health Organization considers the health of young people through key indicators, including tobacco smoking. Regardless of the number of tobacco products consumed per day, teenagers who regularly smoke constitute a risk group, which, by the end of schooling, shows serious deviations in health status. The threat of increases in disease rates among children and adolescents has prompted the need for active implementation of effective and systematic mechanisms for monitoring the prevalence of tobacco smoking, and control, management, and identification of factors that increase the risk of tobacco smoking among the younger generation [1, 6–11].

Comprehensive study of personal and behavioral aspects, and their impact on smoking status among children and adolescents is a promising but insufficiently developed research area in the effort to reduce the incidence of smoking among youth [12-16]. Currently, there is a need to examine various conditions that prevent children and adolescents from using tobacco. In addition, there is a need to develop and implement measures to prevent smoking, by examining aspects of the individual's personality that lead to the initiation of smoking behavior. Thus, national representative studies in Kazakhstan on the prevalence of smoking among adolescents and systematic monitoring of key indicators of tobacco control are important and necessary steps toward the implementation of relevant policies and programs aimed at reducing tobacco smoking.

**Methods.** The Global Youth Tobacco Survey (GYTS) was administered among a representative sample of adolescents, aged 13–15, in 7 regions of the Republic of Kazakhstan, on the initiative of the World Health Organization, and through the coordination of the National Center for Problems of Healthy Lifestyle Development (2014). The GYTS, a component of the Global Tobacco Surveillance System (GTSS), is the international standard for the systematic monitoring of the prevalence of tobacco consumption (both smoking and smokeless) among young people and the monitoring of key indicators of tobacco control.

The GYTS uses a globally standardized methodology that includes a two-stage sample where the likelihood of choosing schools is proportional to the number of students in schools comprising students of the appropriate age range. Classes in selected schools are chosen at random, and all students in the selected classes have the right to participate in the survey. The survey uses a standard core questionnaire with a set of additional questions, which allows it to be adapted to meet the country's needs for information on tobacco use and on key indicators of tobacco control. Participants assent and the permission of their parents were obtained.

The study involved 2,083 students in grades 7–9, of which 1715 were 13–15 years of age. The current study presents results of a comparative assessment of motivating factors for smoking among both smokers and non-smokers.

Statistical processing of research materials was carried out using Excel and SPSS 15.0 for Windows. When analyzing the conjugacy tables, the Pearson chi-square criterion was used. This method makes it possible to evaluate the statistical significance of the differences in indicators of factors related to smoking among smokers and non-smokers. A binary logistic regression analysis of the predictors of smoking was performed and the odds ratio (OR) indicator was calculated.

**Results.** According to the results of the GYTS study, the prevalence of tobacco smoking among children aged 13–15 was 2.8% (girls = 3.5%, boys = 1.9%).

Investigation of the relationship of parental smoking showed that, one or both parents of smoking adolescents smoked more often (9.8%) than did parents of non-smoking adolescents (3.8%). Furthermore, "smoking only by the father" was noted by 39.0% of smoking adolescents, and in only 10.7% of non-smoking adolescents. Additionally, "smoking only by the mother" was observed in 14.2% of smokers and 12.9% of non-smokers. A Pearson's $\chi^2$ comparison test points to the presence of statistically significant differences between the data of the two groups of adolescents ($\chi^2 = 38.9$, df = 3, $p < 0.001$; figure 1).

Children who smoke do not always fully understand the negative consequences of smoking on health. Awareness in children about the dangers of smoking is reflected in the distribution of answers to the question "Do you think that smoking tobacco harms your health?" Among the adolescents surveyed,

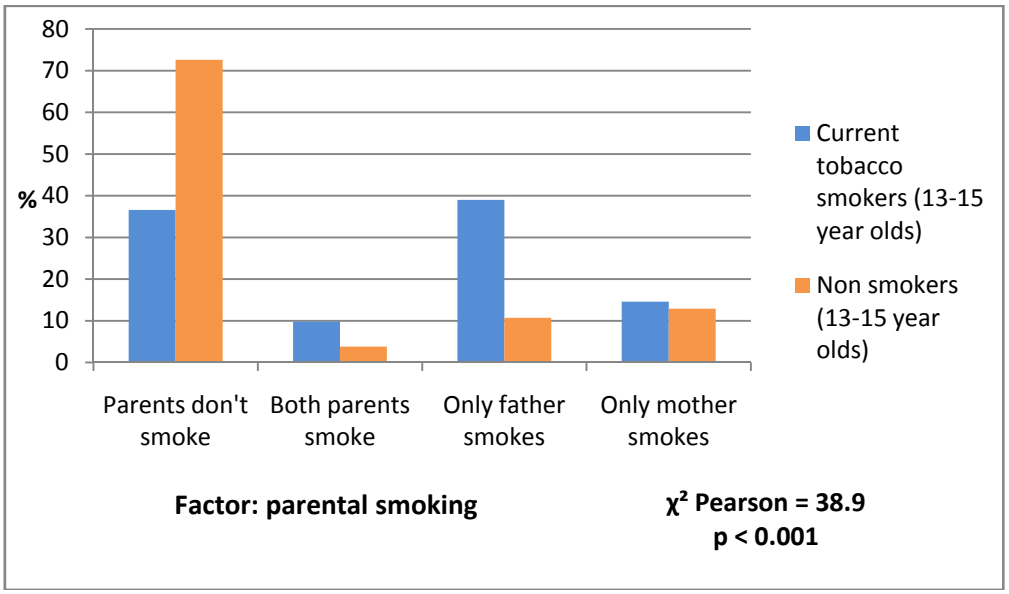


Figure 1 – Parental smoking and smoking status of adolescents

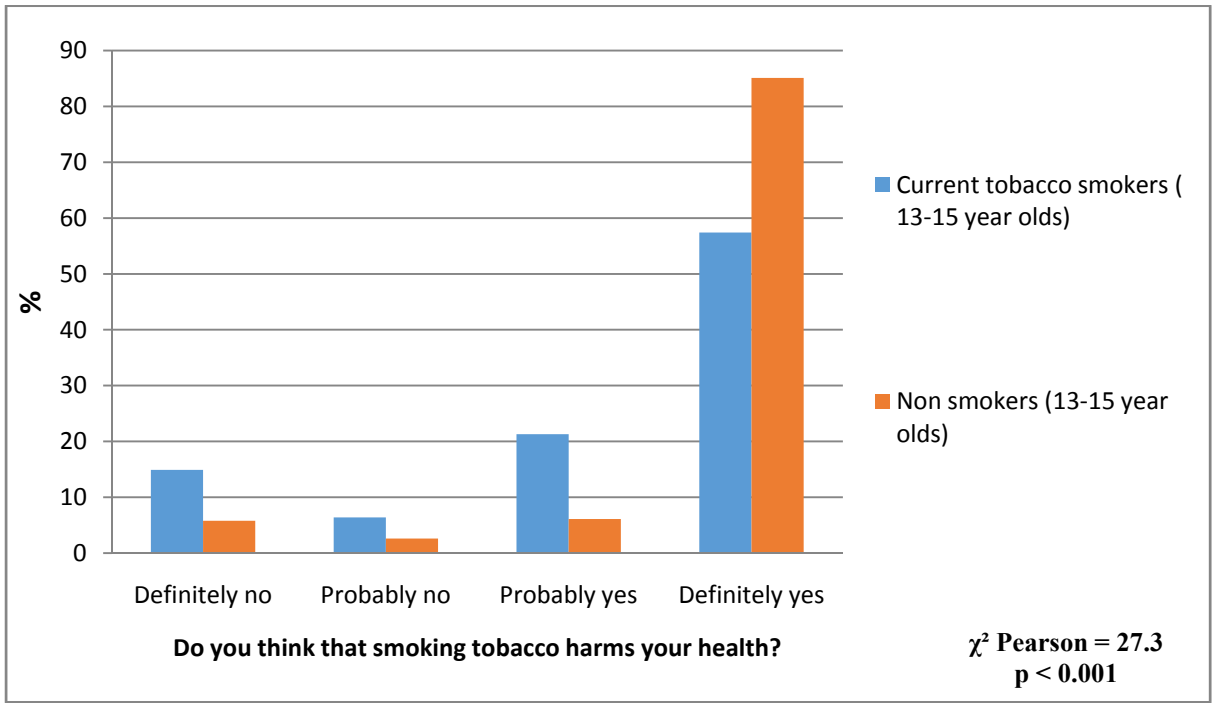


Figure 2 – Adolescents' awareness of the dangers of smoking

78.7% of smoking teenagers and 91.2% non-smokers answered that smoking is harmful to health ($\chi^2 = 27.4$, df = 3, $p < 0.001$; figure 2).

In the youth environment, behaviors such as curiosity, imitation of friends/parents, as well as the desire to appear as adults, independent, modern, and fashionable are common. Often, smoking is considered by youth as an indicator of the above "achievements." During this study, respondents' opinions were considered, specifically concerning how much smoking can affect communication. We asked if they believed that young people who smoke usually have more or less friends. Results indicated that adolescent smokers (39.1%) were significantly more likely to think smoking made it is easier to find friends. However, this opinion existed in only 10.2% of non-smoking teenagers ($\chi^2 = 44.2$, df = 2, $p < 0.001$).

We further examined the opinion of whether smoking makes young people more (or less) attractive. A total of 24.4% of smokers and 11.7% of non-smokers believed that smoking made an individual more attractive. Conversely, only 31.1% of teenage smokers noted that smoking lowers attractiveness, while more than half (54.3%) of non-smoking individuals held this belief. Statistical testing demonstrated a significant difference between these groups ($\chi^2 = 11.7$, df = 2, $p < 0.01$).

Nearly half of the smokers (43.5%) believed that smoking helps young people to feel more comfortable at public events, such as celebrations and parties, while non-smokers demonstrated this opinion four times less frequently (11.8%). It was noted that only 8.7% of smokers and 26.4% of non-smokers believed that smoking made an individual less comfortable at such events. Most non-smoking respondents (61.8%) answered that smoking has no effect on comfort, while fewer smokers (47.8%) agreed with this answer. Such misconceptions can lead to an increase in the prevalence of addictive behaviors in children and adolescents.

We asked whether respondents would agree to smoke if their best friend(s) offered the opportunity to smoke. A positive response was given by more than half (51.1%) of adolescents who smoked, but only by 2.8% of non-smokers.

According to the data of our study, 52.2% of smoking adolescents also reported hookah smoking, compared to only 7.8% of non-smoking adolescents. These differences were statistically significant ($\chi^2 = 106.5$, df = 1, $p < 0.001$).

The prevalence of smokeless tobacco consumption among teenagers was 0.6% (95% CI 0.3–1.3). Similar to the results for hookah smoking, the number of children using nasvay (chewing tobacco)

(13.0%) was significantly higher in the group of tobacco smokers (among non-smokers, the figure was 3.7%).

To more accurately identify the relationship between adolescent smoking and motivating factors (predictors), binary logistic regression models were used and ORs were calculated. To form dichotomous data, a combination of similar variables or an exception of independent variables was carried out. Specifically, two statistical approaches were used. First, all eight factors were included in the regression model to determine the strongest predictors (table 1). Then, a model of step-by step inclusion of the most significant predictors was built.

Table 1 – Logistic regression of predictors of smoking among children aged 13–15 by the Enter method

| | | Regression coefficient (B) | Standard error (S.E.) | Wald | (df) | Significance (Sig.) | Exp (B) |
|---|---|---|---|---|---|---|---|
| (Step) 1 | Factor – parental smoking | 1,037 | 1,023 | 1,027 | 1 | 0,311 | 2,821 |
| | Opinion about the dangers of smoking | 0,555 | 1,093 | 0,258 | 1 | 0,611 | 1,742 |
| | Opinion on the influence of smoking on the number of friends | 0,222 | 1,093 | 0,041 | 1 | 0,839 | 1,249 |
| | Opinion about the influence of smoking on attractiveness | -0,628 | 1,089 | 0,333 | 1 | 0,564 | 0,533 |
| | **Belief that smoking makes one feel comfortable at parties** | **3,182** | **1,450** | **4,815** | **1** | **0,028** | **24,098** |
| | **Positive response to offer to smoke from friends** | **2,598** | **1,051** | **6,114** | **1** | **0,013** | **13,441** |
| | **Hookah smoking** | **1,673** | **1,030** | **2,638** | **1** | **0,104** | **5,326** |
| | Nasvay use | 1,575 | 1,264 | 1,553 | 1 | 0,213 | 4,831 |
| | Constant | -17,061 | 5,126 | 11,078 | 1 | 0,001 | 0,000 |

The results of binary logistic regression modeling showed statistically significant associations with smoking among children and the following predictors: smoking helps me feel more comfortable at parties; a positive response to a proposal to smoke from friends; and hookah smoking (table 2).

The ORs for each motivating factor are presented in table 3. Each of the separately examined factors (predictors) played a role in motivation for smoking. Similar to the results of the regression, the most significant factors associated with adolescent smoking initiation were that smoking helps individuals to

Table 2 – Logistic regression of predictors of smoking among children aged 13–15 by the Forward Conditional method

| | | Regression coefficient (B) | Standard error (S.E.) | Wald | (df) | Significance (Sig.) | Exp (B) |
|---|---|---|---|---|---|---|---|
| (Step) 1(a) | Positive response to offer to smoke from friends | 3,750 | 0,773 | 23,547 | 1 | 0,000 | 42,500 |
| | Constant | -7,163 | 2,025 | 12,505 | 1 | 0,000 | 0,001 |
| (Step) 2(b) | Belief that smoking makes one feel comfortable at parties | 2,405 | 1,110 | 4,691 | 1 | 0,030 | 11,078 |
| | Positive response to offer to smoke from friends | 3,146 | 0,819 | 14,751 | 1 | 0,000 | 23,239 |
| | Constant | -8,798 | 2,387 | 13,583 | 1 | 0,000 | 0,000 |
| (Step) 3(c) | Belief that smoking makes one feel comfortable at parties | 2,362 | 1,150 | 4,218 | 1 | 0,040 | 10,611 |
| | Positive response to offer to smoke from friends | 3,272 | 0,869 | 14,166 | 1 | 0,000 | 26,370 |
| | Hookah smoking | 1,930 | 0,876 | 4,850 | 1 | 0,028 | 6,887 |
| | Constant | -12,420 | 3,300 | 14,162 | 1 | 0,000 | 0,000 |

a – Variable entered on step 1: Positive response to offer to smoke from friends.
b – Variable entered on step 2: Does smoking make you feel comfortable at parties?
c – Variable entered on step 3: Hookah smoking.

Table 3 – Odds ratio for smoking: motivating factors

| | | Current tobacco smokers (children 13–15-year-olds), % | Non-smokers (children 13–15-year-olds), % | Odds ratio (95% CI) Probability of error |
|---|---|---|---|---|
| **Parental smoking** | **One or both parents smoke** | **63,4** | **27,4** | **4,6 (2,4–8,8) p<0,001** |
| | **Parents do not smoke** | **36,6** | **72,6** | |
| Opinion of children about the dangers of smoking | No harm | 21,3 | 8,4 | 2,9 (1,4–6,0) p<0,01 |
| | Does harm | 78,7 | 91,6 | |
| **The opinion of children about the effect of smoking on the number of friends** | **Smokers have more friends** | **78,3** | **19,7** | **14,7 (5,4–40,1) p<0,001** |
| | **Smokers have less friends** | **21,7** | **80,3** | |
| The opinion of children about the influence of smoking on attractiveness | Smoking makes people more attractive | 44,0 | 17,7 | 3,7 (1,6–8,2) p<0,01 |
| | Smoking makes people less attractive | 56,0 | 82,3 | |
| **Children's belief that smoking helps people feel more comfortable at parties** | **More comfortable** | **83,3** | **30,9** | **11,2 (3,8–33,1) p<0,01** |
| | **Less comfortable** | **16,7** | **69,1** | |
| Response to best friends offering tobacco product | Positive | 51,1 | 2,9 | 35,3 (18,6–67,1) p<0,001 |
| | Negative | 48,9 | 97,1 | |
| **Hookah smoking** | **Yes** | **52,2** | **7,8** | **12,9 (7,0–23,6) p<0,001** |
| | **No** | **47,8** | **92,2** | |
| Nasvay use | Yes | 13,0 | 3,7 | 3,9 (1,6–9,5) p<0,01 |
| | No | 87,0 | 96,3 | |

feel comfortable at parties, a positive response to use a tobacco product if offered by best friends, and hookah smoking. Factors with the lowest ORs were awareness in children about the dangers of smoking (i.e., knowledge of the harm that smoking inflicts does not influence involvement in tobacco smoking), the association between smoking and the attractiveness of a person, and nasvay use.

**Discussion.** Because smoking was, and remains, one of the most common behavioral risk factors affecting a large part of the youth population, it is important to study the causes and motivating factors of this high level of early tobacco use. Despite strict laws and anti-smoking programs, the problem of tobacco use among children and adolescents remains.

As our research and studies of other scientists show, among the factors predisposing individuals to smoking, social factors (e.g., environment, parents' example, awareness) play a leading role [7, 8]. For various reasons, children and adolescents easily would use a tobacco product if it was offered by their best friends.

Often among teenagers, false ideas (i.e., myths) about smoking can be propagated. The current results indicate the development of several incorrect beliefs about tobacco use, such as "young people who smoke usually have more friends," "smoking helps young people feel more comfortable at parties," etc. Knowledge about the negative impact of tobacco on health among adolescents who smoke is insufficient and fragmentary. Unfortunately, this dearth of adequate information leads to a lack of formation of positive motivations for not initiating or quitting smoking.

A comparative evaluation of two groups (i.e., smokers and non-smokers) showed that smokers were significantly more likely to have parents who smoked (one or both parents smoking). Furthermore, children who used tobacco were more likely to report that smoking does not harm health and that young people who smoke usually have more friends. Additionally, smoking teens were much more likely to believe that smoking makes young people more attractive, helps them feel more comfortable at parties and other similar events, and were more likely to freely agree to smoke when it was suggested by friends. Moreover, smoking hookah and the use of nasvay were significantly more common among adolescent tobacco smokers. Finally, the most important factors motivating smoking among children and adolescents

were 1) smoking helps individuals feel comfortable at parties; 2) a positive response to an offer to smoke from friends, and 3) hookah smoking.

**Conclusions.** The findings of this study reveal the need for effective psychological, pedagogical, and educational technologies in addition to legislative measures, when developing primary and secondary smoking prevention measures for children and adolescents. In addition, these measures should be aimed at the level of schools and families, and families with parental smoking should be targeted.

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## ҚАЗАҚСТАН РЕСПУБЛИКАСЫНДА ЖАСӨСПІРІМДЕР АРАСЫНДА ТЕМЕКІНІ ТҰТЫНУҒА ЫНТАЛАНДЫРАТЫН ФАКТОРЛАРДЫ САЛЫСТЫРМАЛЫ ТАЛДАУ

**Аннотация.** *Кіріспе.* Оқушылар арасында темекіні тұтынудың таралуы қоғамдағы жетекші әлеуметтік маңызды мәселелердің бірі болып қалуда. Балалар мен жасөспірімдер арасында тұлғалық және мінез-құлықтық аспектілер және олардың темекі шегуге ықпалын жан-жақты зерттеу өскеең ұрпақ арасында темекі шегу жиілігін төмендету жөніндегі шаралар жүйесінде үміті зор бағыттардың бірі болып табылады. Аталған зерттеуде балалар мен жасөспірімдер арасында темекіні тұтынуға ықпал ететін факторлар қатары зерттелуде.

*Әдістер.* Зерттеуге Қазақстанда (2014 жылы) өткізілген Жастарды темекіні тұтыну бойынша ғаламдық зерттеу (Global youth tobacco survey, GYTS) шеңберінде 13-15 жастағы (жалпы білім беретін мектептердің 7-9 сыныптары) 1715 оқушы қамтылды. GYTS темекіні тұтынудың таралуы туралы мектеп сауалнамасын және қайталап таныстырмалы іріктеме арасында темекіге қарсы күрестің негізгі шараларын көрсетеді. Зерттеудің негізіне мектептер мен сыныптарды екі сатылы іріктеуді қамтитын стандартталған әдістеме жатады.

*Нәтижелері.* Сауалнама нәтижелері оқушылардың 2,8%-ы темекі шеккенін көрсеткен. Ата-ананың біреуінің немесе екеуінің темекі шегуі балалар арасында темекі шегуге ықпал еткен. Сонымен қатар, темекі шегетін жастар темекі тұтынудың жағымдды бейнесін көрсеткен. Темекі шегуді ынталандыратын факторлар бар: 1) темекі шегу кештерде өзіңді жайлы сезінуге көмектеседі 2) достардан темекі шегуге ұсыныстан оң жауап алу және 3) қорқор тарту.

*Қорытынды.* Ата-аналарға, әсіресе темекі шегетін ата-аналарға, сондай-ақ оқушыларға арналған тиімді психологиялық-педагогикалық оқыту технологиялары/бағдарламалар қажет. Бұл бағдарламалар темекіге кері көзқарасты дамыту және темекіні тастағысы келетіндерге көмекті күшейту үшін отбасы және мектеп деңгейіне бағдарлануы қажет. Сонымен қатар, түтінсіз ортаны құру мен темекіге қолжетімділікті төмендету жөніндегі шешуші заңнамалық шараларды қабылдау қажет.

**Түйін сөздер:** шылымқорлық, балалар, жасөспірімдер, мінез-құлықтық қауіпті факторлар, ынталандырушы факторлар.

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## СРАВНИТЕЛЬНЫЙ АНАЛИЗ ФАКТОРОВ, МОТИВИРУЮЩИХ К ПОТРЕБЛЕНИЮ ТАБАКА СРЕДИ ПОДРОСТКОВ В РЕСПУБЛИКЕ КАЗАХСТАН

**Аннотация.** *Введение.* Распространенность употребления табака среди школьников продолжает оставаться одной из ведущих социально значимых проблем общества. Всестороннее изучение личностных и поведенческих аспектов и их влияния на статус курения среди детей и подростков является одним из наиболее перспективных направлений в системе мер по снижению частоты курения среди подрастающего поколения. В данном исследовании изучаются ряд факторов, способствующих употреблению табака среди детей и подростков.

*Методы.* В исследование было включено 1715 школьников в возрасте 13-15 лет (7–9-ые классы общеобразовательных школ) в рамках Глобального обследования молодежи по потреблению табака (Global youth tobacco survey, GYTS), проведенного в Казахстане (2014 год). GYTS представляет собой школьный опрос о распространенности употребления табака и ключевых мерах борьбы против табака среди репрезентативной выборки. В основе исследования лежит стандартизированная методология, которая включает в себя двухступенчатую выборку школ и классов.

*Результаты.* Результаты опроса показали, что 2,8% школьников курили табак. Курение одного или обоих родителей влияло на курение среди детей. Кроме того, курящая молодежь демонстрировала поло-

жительный образ употребления табака. Существенные мотивирующие факторы курения включали: 1) курение помогает чувствовать себя комфортнее на вечеринках 2) положительный ответ на предложение покурить от друзей и 3) курение кальяна.

*Выводы*. Необходимы эффективные психолого-педагогические образовательные технологии / программы, предназначенные для родителей, особенно для тех, кто курит, а также школьников. Эти программы должны быть ориентированы на семейный и школьный уровни для развития негативного отношения к курению и усиления помощи желающим бросить курить. Кроме того, следует принять решительные законодательные меры по созданию бездымной среды и снижению доступности табака.

**Ключевые слова:** табакокурение, дети, подростки, поведенческие факторы риска, мотивирующие факторы.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.3**
Volume 5, Number 329 (2018), 16 – 24

UDC 580:502.7 (574.245)

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# CENOFLORA OF *ADONIS WOLGENSIS* STEVEN IN NORTHERN KAZAKHSTAN

**Abstract.** The article presents the research results of the *Adonis Wolgensis* Steven cenoflora in Northern Kazakhstan. The materials were gathered in the process of field studies, the literary data was taken into account. The list of *Adonis Wolgensis* flora in Northern Kazakhstan is given on the basis of detailed-route studies. Cenoflora analysis of systematic structure, life forms composition, ecological groups, life expectancy of the individuals and ecological cenotic groups revealed the features of the *Adonis Wolgensis* populations' current state and position in the vegetation cover. According to systematic structure and composition of the ecological groups, this cenoflora does not differ significantly from the flora of Northern and Central Kazakhstan. It reflects particularity of the steppe zone's shrub thickets in Northern Kazakhstan. Spectrum of life forms and composition of ecological cenotic groups reflects the influence of zonal steppe communities. The peculiarity of modern ecological niche for *Adonis Wolgensis* is characterized by a group of meadow plants found in the communities of shrub thickets of Northern Kazakhstan. Currently, the cenopopulation of *Adonis Wolgensis* retains its ability for self-sustain and regeneration within the occupied ecological niche with a small anthropogenic load.

**Key words:** *Adonis Wolgensis* Steven, cenopopulation, Northern Kazakhstan, systematic structure, ecological cenotic groups.

**Introduction**. *Adonis Wolgensis* Steven is a steppe Pontic-Pannonian Zavolzhsky Kazakh type, widespread in the southern and the southeastern regions of the European part of Russia, in the central and the southern regions of Ukraine, in Central and Northern Kazakhstan, in the south of Western Siberia. The species was listed into the Red Book of Kazakhstan in 2014, as well as into the Red Book of the Saratov Region in 2006 [1, 2]. Literary data describes status of some *Adonis Wolgensis* populations in the Saratov region indicating the main phytocenoses in which they grow [3]. In Kazakhstan this kind of work has not been carried out before. Rare and endangered species need cenotic environment, which can show threats to their existence. Although floristic studies in Northern Kazakhstan have a long history, no studies have been carried out to study the cenoflor of rare species. Therefore, the aim of the research is to study the cenoflora of *Adonis Wolgensis* in Northern Kazakhstan.

**Material and research methods.** The studies were carried out during the flowering period of *Adonis Wolgensis* (26.04 – 15.05. 2018) in Pavlodar, Akmola and Kostanay regions: the eastern border - Ekibastuz district; the western border - Kostanay district (figure 1). For floristic description were selected the places with a high density of flowering *Adonis Wolgensis*. The studies were carried out by a detailed-route

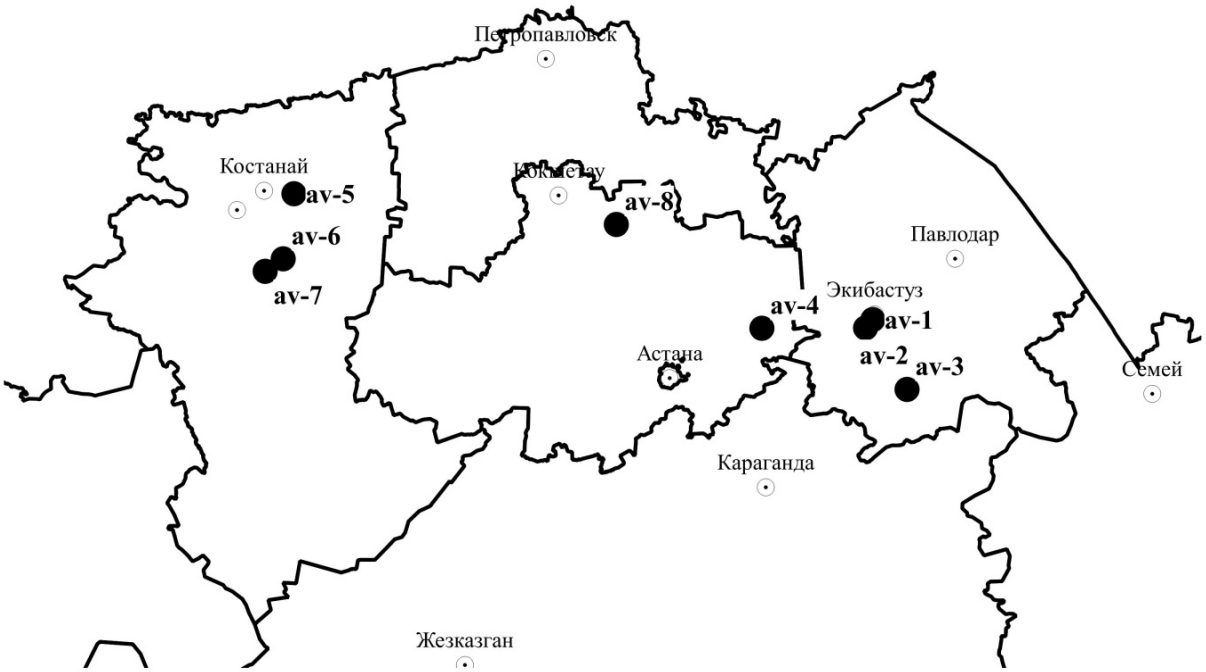


Figure 1 – Placement of studied *Adonis Wolgensis* Steven populations in Northern Kazakhstan

method, there have been examined and described 8 loci of *Adonis Wolgensis* populations and the communities with its participation. Basing on the collected data, there has been compiled a list of species, the analysis of which is present in this article.

The volume of families is given according to the summary of S.K. Cherepanov (1995), including modern data [4]. The families of flowering plants are arranged by the system of A.L. Takhtadzhyan [5]. The species in genera and the genera in families are arranged alphabetically.

**Results and discussion.** Populations of *Adonis Wolgensis* can be found almost on the entire territory of Northern Kazakhstan, which is more common in comparison with the existing data from the Flora of Kazakhstan [6]. The species was found for the first time in Kokshetau floral district.

It should be noted that in the south of Russia the spectrum occupied by *Adonis Wolgensis* steppe community is quite wide - from the most mesophytic variants of communities with a dominance of *Poa angustifolia* L. on the slopes and bottoms of shallow gulches and ecotones on the border with forest phytocenoses to the white wormwood-fescue phytocenoses on solonetsous chestnut soils [3].

In Northern Kazakhstan, *Adonis Wolgensis* also grows in various types of communities. Its populations occupy areas of 200-600 square meters. The location of plants is curt: each curtain is made up of several individuals of different age. In spring adonis forms an aspect and its projective coverage can reach up to 3%.

In the environs of Ekibastuz populations of *Adonis Wolgensis* (CP 1,2) are located along the slopes and inter-sugarloaf downhills in shrub thickets on slightly and moderate saline clay soils. In the Bayanaul Mountains (CP 3) this species grows in dells and at the foot of slopes on dark chestnut soils in thickets of steppe shrubs. In the Erejmentau Mountains (CP 4), the population under study is in the solonetsous meadow formed at the foot of a hill. In Kostanay region the populations are found along the fringes of pine forests on sandy soil (CP 5) and also on the site of an old burnt forest (CP 6) with a formed cereal-bean community (*Amygdalus nana*). Another population grows on the territory of "Stone Lake" in the shrubs thickets (CP 7). On the Kokshetau Upland (CP 8) *Adonis Wolgensis* populations are located along the edges of birch and pine forests on not-completely developed chestnut soils. The data on the location of the investigated cenopopulations is presented in table 1.

The cenoflora of *Adonis Wolgensis* includes 119 species belonging to 28 families and 75 genera (table 2). The most rich in species composition families are *Asteraceae, Rosaceae* and *Poaceae*. Only four families (*Asteraceae, Rosaceae, Poaceae, Fabaceae*) have more than three genera, the remaining have 1-3 genera.

Table 1 – Characteristics of cenopopulations (CP) of *Adonis Wolgensis* Steven

| Number of CP | Location of CP | Habitat | Density of species, species/100m$^2$ | GPS, % |
|---|---|---|---|---|
| CP 1 | Pavlodar region, Ekibastuz district, N51.66494°, W75.28173°, h=412 m above sea level | Inter-sugarloaf downhills, feather grass-fescue steppe. | 24 | 60 |
| CP 2 | Pavlodar region, Ekibastuz district, natural boundary "Three birches", N51.57517°, W75.13187°, h=403 m above sea level | Eastern slope of sugarloaf, feather grass-fescue steppe. | 29 | 60 |
| CP 3 | Pavlodar region, Bayanaul district, N50.2209°, W75.8009°, h=406 m above sea level | Slope foot, fossilized fescue-feather grass steppe. | 29 | 90 |
| CP 4 | Akmola region, Erejmentau district, Mount Ereimentau, N51.65717°, W73.19056°, h=313 m above sea level | Slope foot, solonetsous sagebrush-feather grass steppe. | 25 | 100 |
| CP 5 | Kostanay region, Shcherbakov district, N53.20453°, W64.21550°, h=193 m above sea level | Sparse pine forest on the sands. | 20 | 30 |
| CP 6 | Kostanay region, Ozerny district, Novonezhenskoe forestry, quarter #21, N52.43971°, W64.09279°, h=213 m above sea level | Secondary psammophyte steppe in the place of an old fire. | 38 | 100 |
| CP 7 | Kostanay region, Zarechny district, natural monument "Stone Lake", N52.28013°, W63.76616°, h=134 m above sea level | Northern slope to the lake basin, shrubbery feather grass steppe. | 23 | 100 |
| CP 8 | Akmola region, Katarkol district, N52.93287°, W70.49210°, h=431 m above sea level | Edge of birch-pine forest. | 20 | 60 |
| *Note*. GPS - general projective grass covering. | | | | |

Table 2 – Composition of *Adonis Wolgensis* cenoflora

| Species | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| **Equisetaceae** Rich. ex DC. family | | | | |
| *Equisetum hyemale* L. | P | Lr | XM | Meadow |
| **Pinaceae** Spreng. ex Rudolphi family | | | | |
| *Pinus sylvestris* L. | P | T | XM | Forest |
| **Ephedraceae** Dumert. family | | | | |
| *Ephedra distachya* L. | P | Sh | X | Steppe |
| **Ranunculaceae** Juss. family | | | | |
| *Adonis Wolgensis* Steven | P | Shr | M | Steppe |
| *Pulsatilla flavescens* (Zucc.) Juz. | P | Shr | M | Steppe |
| *Pulsatilla patens* (L.) Mill. | P | Shr | M | Steppe |
| *Ranunculus polyanthemos* L. | P | F | M | Meadow |
| *Ranunculus polyrhizos* Steph. | P | F | M | Meadow |
| **Betulaceae** S. F. Gray family | | | | |
| *Betula pendula* Roth | P | T | M | Forest |
| **Caryophyllaceae** Juss. family | | | | |
| *Eremogone longifolia* (M.Bieb.) Fenzl | P | Lr | XM | Meadow |
| *Gypsophila paniculata* L. | P | Tr | XM | Steppe |
| *Otites wolgensis* (Hornem.)Grossh. | O-B | Tr | XM | Steppe |
| *Silene chlorantha* (Willd.) Ehrh. | P | Tr | M | Meadow |
| **Polygonaceae** Juss. family | | | | |
| *Rumex acetosa* L. | P | Tr | M | Meadow |
| **Limoniaceae** Ser. family | | | | |
| *Limonium gmelinii* (Willd.) Kuntze | P | Shr | XM | Steppe |

*Continuation of table 2*

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Tamaricaceae** Link family | | | | |
| *Tamarix ramosissima* Ledeb. | P | Sh | XM | Steppe |
| **Primulaceae** Batsch ex Borkh. family | | | | |
| *Androsace maxima* L. | E | Tr | GM | Steppe |
| **Brassicaeae** Burnett family | | | | |
| *Alyssum desertorum* Stapf | E | Tr | GM | Steppe |
| *Draba nemorosa* L. | E | Tr | GM | Steppe |
| **Salicaceae** Mirb. family | | | | |
| *Populus tremula* L. | P | T | M | Forest |
| **Crassulaceae** J. St.-Hil. family | | | | |
| *Sedum telephium* L. | P | Lr | M | Meadow |
| **Rosaceae** Juss. family | | | | |
| *Amygdalus nana* L. | P | Sh | XM | Steppe |
| *Filipendula stepposa* Juz. | P | Tr | XM | Steppe |
| *Filipendula ulmaria* (L.) Maxim. | P | Tr | M | Meadow |
| *Filipendula vulgaris* Moench | P | Tr | XM | Steppe |
| *Fragaria vesca* L. | P | Lr | M | Meadow |
| *Fragaria viridis* (Duchesne) Weston | P | Lr | XM | Meadow |
| *Potentilla arenaria* Borkh. | P | Lr | X | Steppe |
| *Potentilla asiatica* (Th. Wolf) Juz. | P | Shr | XM | Steppe |
| *Potentilla bifurca* L. | P | Lr | XM | Meadow |
| *Potentilla canescens* Besser | P | Shr | XM | Steppe |
| *Potentilla humifusa* Willd. ex Schltdl. | P | Shr | XM | Steppe |
| *Rosa acicularis* Lindl. | P | Sh | XM | Steppe |
| *Rosa majalis* Herrm. | P | Sh | XM | Forest |
| *Rosa spinosissima* L. | P | Sh | XM | Steppe |
| *Spiraea hypericifolia* L. | P | Sh | XM | Steppe |
| **Onagraceae** Juss. family | | | | |
| *Oenothera biennis* L. | O-B | Tr | M | Weed |
| **Fabaceae** Lindl. family | | | | |
| *Astragalus testiculatus* Pall. | P | Ssh | X | Steppe |
| *Caragana frutex* (L.) K.Koch | P | Sh | XM | Steppe |
| *Genista tinctoria* L. | P | Sh | Xм | Steppe |
| *Glycyrrhiza uralensis* Fisch. | P | Lr | M | Steppe |
| *Medicago falcata* L. | P | Tr | XM | Steppe |
| *Melilotus officinalis* (L.) Pall. | O-B | Tr | XM | Weed |
| **Valerianaceae** Batsch family | | | | |
| *Valeriana tuberosa* L. | P | Tr | M | Steppe |
| **Dipsacaceae** Juss. family | | | | |
| *Scabiosa isetensis* L. | P | Lr | XM | Steppe |
| **Apiaceae** Lindl. family | | | | |
| *Ferula soongarica* Pall. ex Spreng. | P | Tr | M | Steppe |
| *Seseli ledebourii* G.Don | P | Shr | XM | Steppe |

*Continuation of table 2*

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| *Seseli libanotis* (L.) W.D.J.Koch | P | Tr | M | Meadow |
| *Xanthoselinum alsaticum* (L.) Schur | P | Shr | M | Meadow |
| **Asteraceae** Bercht. et J. Presl family | | | | |
| *Achillea asiatica* Serg. | P | Lr | XM | Meadow |
| *Achillea millefolium* L. | P | Lr | M | Meadow |
| *Achillea nobilis* L. | O-B | F | XM | Steppe |
| *Achillea setacea* Waldst. & Kit. | P | Lr | XM | Steppe |
| *Ancathia igniaria* (Spreng.) DC. | O-B | Tr | X | Steppe |
| *Artemisia absinthium* L. | P | Shr | XM | Weed |
| *Artemisia austriaca* Jacq. | P | Lr | XM | Steppe |
| *Artemisia campestris* L. | P | Tr | XM | Steppe |
| *Artemisia commutata* Besser | P | Tr | XM | Steppe |
| *Artemisia compacta* Fisch. ex DC. | P | Tr | XM | Steppe |
| *Artemisia dracunculus* L. | P | Lr | XM | Meadow |
| *Artemisia filatovae* Kupr. | P | Tr | XM | Steppe |
| *Artemisia frigida* Willd. | P | Ssh | XM | Steppe |
| *Artemisia nitrosa* Weber | P | Lr | XM | Steppe |
| *Artemisia pauciflora* Weber | P | Tr | X | Steppe |
| *Artemisia schrenkiana* Ledeb. | P | Tr | X | Steppe |
| *Carduus crispus* L. | O-B | Tr | XM | Weed |
| *Carduus nutans* L. | O-B | Tr | XM | Weed |
| *Centaurea marschalliana* Spreng. | P | Tr | XM | Steppe |
| *Centaurea scabiosa* L. | P | Tr | XM | Weed |
| *Echinops sphaerocephalus* L. | O-B | Tr | M | Weed |
| *Galatella* sp. | P | Lr | XM | Steppe |
| *Galatella tatarica* (Less.) Novopokr. | P | Lr | XM | Steppe |
| *Hieracium umbellatum* L. | P | F | XM | Forest |
| *Jacobaea erucifolia* (L.) Gaertn., Mey. et Scherb. | P | Shr | M | Meadow |
| *Jacobaea vulgaris* Gaertn. | O-B | Tr | XM | Weed |
| *Jurinea multiflora* (L.) B.Fedtsch. | P | Lr | X | Steppe |
| *Saussurea salsa* (Pall. ex M.Bieb.) Spreng. | P | Tr | XM | Steppe |
| *Scorzonera ensifolia* M.Bieb. | P | Shr | X | Steppe |
| *Serratula cardunculus* (Pall.) Schischk. | P | Lr | XM | Steppe |
| *Solidago virgaurea* L. | P | Shr | M | Forest |
| *Taraxacum officinale* F.H.Wigg. | O-B | Tr | M | Weed |
| **Rubiaceae** Juss. family | | | | |
| *Galium verum* L. | P | Shr | XM | Steppe |
| **Boraginaceae** Juss. family | | | | |
| *Onosma simplicissima* L. | P | Lr | XM | Steppe |
| **Scrophulariaceae** Juss. family | | | | |
| *Linaria vulgaris* Mill. | P | Lr | M | Weed |
| *Verbascum phoeniceum* L. | P | Tr | XM | Steppe |
| *Veronica incana* L. | P | Lr | X | Steppe |

*Continuation of table 2*

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| *Veronica longifolia* L. | P | Lr | M | Meadow |
| *Veronica spicata* L. | P | Lr | XM | Steppe |
| *Veronica spuria* L. | P | Lr | XM | Steppe |
| **Lamiaceae** Martinov family | | | | |
| *Phlomoides tuberosa* (L.) Moench | P | Tr | XM | Steppe |
| *Thymus marschallianus* Willd. | P | Lr | XM | Steppe |
| *Thymus serpyllum* L. | P | Lr | XM | Steppe |
| **Liliaceae** Juss. family | | | | |
| *Fritillaria ruthenica* Wikstr. | P | Br | M | Steppe |
| *Gagea fedtschenkoana* Pascher | P | Br | M | Steppe |
| *Gagea granulosa* Turcz. | P | Br | M | Steppe |
| *Tulipa biebersteiniana* Schult. & Schult. f. | P | Br | M | Steppe |
| *Tulipa patens* C.Agardh ex Schult. & Schult. f. | P | Br | M | Steppe |
| **Alliaceae** Borkh. family | | | | |
| *Allium globosum* M.Bieb. ex Redoute | P | Br | XM | Steppe |
| *Allium nutans* L. | P | Br | XM | Steppe |
| *Allium strictum* Schrad. | P | Br | XM | Steppe |
| *Allium tulipifolium* Ledeb. | P | Br | M | Steppe |
| **Cyperaceae** Juss. family | | | | |
| *Carex ericetorum* Pollich | P | Lr | XM | Steppe |
| *Carex pediformis* C.A.Mey. | P | Lr | XM | Steppe |
| *Carex* sp. | P | Lr | XM | Meadow |
| *Carex supina* Willd. ex Wahlenb. | P | Lr | X | Steppe |
| **Poaceae** Barnhart family | | | | |
| *Achnatherum splendens* (Trin.) Nevski | P | Shr | XM | Steppe |
| *Agropyron cristatum* (L.) Beauv. | P | Shr | XM | Steppe |
| *Agropyron pectinatum* (M.Bieb.) Beauv. | P | Shr | XM | Steppe |
| *Bromopsis inermis* (Leyss.) Holub | P | Lr | M | Meadow |
| *Calamagrostis epigeios* (L.) Roth | P | Lr | XM | Meadow |
| *Elytrigia repens* (L.) Nevski | P | Lr | M | Weed |
| *Festuca valesiaca* Gaudin | P | Shr | X | Steppe |
| *Koeleria cri*stata (L.) Pers. | P | Lr | X | Steppe |
| *Phleum phleoides* (L.) H.Karst. | P | Lr | XM | Steppe |
| *Phragmites australis* (Cav.) Trin. ex Steud. | P | Lr | M | Coastal-aquatic |
| *Poa angus*tifolia L. | P | Lr | XM | Steppe |
| *Poa pratensi*s L. | P | Lr | M | Meadow |
| *Stipa capillata* L. | P | Shr | X | Steppe |
| *Stipa pennata* L. | P | Shr | X | Steppe |

*Note.*

Column 1 shows the life span of individuals (P – perennials, O-B – long-vegetating one-biennials, E – ephemera).

Column 2 shows the life forms (T - tree, Sh - shrub, Ssh - semi-shrub, Lr - long-root grasses, Shr - short-root grasses, Tr - tuberous grasses, Br - bulb grasses, Tr - taproot grasses, F - fibrous grasses).

Column 3 shows ecological groups in relation to the moisture availability of habitats (X - Xerophytes, XM - xerome-sophytes, M - mesophytes, GM - gigromesophytes).

Column 4 shows ecological cenotic groups.

In the *Asteraceae* family, there have been found four species of the *Achillea* genus and eleven species of the *Artemisia* genus. This indicates that the cenoflora on the one hand has a meadow-steppe character, and on the other, includes solonetsous habitats. The *Rosaceae* family has five species of the *Potentilla* genus and three species of the *Rosa* genus.

The composition of the leading families does not include *Caryophyllaceae* and *Brassicaceae*, but the *Ranunculaceae* and *Liliaceae* families have a higher rank in comparison with the spectrum of the flora leading families of all Kazakh hills.

The noted changes give the *Adonis Wolgensis* cenoflora a more boreal character than the steppe flora of the Central-Kazakhstan hills [7], thus, it is more characteristic of the Eastern Europe flora [8]. These features of cenoflora correlate well with the ecological conditions of shrub thickets in which *Adonis Wolgensis* populations emerge - with greater protection from drying and a smooth change of temperatures much lower than in open steppe areas.

The basis of the cenoflora is perennial plants (96 species). One-biennial plants are represented by 13 species, which is 11% of the species composition of the cenoflora. The latter group consists of long-vegetating one-biennials (10 species) and ephemerals - annuals with a short vegetation period (3 species). An insignificant part of one-biennials' participation in the composition of the cenoflora is characteristic of meadow-steppe cenofloras. A group of long-growing one-biennials mostly consists of weed plants, which reflects anthropogenic effects on the cenoflora.

As for the life forms, long-root grasses (38 species) predominate in composition of the cenoflora. They are represented mainly by long-term meadow-steppe plants. Taproot plants (24 species) are represented mainly by steppe species and one-biennial weeds. Short-root perennial herbs are represented by 22 species. The cenoflora also has a significant proportion (9 species) of tuberous grasses, which reflects the zonal conditions of the steppe with a strong summer drought. A rather large proportion (8%, 9 species) is represented by shrubs, which reflects the peculiarities of the habitat of *Adonis Wolgensis*.

Concerning factor of moistening, the cenoflora is formed by mezoxerophytes (63 species) and mesophytes (38 species). The predominance of mezoxerophytes and mesophytes is easily explained by the habitat of cenopopulations in shrubby thickets and along the edges of small-leaved and pine forests, and by the peculiar microclimate that they make. It is noteworthy, that the participation of xerophytes is comparatively small (14 species), and this fact again indicates the mesocerotrophic character of the *Adonis wolgensis* cenopopulations.

While analyzing the cenoflora composition by ecological cenotic groups, selection of groups and reference of specific species to a certain group were made on the basis of predominant occurrence of one or another species in various locations of *Adonis Wolgensis*. Thus, the species belonging to a particular ecological cenotic group reflects here its predominant occurrence in one or another vegetation type and its local ecological "preferences".

The core of cenoflora is represented by the species of zonal steppe type (80 species), which actually characterizes the *Adonis Wolgensis* cenopopulations. Meadow species have a subordinate position (22 species) and they are not regular in the composition of cenoflora, as well as forest (6 species) and coastal-aquatic (1 species). Weed species are not numerous (8 species), which indicates a moderate anthropogenic impact.

Only 8 species have a prevalence of more than 50% among 8 studied communities. They are steppe species *Stipa capillata* and *Festuca valesiaca*, which again speaks about a steppe nature of the cenoflora. There was noted a high occurrence (62.5%) of *Spiraea hypericifolia*, which emphasizes that the cenoflora belongs to shrubberies. Among other species with high occurrence there are *Onosma simplicissima, Phlomoides tuberosa, Potentilla humifusa, Calamagrostis epigeios, Bromopsis inermis.*

**Conclusion.** *Adonis Wolgensis* Steven is located in Northern Kazakhstan near the north-eastern border of the area. There it occupies a rather wide ecological niche in the thickets of steppe shrubs and on the edges of deciduous and pine forests. In these conditions, Adonis acts as an assectator, and in some cases as a dominant early spring species of steppe communities. Despite the area is considerably wast, the cenoflora of these communities is not great, but quite diverse in species composition. Systematic structure and ecological groups' composition of the cenoflora do not differ significantly from the flora of Northern and Central Kazakhstan. It reflects particularity of the shrub thickets in steppe zone of Northern Kazakhstan, and moreover a relatively high humidity of the substrate and the air, and a greater snow accumula-

tion in winter. Spectrum of life forms and composition of ecological cenotic groups reflect the influence of zonal steppe communities. The peculiarity of modern ecological niche occupied by Adonis is emphasized by a small, but characteristic group of meadow plants found in the communities of shrub thickets in Northern Kazakhstan. Currently, the cenopopulation of *Adonis Wolgensis* retains its ability for self-sustain and regeneration within the occupied ecological niche with a little anthropogenic load.

*The research was carried out within the framework of grant financing project of the Ministry of Education and Science, the Republic of Kazakhstan for 2018-2020. "Molecular genetic analysis of gene pools of rare plant species populations in Northern Kazakhstan" № AP05132458, number of the state registration is 0118RK00404.*

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## СОЛТҮСТІК ҚАЗАҚСТАНДАҒЫ ЕДІЛ ЖАНАРГҮЛІНІҢ (*ADONIS WOLGENSIS* STEV.) ЦЕНОФЛОРАСЫ

**Аннотация.** Мақалада Солтүстік Қазақстандағы Еділ жанаргүлінің (*Adonis wolgensis* Stev.) ценофлорасын зерттеу нәтижелері келтірілген. Материалдар далалық зерттеулер нәтижесінде алынды, әдеби деректер ескерілді. Нақтылы-маршрутты зерттеулер негізінде Солтүстік Қазақстандағы Еділ жанаргүлі флорасының тізімі келтіріледі. Систематикалық құрылым, тіршілік нысандары мен экологиялық топтарының құрамы, сонымен бірге даралардың тіршілік ұзақтығы мен экология-ценотикалық топтар бойынша ценофлораның талдауы *Adonis wolgensis* популяцияларының қазіргі жағдайының ерекшеліктерін және өсімдік жамылғысы құрамындағы орнын анықтады. Ценофлора систематикалық құрылымы мен экологиялық топтарының құрамы бойынша Солтүстік және Орталық Қазақстанның флорасынан айтарлықтай ерекшеленбейді және Солтүстік Қазақстанның далалы аймағындағы бұталы тоғайлардың ерекшелігін көрсетеді. Тіршілік нысандарының спектрі және экология-ценотикалық топтардың құрамы аймақтық далалы бірлестіктердің әсерін көрсетеді. Еділ жанаргүлімен қамтылған экологиялық деңгейдің өзгешілігі Солтүстік Қазақстанда бұталы тоғайлар бірлестіктерінде кездесетін шалғынды өсімдіктер тобымен анықталады. Қазіргі уақытта Еділ жанаргүлінің ценопопуляциясы алатын экологиялық деңгей аясында шағын антропогендік жүктемеде өз қалпына келуіне қабілеттілігін сақтайды.

**Түйін сөздер:** *Adonis wolgensis* Stev., ценопопуляция, Солтүстік Қазақстан, систематикалық құрылым, экология-ценотикалық топтар.

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# ЦЕНОФЛОРА АДОНИСА ВОЛЖСКОГО (*ADONIS WOLGENSIS* STEV.) В СЕВЕРНОМ КАЗАХСТАНЕ

**Аннотация.** В статье приведены результаты изучения ценофлоры адониса волжского (*Adonis wolgensis* Stev.) в Северном Казахстане. Материалы получены в результате полевых исследований, учтены литературные данные. На основании детально-маршрутных исследований приводится список флоры адониса волжского в Северном Казахстане. Анализ ценофлоры по систематической структуре, составу жизненных форм и экологических групп, а также длительности жизни особей и эколого-ценотическим группам выявил особенности современного состояния популяций *Adonis wolgensis* и их положение в составе растительного покрова. По систематической структуре и составу экологических групп ценофлора существенно не отличается от флоры Северного и Центрального Казахстана, она отражает специфику кустарниковых зарослей степной зоны Северного Казахстана. Спектр жизненных форм и состав эколого-ценотических групп отражает влияние зональных степных сообществ. Своеобразие современной экологической ниши, занимаемой адонисом волжским, подчеркивается группой луговых растений, встречающихся в Северном Казахстане в сообществах кустарниковых зарослей. В настоящее время ценопопуляция адониса волжского сохраняет способность к самоподдержанию и восстановлению в пределах занимаемой экологической ниши при наличии небольшой антропогенной нагрузки.

**Ключевые слова:** *Adonis wolgensis* Stev., ценопопуляция, Северный Казахстан, систематическая структура, эколого-ценотические группы.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.4**
Volume 5, Number 329 (2018), 25 – 36

МНРТИ 34.23.35
UDC 575.17

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# MtDNA CONTROL REGIONS ANALYSIS AT ETHNIC KAZAKHS

**Abstract.** The analysis of mitochondrial DNA of modern Kazakhs with a wide geographic localization and tribal affiliation shows that the Kazakh's maternal lines are characterized by great diversity of mtDNA haplogroups, reflecting the historical migration of the population of Eurasia with the predominance of "Asian" and "European" components. The analysis of mutations of hypervariable regions of mtDNA (HVR1, HVR2) regarding affiliation to Zhuz determines the genetic affinity of all Kazakh maternal lines.

**Keywords:** modern Kazakh, mtDNA, HVR1, HVR2, haplogroup.

Due to intensive studies over the past decades, considerable data on the DNA polymorphism in human populations have been accumulated. A variety of polymorphic markers are used to analyze the gene pool of populations and individual ethnic groups, determine their basic characteristics, dynamics, history and geography. There are high polymorphic loci of coding genes, insertion-deletion polymorphism, micro- and minisatellite, single-nucleotide substitution (SNP), and copy number variants (CNV).

The Y-chromosome and mitochondrial DNA (mtDNA) polymorphisms have become widely used genetic markers in population studies related to the genogeography and Human history because they reflect the inheritance and variability of paternal and maternal lines. The mtDNA polymorphism characterizes the absence of recombinations and the maternal type of inheritance. In this regard, the mitochondrial genome can evolve only through the successive accumulation of mutations in generations. In the mitochondrial genome, two main areas are identified: the coding region and the non-coding region (D-loop). The non-coding region is the most variable region of mtDNA and contains about 23% of the variations in the entire mitochondrial genome. About 30% of the variability of mtDNA associates with interpopulation and intergroup differences. In comparison with the nuclear genome, the mtDNA mutation rate determined the advantages of mitochondrial DNA in front of nuclear genetic markers, which make it possible to use it as a tool for population-genetic studies.

To date, there are huge data on population-based mtDNA polymorphism in many modern and ancient human populations. In this respect, the most studied are the peoples of the New World, Africa, Southeast Asia and Oceania, as well as Western Europe. At the same time, polymorphism of the mitochondrial genome of Turkic-speaking peoples, one of the vast and most ancient ethnic groups in Eurasia, has been little studied.

The ethnogenesis of the Kazakh people is based on historical, demographic, population-genetic and anthropological background, conditioned by the influence of the Aryan, Indo-Iranian and Turkic tribes, from Saks, Sarmatians, Massagets to Huns, Turks, Karluks, Oguzes, Kimaks, Kipchaks and other ethnic groups. Later Turkic-Mongolian tribes later formed a Kazakh ethnos, known since the 15th century.

A few genetic studies of archaeological material and modern populations from Kazakhstan [1-5] testify the genetic homogeneity of modern Kazakhs, which makes it possible to differentiate the Kazakh people from other Eurasian population, despite the wide polymorphism and intrapopulation diversity.

The usage of mtDNA markers indicates a high heterogeneity of mtDNA haplogroups among Kazakhs and suggests that 55% of Kazakh mtDNA haplogroups originated from Eastern Eurasia, while 41% are from Western Eurasia [2-5]. Some authors point to the similarity of mtDNA haplotypes of modern Kazakhs with barrow cultures of the 1st millennium BC [5, 6]. A study of 304 Kazakhs with a wide geographic distribution (10 populations of rural residents) revealed that 58-59% of Kazakhs exhibit Asian mtDNA haplotypes (D, C, G, A, M and F) and 41% European (H, T, J, K, U2, I, U5 and HVR) [3, 7]. Based on the variability of the hypervariable region of mtDNA (HVR1) analysis of the genetic relationships of different Asian populations, which was performed on a large sample size (33 groups, about 3,000 samples), showed the genetic relationship of Altai Kazakhs with other ethnic groups from Altai (Kalmyks, Soyots, Hamnigans, Buryats, Tolengites and other Altai peoples) [7-9]. The distinct differences in the nature of genetic variability between the maternal and paternal genetic lines among Altai Kazakhs (119 individuals) was noticed by Dulik M.S. with co-authors [10]. While on the maternal line the mtDNA haplotypes widespread in the East and West Europe were determined, the paternal type of inheritance demonstrated a low genetic diversity. Population-genetic study of the Y-chromosome and mtDNA of 160 representatives of the Kazakh tribe Naiman showed that maternal lines represent high migration activity and the diversity of mtDNA [11].

So, the most studies were conducted on a representatives of separate tribe or specialized geographically location. To replenish the information about maternal lines of modern Kazakhs we conducted a research of a selected cohort with high tribal affiliation and geographic distribution.

**Materials and methods.** *Study objects*. The study objects were data of questionnaires, EDTA-treated peripheral blood samples which were taken from 96 modern Kazakhs with different tribal affiliation and geographic localization. Before collection of blood samples we asked people the voluntary consent to participate in genetic research. A detailed questioning was done after obtaining the signed voluntary informed consents. The knowledge of the maternal line history was the main selection criterium for the study. Questionnaires included the information on the paternal and maternal tribal affiliation of the persons (shezhire).

*Extraction of DNA*. Genomic DNA was extracted from EDTA-treated peripheral blood samples using "Genomic DNA Purification Kit" (Thermo Scientific). Qualitative and quantitative characteristics of the DNA samples were estimated using Eppendorf BioPhotometer plus (Eppendorf, Germany) or NanoDrop 2000 (Thermo Scientific, USA). DNA samples were stored at -20°C.

*Mitochondrial DNA analysis*. Sequencing of the hypervariable regions of mtDNA (HVR1, HVR2), as well as complete mtDNA sequencing, were performed using a next generation sequencing (NGS) analyzer MiSeq (Illumina, San Diego, USA).

PCR amplification, for the creation of four amplicons (nucleotide positions: 29-285, 172-408, 15997-16236 and 16159-16401) representing the 2 hypervariable regions of the ring mitochondrial DNA (HVR1, HVR2), was performed in four separate reactions on a single sample using a kit "Human mtDNA D-Loop Hypervariable Region" (Illumina, San Diego, USA). The quantity and quality of PCR amplicons were determined by electrophoresis and the Quantus ™ Fluorometer. The DNA amplicons were normalized to 0.2 ng/μl and combined in a ratio of 1: 1: 1: 1 in a total volume of 20 μl (5 μl each). The DNA libraries for sequencing were obtained from normalized PCR products (1 ng total input) using the "Next Era XT DNA Sample Preparation" kit (Illumina, San Diego, USA) in accordance with the manufacturer's guidelines. The mtDNA samples were combined with 25% PhiX control and were sequenced at a concentration of 10 pM according to the manufacturer's instructions in 2 x 151 cycles.

*Bioinformatic and statistical analysis*. The MiSeq data was analyzed using the mtDNA MiSeq Reporter (MSR) plug-in, and interpreted using the BaseSpace® mtDNA Variant Processor v1.0 App (Illumina, San Diego, USA) software. This program allows to align and order the sequenced sequences which are matched to the reference sequence of the full mtDNA genome - Cambridge Reference Sequence (rCRS) [12]. The program allows to analyze any part of the complete genome of the ring mtDNA using a quality and overlapping coverage (Quality for variant call Q30) with the identification of start points. To use this program, the primary sequencing data obtained in the FASTQ format (mtDNA MiSeq Reporter)

were converted into BAM and VCF formats. For identification of mtDNA haplotypes we used the Haplogrep programs (version 2.0, https://haplogrep.uibk.ac.at/), Haplofind (https://haplofind.unibo.it) and mtDNA manager [13]. Mutation frequencies, molecular difference analysis and pairwise genetic distances were calculated using the GeneAlEx 6.2 program. Phylogenetic relationships were defined using the MEGA7 program.

**Results and their discussion.** The selection a cohort for the study was determined by the availability of personal data on the maternal lines of inheritance. At the same time, we were oriented to the fact that at least 2 generations (mother and grandmother) would belong to the same clan by maternal inheritance. Also we have count the wide geography distributions and tribal affiliation. Thus, 96 persons were selected, who belonging to different families and having different geographical localization. Among them were 55 men and 41 women.

The table S1 (Application 1) presents our data on shezhire, mtDNA control region mutations (HVR1 & HVR2) and sex of investigated individuals. The diversity of mtDNA haplotypes in cohort of modern Kazakhs with different tribal affiliations and geographical localization is shown on figure 1.

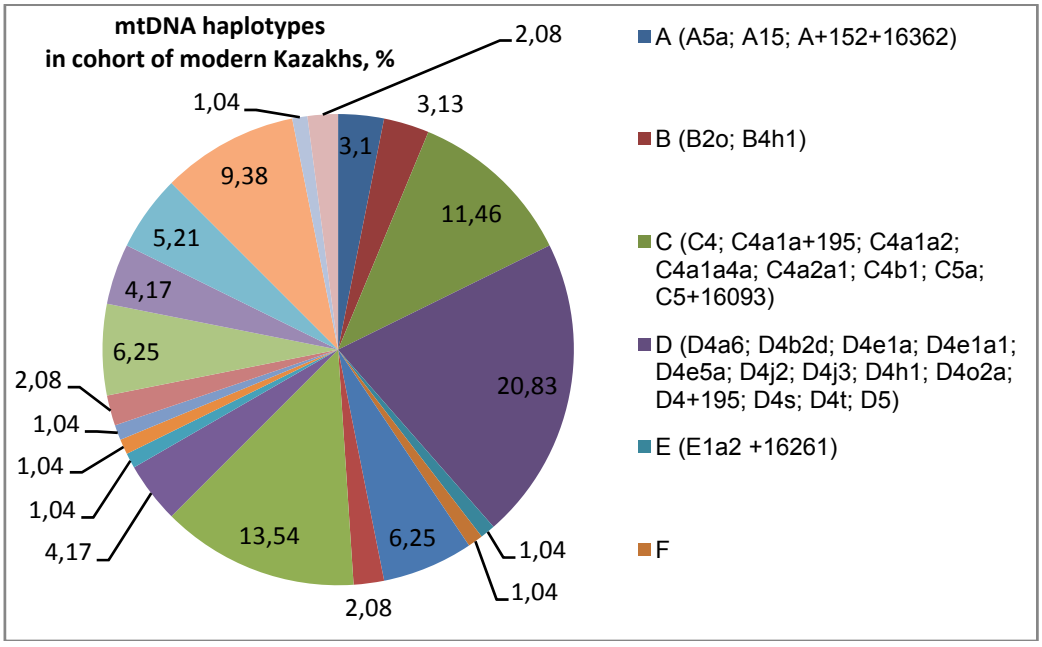


Figure 1 – mtDNA haplotypes in cohort of modern Kazakhs

In total, 81 haplotypes of mtDNA were identified in the studied cohort:

1) A5a; A15; A+152+16362; B2o; C4; C4a1a2; C4a1a4a; C4b1; C5a; C5+16093; D4a6; D4b2d; D4e1a; D4j2; D4h1; D4o2a; D4s; E1a2 +16261; F; G2a2; G2a5; I1; I1a; H1e1a4; H1+16189; H1ao; H1b; H1e2c; H1e-16129; H2a+152+16311; H2a2a; H2a2a2; H7a1; H13a1d; HV4b; J1c16; J1d; J2b1c1; JT; K1c; L3h1a2a; Z+152 (M8); M6; M10a1a1b; N1a3a; N9a2'4'5'11; R2; R7; R8; R31; T; T1a1; T1a1'3; T2; T2b11; U1a3; U1b2; U2e1h; U2e1b; U2e1'2'3'; U3a3; U4; U4b1b1c; U5a2+1629; X2; W3; W4 – for 1 person from studied individuals (1,04%)

2) B4h1, C4a2a1; D4e1a1; D4e5a; D4j3; D4+195; D5; G2a; G2a+152; – for 2 persons (2,08%);

3) C4a1a+195; D4t; – for 3 persons (3,13%);

4) N9a – for 4 persons (4,17%).

As can be seen from presented data, the highest frequency is typical for the D mtDNA haplogroup, which together with the subclades (D4a6, D4b2d, D4e1a, D4e1a1, D4e5a, D4j2, D4j3, D4h1, D4o2a, D4+195, D4s, D4t, D5) represents 20 individuals (20,83%). Subclades of haplogroup H (H1e1a4, H1+16189, H1ao, H1b, H1e2c, H1e-16129, H2a+152+16311, H2a2a, H2a2a2, H7a1, H13a1d, HV4b) were identified in 13 individuals (13,54%). Another most distribted hapogroup of mtDNA is C (11 persons – 11,46%), which represented in studied cohort by subclades of C4, C4a1a+195, C4a1a2, C4a1a4a, C4a2a1, C4b1, C5a, and C5+16093.

**Application 1**

Table S1 – Haplotypes of mtDNA of studied cohort regarding the tribal affiliation of modern Kazakh individuals

| Maternal line | | | | Haplotype | mtDNA mutations | | Gender | No. of ind. |
|---|---|---|---|---|---|---|---|---|
| **Tribe** | **Subtribe** | **Clan** | Subclan | | HVR1 | HVR1 | | |
| ***Uly zhuz*** | | | | | | | | |
| **Zhalaiyr** | Andas | Borte | | D4e1a1 | 16093C, 16176T, 16223T, 16362C | 73G, 94A, 194T, 263G, 315.1C | male | 1 |
| **Dulat** | ? | | | H1e-16129 | 16129A | 263G, 309.1C, 315.1C | male | 1 |
| Saty | ? | | | U2e1'2'3 | 16051G, 16129C, 16182d, 16183C, 16189C, 16362C | 73G, 152C, 217C, 263G, 315.1C | female | 1 |
| **Alban** | Alaman | | | D4+195 | 16218T, 16223T | 73G, 195C, 263G, 315.1C | female | 2 |
| **Kanly** | ? | | | J1c16 | 16069T, 16126C, 16218T | 73G, 152C, 185A, 228A, 263G, 309.1C, 315.1C | male | 1 |
| **Oshakty** | | | | | | | | |
| Atalyk | Alimbet | Biguly | Karasirak | N9a | 16223T, 16257A, 16261T | 73G, 150T, 263G, 315.1C | female | 1 |
| Konyr | ? | | | C5a | 16223T, 16261T, 16288C, 16298C | 73G, 249d, 263G, 315.1C | male | 1 |
| Taszhurek | ? | | | J1c2 | 16126C | 73G, 185A, 188G, 228A, 263G, 295T, 309.2C, 315.1C | male | 1 |
| **Uisun (Sary uisun)** | ? | | | D4j3 | 16184T, 16223T, 16311C, 16362C | 73G, 146C, 227T, 263G, 309.2C, 310C, 315.1C | male | 1 |
| Zhakyp | ? | | | I1a | 16129A, 16172C, 16223T | 73G, 195C, 199C, 203A, 204C, 250C, 263G, 309.1C, 315.1C | female | 1 |
| Pusyrman | ? | | | T2 | 16078G, 16126C, 16177G, 16294T, 16296T | 73G, 263G, 315.1C | female | 1 |
| **Suan** | Aksham | | | C4 | 16223T, 16298C, 16327T | 73G, 152C, 195C, 248d, 263G, 315.1C | male | 1 |
| **Shaprashty** | | | | | | | | |
| Ikei | Kosai | | | C4a1a2 | 16093C, 16129A, 16223T, 16298C, 16327T | 73G, 195C, 248d, 263G, 315.1C | female | 1 |
| Eskozha | Baba | | | C4b1 | 16223T, 16298C, 16327T | 73G, 146C, 234G, 248d, 249A, 263G, 309.1C, 309.2C, 315.1C | male | 1 |
| Koshek | Alshan | | | H7a1 | 16126C, 16261T | 263G, 309.1C, 315.1C | female | 1 |
| **Ysty** | Tilik | | | U1b2 | 16111T, 16214A, 16231C, 16249C, 16327T | 73G, 146C, 152C, 263G, 285T, 309.1C, 315.1C | male | 1 |
| **Shanyshkyly** | | | | | | | | |
| Arynshi | ? | | | T1a1 | 16126C, 16163G, 16186T, 16189C, 16294T | 73G, 152C, 195C, 263G, 309.1C, 315.1C | male | 1 |
| Katagan | ? | | | G2a5 | 16093C, 16223T, 16227G, 16234T, 16278T, 16309G, 16362C | 73G, 152C, 263G, 315.1C | male | 1 |
| Mamyt | ? | | | K1c | 16224C, 16311C | 73G, 146C, 152C, 263G, 315.1C | male | 1 |
| ***Orta zhuz*** | | | | | | | | |
| **Argyn** | ? | | | U3a3 | 16148T, 16189C, 16343G, 16355T, 16390A | 73G, 185A, 263G, 315.1C | male | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Saidaly | | | N1a3a | 16201T, 16223T, 16265G | 73G, 189G, 195C, 204C, 207A, 210G, 263G, 315.1C | female | 1 |
| | Tolengit | | | M6 | 16223T, 16362C | 73G, 195T, 263G 315.1C | male | 1 |
| Meiram | Suindik | Karzhas | | H33c | 16188T, | 263G, 315.1C | female | 1 |
| | | | | D4b2d | 16223T, 16274A, 16278T 16287T, 16362C | 73G, 151T, 152C, 237G, 263G, 315.1C | male | 1 |
| | | | | U2e1h | 16051G, 16129C, 16183C, 16193.1C | 73G, 195C, 217C, 228A, 263G, 309.1C, 309.2C, 315.1C, 340T | male | 1 |
| | | | Khangeldi-Kushik | H13a1d | 16234T | 152C, 263G, 309.1C, 315.1C | male | 1 |
| | | Kulboldy | Aidabol-Tulpar | G2a+152 | 16169T, 16223T, 16227G 16265C, 16278T | 73G, 146C, 152C, 263G, 315.1C | female | 1 |
| | | | Aidabol | R31 | 16362C | 73G, 263G, 309.1C, 315.1C | male | 1 |
| | | | | C4a1a+195 | 16129A, 16223T, 16298C, 16327T | 73G, 195C, 248A, 263G, 309.1C, 315.1C | male | 1 |
| | | | | G2a+152 | 16169T, 16223T, 16227G, 16265C, 16278T | 73G, 146C, 152C, 263G, 315.1C | male | 1 |
| | | | Kulik | JT | 16126C | 73G, 146C, 315.1C | male | 1 |
| | | ? | | C5+16093 | 16093C, 16223T, 16288C, 16298C, 16327T | 73G, 248A, 263G, 315.1C | male | 1 |
| | | Orman-shy | | J1d | 16069T, 16126C, 16153A, 16193T | 44.1C, 73G, 146C, 152C 263G, 295T, 309.1C, 315.1C | female | 1 |
| | Karakesek | Kernei | Daua | D4t | 16129A, 16213A, 16223T 16298C | 73G, 195C, 198T, 247d, 309.1C, 315.1C | male | 1 |
| | | Baibori | | N9a | 16189C ,16193.1C, 16223T, 16257A, 16261T | 73G, 150T, 263G, 309.1C, 315.1C | female | 1 |
| | | ? | | A15 | 16093C, 16223T, 16290T, 16319A, 16362C | 73G, 152C, 207A, 235G, 309.2C, 315.1C | male | 1 |
| | | Aksha | Boshan-Moshai-Koyanshi | D4e5a | 16223T, 16274A, 16362C | 73G, 152C, 263G, 309.1C, 315.1C | female | 1 |
| | | Kara | | H2a2a2 | 16184G, 16264T, 16295T, 16390A | 60.1T, 64T, 152C, 309.1C, 309.2C, 315.1C | female | 1 |
| | | Bolat-kozha | Tuiten-Tanas-Botei-Batshor-Shekshek | M10a1a1b | 16129A, 16193.1T, 16223T, 16311C, 16357C | 73G, 146C | male | 1 |
| | | | Tuiten-Tanas-Botei-Batshor-Shashty | C4a2a1 | 16167T, 16171G, 16213A, 16223T, 16298C, 16327T, 16344T, 16357C | 47A, 73G, 152C, 248A, 263G, 309.1C, 315.1C | male | 1 |
| | | ? | | T1a1'3 | 16126C, 16163G, 16186T, 16189C, 16192T, 16294T | 73G, 152C, 195C, 263G, 315.1C | male | 1 |
| | | ? | | N9a | 16189C, 16223T, 16257A, 16261T | 73G, 150T, 263G, 309.1C, 315.1C | male | 1 |
| | Begendik | Kozgan | | L3h1a2a | 16093C, 16193.1T, 16223T, 16311C, 16357C, 16399G | 73G, 146C, 199C, 263G, 309.1C, 315.1C | male | 1 |
| | Kuandyk | Karpyk | Toka-Kulumbet | B4h1 | 16129A, 16182C, 16183C, 16189C, | 73G,263G, 315.1C | female | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 16261T | | | |
| | | Temesh | | W4 | 16129A, 16223T, 16284G, 16287T, 16304C, 16362C | 73G, 143A, 189G, 194T, 195C, 196C, 204C, 207A, 263G, 309.1C, 315.1C | male | 1 |
| | Basentiyin | Syrym | | X2 | 16182C, 16183C, 16189C, 16223T, 16278T | 73G, 146C, 153G, 195C, 263G, 309.1C, 315.1C | female | 1 |
| | | Karpyk | | HV4b | 16069T | 263G, 315.1C | male | 1 |
| Momyn | Tobykty | ? | | D4e1a | 16092C, 16111T, 16213A, 16223T, 16362C | 73G, 94A, 146C, 263G, 309.1C, 315.1C | male | 1 |
| | | Koybas | Zhaush | R8 | 16357C | 73G, 195C, 263G, 309.1C, 315.1C | female | 1 |
| | | | | G2a2a | 16223T, 16227G, 16278T | 195C, 207A, 263G | female | 1 |
| | | Zhuan-tayak | | R7 | 16189C, 16193.1C, 162223T, 16261T, 16319A, 16362C | 73G, 183G, 263G, 309.1C, 315.1C | female | 1 |
| | | | | D4t | 16223T, 16362C | 73G, 309.1C, 315.1C | female | 1 |
| | Atygai | | | D4a6 | 16093C, 16129A, 16223T, 16362C | 73G, 152C, 204C, 217C, 263G, 315.1C | male | 1 |
| | Kanzhigaly | | | U4b1b1c | 16235G, 16311C, 16356C | 73G, 146C, 152C, 195C, 263G, 309.1C, 315.1C | male | 1 |
| | | | | U5a2+16294 | 16192T, 16270T, 16294T | 73G, 263G, 315.1C | male | 1 |
| **Kerei** | ? | | | N9a | 16223T, 16257A, 16261T | 73G, 150T, 263G, 315.1C | female | 1 |
| Ashamaily | ? | | | D4j3 | 16184T, 16223T, 16265C, 16311C, 16362C | 73G, 152C, 263G, 309.1C, 315.1C | female | 1 |
| | Iteli | Asha-maily | | D4o2a | 16093C 16223T 16232T 16290T | 73G 195C 210G 263G 309.1C 315.1C | female | 1 |
| ? | Kosai-batyr | | | D4s | 16173T, 16223T, 16362C | 73G, 146C, 199C, 263G, 315.1C | male | 1 |
| ? | Zhantekei | Bodes | | W3 | 16093C, 16223T, 16270T, 16292T, 16311C | 73G, 189G, 194T, 195C, 196C, 204C, 207A, 263G, 309.1C, 310C, 315C | male | 1 |
| **Konyrat** | ? | | | D4e5a | 16223T, 16274A, 16362C | 73G, 152C, 263G, 309.1C, 315.1C | male | 1 |
| | Kylshash | | | U2e1b | 16051G, 16129C, 16182d, 16183C, 16189C, 16256T, 16362C | 73G, 152C, 200G, 217C, 263G, 315.1C, 340T | male | 1 |
| Koktinuly | Kulshy-gash | | | C4a1a+195 | 16129A 16223T 16298C | 73G 195C 249d 263G 315.1C | female | 1 |
| **Kypshak** | ? | | | G2a | 16223T, 16227G, 16278T, 16362C | 73G, 263G, 315.1C | female | 1 |
| Zhambai | ? | | | H1+16189 | 16189C, 16193.2C | 263G, 309.2C, 315.1C | female | 1 |
| **Naiman** | ? | | | D4h1 | 16174T, 16223T, 16362C | 73G, 263G, 309.1C | male | 1 |
| | Medet | | | D5 | 16189C 16223T | 73G 150T 152C 263G 309.1C 315.C | female | 1 |
| | Tumatai | | | T | 16126C 16294T | 73G 152C 263G 309.1C 315.1C | female | 1 |
| | ? | | | C4a1+195 | 16093C 16129A 16223T 16298C | 73G 195C 247d 263G 315.1C | female | 1 |
| Okiresh | Belgibai | Suinshi | Tolegetai baba-Kytai bi-Karakerei | A5a | 16187T, 16223T, 16290T, 16319A | 73G, 150T, 235G, 263G, 309.1C, 315.1C | female | 1 |
| Tolegetai | Matai | Togyz | | Z+152 | 16185T, 16189.Del(T), 16223T, 16260T, | 73G, 152C, 246T, 247.Del(-G), 263G, | female | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 16288C, 16298C | 309.1C, 315.1C | | |
| **Uak** | ? | | | D5 | 16189C 16223T | 73G 150T 152C 263G 309.1C 315.C | female | 1 |
| | ? | | | G2a | 16223T, 16227G, 16278T, 16362C | 73G, 152C, 263G, 315.1C | male | 1 |
| | ? | | | D4j2 | 16223T, 16291T, 16362C | 73G, 263G, 315.1C | female | 1 |
| ***Kishi zhuz*** | | | | | | | | |
| **Baiuly** | | | | | | | | |
| Adai | Tazike | Kabakai | Alke | D4t | 16129A 16213A 16223T 16298C | 73G 195C 198T 247d 309.1C 315.1C | female | 1 |
| | ? | | | I1 | 16129A, 16223T, 16311C, 16391A | 73G, 199C, 204C, 250C, 263G, 309.1C, 315.1C | male | 1 |
| Salik | ? | | | C4a2a1 | 16167T, 16171G, 16223T, 16298C, 16327T, 16344T, 16357C | 47A, 73G, 249d, 263G, 309.1C, 315.1C | male | 1 |
| **Alimuly** | | | | | | | | |
| Kete (Ak-kete) | ? | | | H1b | 16189C, 16193.1C, 16356C, 16363C | 249G, 263G, 315.1C | male | 1 |
| Shomekei | Kozha-keldi | | | H1ao | 16278T | 93G, 143A, 263G, 308.1CT, 315.1C | female | 1 |
| Tortkara | ? | | | A+152+16362 | 16086C, 16223T, 16256T, 16290T, 16319A, 16362C | 73G, 152C, 235G, 263G, 309.1C, 315.1C | male | 1 |
| **Zhetiru** | | | | | | | | |
| Zhagalbaily | ? | | | H2a+152+16311 | 16311C, 16324C | 152C, 207A, 263G, 309.1C, 315.1C | male | 1 |
| Tama | ? | | | H1e2c | - | 73G, 263G, 309.1C, 315.1C | male | 1 |
| | ? | | | J2b1c1 | 16069T, 16126C, 16148T, 16193T, 16261T, 16301T, 16311C, 16319A, 16355T, 16356C, 16362C, 16368C, 16390A, 16399G | 73G, 150T, 152C, 263G, 315.1C | male | 1 |
| Tabyn | ? | | | D4t | 16223T, 16362C | 73G, 194T, 279G, 315.1C | male | 1 |
| | ? | | | E1a2+(16261) | 16147A, 16172C, 16189C, 16223T, 16261T, 16301T, 16311C, 16319A, 16355T, 16356C, 16362C, 16368C, 16390A, 16399G | 63C , 73G, 152C, 199C, 204C, 263G, 315.1C | male | 1 |
| ***Non belong to any zhuz*** | | | | | | | | |
| **Tore** | ? | | | | | | | |
| | ? | | | D4e1a1 | 16223T, 16362C | 73G, 94A, 263G, 315.1C | male | 1 |
| Zhadik auleity | ? | | | U1a3 | 16182d, 16183C, 16189C, 16249C | 73G, 146C, 263G, 285T, 309.1C, 315.1C | male | 1 |
| **Kozha** | ? | | | R2 | 16037G, 16071T, 16172C | 73G, 152C, 263G, 309.1C, 315.1C | female | 1 |
| | Aksuiek | | | B2o | 16092C 16182C 16183C 16189C 16217C | 73G 263G 315.1C | female | 1 |
| Kereyit kozha | ? | | | C4a1a4a | 16129A, 16150T, 16223T, 16298C, 16301T, 16311C, 16327T, 16355T, 16356C, 16368C, | 73G, 195C, 248d, 263G, 315.1C | female | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 16390A, 16399G | | | |
| Seyit | ? | | | H1e1a4 | 16311C | 263G, 309.1C, 309.2C, 315.1C | female | 1 |
| **Sunak** | ? | | | H2a2a | - | 263G, 315.1C | male | 1 |
| **Nogai-kazakh** | ? | | | N9a2'4'5'11 | 16166G, 16172C, 16223T, 16257A, 16261T, 16304C | 73G, 150T, 263G, 309.1C, 315.1C | male | 1 |
| | ? | | | U4 | 16356C | 73G, 195C, 263G, 309.1C, 315.1C | male | 1 |

Corresponding to the Cambridge Reference Sequence (CRS) [12, 13], with which all other Human mtDNAs were compared, the D haplogroup was originated from haplogroup HVR D haplogroup has an East Asian origin [14]. It is believed, that mtDNA D haplogroup appeared in Asia 48000 B.C. [15]. The subclade D4 are the principle branch of D. D4 is the most common mtDNA haplogroup among modern populations of northern East Asia, such as Japanese, Okinawans, Koreans, and Mongolic- or Tungusic-speaking populations of northern China [7, 16]. D4 is also the most frequently occurring haplogroup among the Buryats, Khamnigans, Kalmyks, and the Telenghits and Kazakhs of the Altai region [7, 17]. D4 mtDNA branch spread also all over China, Southeast Asia, Siberia, Central Asia, and indigenous peoples of the Americas [18, 19].

H haplogroup is believed to have arisen in eastern Europe or western Asia [20]. There is an opinion, that origin of H clade is associated with Southwest Asia [21], around 20000 to 25000 years ago. Nowaday, the mtDNA haplogroup H is predominantly found in Europe, and is believed to have evolved before the Last Glacial Maximum (LGM). Firstly it expanded in the northern Near East and Southern Caucasus between 33000 and 26000 years ago. Later migrations from Iberia allows to suggest, that the clade reached Europe before the LGM. mtDNA H haplogroup has also spread to parts of Africa, Siberia and inner Asia. Today, around 40% of all maternal lineages in Europe belong to haplogroup H.

It is believed, that mtDNA C haplogroup to have originated somewhere between the Caspian Sea and Lake Baikal some 24000 years B.C. Haplogroup C is spread in Northeast Asia [7], including Siberia. Rissian scientists showed, that, in Eurasia, mtDNA C haplogroup was most frequent among populations of arctic Siberia, such as Yukaghirs and Nganasans [19]. At indigenous peoples of the Americas, the haplogroup C (with subclades C1b, C1c, C1d, and C4c) is one of five mtDNA haplogroups, the others are A, B, D, and X haplogroups [22]. The subclade C1a is found only in population of Asia.

For most mtDNA haplotypes, regional and racial specificity have been established. For an example, in the gene pools of the peoples of Europe and Western Asia, there are mainly 10 major mtDNA haplotypes (HVR *, H, V, J, T, U, K, I, W, X). In the gene pools of Mongoloid populations of Eastern, Central and Nothern Asia another 10 mtDNA haplogroups found (A, B, C, D, E, F, G, Y, Z, M *), and in Negroids - mtDNA of macro group L [2, 4, 7, 23].

Known data about modern Kazakh mtDNA types are contradictory, which may be due to the insufficient amount of collected genetic material for reliable generalization. According to the studies of two different research groups [2, 4], 31.7-45% of mitochondrial haplotypes of the Kazakh ethnos have an "West Eurasian" origin, 50-63.4% have an "Eastern Eurasian" origin, and 0-4.9% are characteristic of the population of India. We should note that in the work of D. Comas and others [2] mtDNA haplotypes of 232 individuals from 12 populations were investigated, among others only 20 were Kazakhs, which is an unrepresentative sample for any conclusions.

More representative population of modern Kazakh (246 individuals with different geographical localization) has been studied by Berezina G.M. with co-authors [3]. According to the results, 58% of Kazakh mtDNAs were haplogroup D (17.9%), C (16%), G (16%), A (3.25%), F (2.44%), presumably Eastern Eurasian. And 41.46% were haplogroups H (13%), T (4.07%), J (4.07%), K (4.07%), U5 (3.25%), I (0.41% ), V (0.81%), W (1.63%), presumably of Western Eurasian origin.

In general, in the studied cohort of modern Kazakh, the presence of typically "Asian" mtDNA haplotypes (A5a, A15, A+152+16362, B2o, B4h1, C4, C4a1a+195, C4a1a2, C4a1a4a, C4a2a1, C4b1, C5a, C5+16093, D4a6, D4b2d, D4e1a, D4e1a1, D4e5a, D4j2, D4j3, D4s, D4t, D4+195, D4o2a, D5, E1a2 +16261, F, G2a, G2a+152, G2a2, G2a5, Z+152(M8), M6, M10a1a1b) is estimated as 50%, "European" (H1+16189, H1ao, H1b, H1e1a4, H1e2c, H1e-16129, H2a+152+16311, H2a2a, H2a2a2, H7a1, H13a1d,

HV4b, I1, I1a, J1c16, J1d, J2b1c1, JT, K1c, T1a1, T1a1'3, T2, T, T2b11, U1a3, U1b2, U2e1h, U2e1b, U2e1'2'3', U3a3, U4, U4b1b1c, U5a2+1629, X2, W3, W4) - 38.54%; and ancient groups traced from "Middle East", but originated in Central and South-East Asia (N1a, N1a3a, N1b, N9a N9a1'3, N9a2'4'5'11, R2, R7, R8) - 7.29%; there is even 1 person with an ancient "African" group - L3h1a2a (1.04%).

The presence of such a variety of maternal lines for a small cohort of representatives of the same tribe testifies the Kazakh history full of migrations. That's why we should to mention the malestones in Kazakh ethnic history.

Ethnic history of the Kazakh people is rooted in the ancient period of settling the territory of modern Kazakhstan. The first archaeological finds in the territory of Kazakhstan belong to the Paleolithic period. According to archaeological and paleoanthropological data, the ancient tribes spread on the territory of Kazakhstan since the Bronze Age. During the Bronze Age the ancient population of Kazakhstan was concentrated at the center of a large ethno-cultural region of Eurasia and was one of the representatives of extensive anthropological formation of steppe type proto-European trunk [1]. Nomadic animal husbandry becomes the predominant type of activity to the I millennium BC. The irrigated agriculture, the production of iron and metal manufacture have been developed. Stratification occurred among the nomads, the tribal leaders were indicated, new association of tribes and tribal units appeared, among which the most widely known was Saka Union of tribes. During this period, Savromats tribes settled in western Kazakhstan. At the end of I millennium BC in Kazakhstan there are new tribes: Usuns (from Balkhash to Issyk-Kul lakes), Kangyuy (foothills of Karatau mountains and Syrdarya river basin), Alans (between Aral and Caspian seas).

The statehood on the territory of Kazakhstan established in the I millennium AD. There were areas of sedentary culture: Turk Kaganat (VI cent.), Turgesh and Karluk kaganats (VIII cent.). At the same period the great migration of tribes began from the Altai, southern Siberia and Central Asia to the territory of present-day Kazakhstan and further to the west. The Hun period of "Great Migration" is dated by IV-VII centuries. However, the large-scale movement of the Hun tribes, which led to significant changes in the ethnic and political map of Eurasia, began in I-II centuries. The Huns ancestors - Turkic people "hunnu" lived in the territory of modern Mongolia, Buryatia, and North China.

In X-XI centuries a significant territory of Semirechye was a part of Karakhanid State. Nomadic tribes from south-west and western Kazakhstan entered into an Union of Oguz tribes. In the north-eastern Kazakhstan territory tribal Union of Kimaks was formed. The vast territory of Central Kazakhstan became known as the Kipchaks country or Dasht-i-Kipchak. Start of the XIII century marked by the Mongol invasion and the establishment of the Mongol districts (ulus – Mongolian) in the territory of Kazakhstan. The first Kazakh Khanate (XV-XVI centuries, Semirechye) was a tribal union and included the tribes Uisuns, Kangly, Dulats, Zhalair, Naimans, Argyns and others. These tribes formed a single ethnic array.

Interesting data on paleo-mtDNAs have been presented by C. Lalueza-Fox with co-authors [4]. They studied human teeth 36 of 15 graves located in Kazakhstan, radiocarbon dates vary from XIV-XI centuries BC to the III-V centuries BC. The 21 teeth revealed Caucasoid (Western Eurasian) mtDNA haplotypes, and 6 teeth – the Eastern Eurasian. The authors noticed the dynamics of changes in the haplogroups of the ancient population of Kazakhstan in the direction to the East Eurasia.

Territorially all Kazakh tribes were divided into three major groups ("Zhuzes"): Elder Zhuz (Uly zhuz, 12 tribes), Middle Zhuz (Orta zhuz, 6 tribes), and Junior Zhuz (Kishi zhuz, 3 tribes). Elder Zhuz tribes were mostly occupied South and South-East Kazakhstan, the Middle Zhuz tribes lived in Eastern, Northern and Central Kazakhstan, and the Junior Zhuz tribes traditionally lived in Western Kazakhstan. Also, there are 5 (or 7) tribes which not included to any zhuz.

Obtained data revealed that the modern descendants of ancient Kazakh tribes demonstrate a high degree of heterogeneity in relation to the maternal lines. Because the our studied cohort represents the vast variety of mtDNA haplogroups reflecting the history of ancient nomadic tribes migration we have tried to look after genetic distances between representatives of different tribes combining the data fo tribes unions – Zhuzes.

For this analyses we took into account the mutations in total number of 135 loci in HVR1 and HVR2 regions of mtDNA. Genetic heterogeneity of each locus and cohort (Table 1), the genetic distances and identity (Nei) were calculated in the program GenAlEx 6.2 (table 2).

Table 1 – The heterogeneity characteristics of studied cohorts on HVR1 and HVR2 mtDNA loci

| Indexes* | N | Na | Ne | I | h | uh | Polymorphic Loci, % |
|---|---|---|---|---|---|---|---|
| *Cohort* | Grand Mean and SE over Loci for each Cohorts | | | | | | |
| Uly zhuz | 19,000±0 | 0,889±0,085 | 1,104±0,016 | 0,132±0,015 | 0,075±0,010 | 0,080±0,010 | 43,70% |
| Orta zhuz | 55,000±0 | 1,541±0,073 | 1,097±0,014 | 0,144±0,012 | 0,075±0,008 | 0,076±0,008 | 77,04% |
| Kishi zhuz | 11,000±0 | 0,837±0,085 | 1,142±0,019 | 0,164±0,018 | 0,099±0,012 | 0,109±0,013 | 41,48% |
| Non zhuz | 9,000±0 | 0,533±0,076 | 1,090±0,015 | 0,106±0,016 | 0,064±0,010 | 0,072±0,011 | 25,93% |
| | Grand Mean and SE over Loci | | | | | | |
| *Total Cohort* | 23,500±0,80 | 0,950±0,043 | 1,108±0,008 | 0,136±0,008 | 0,078±0,005 | 0,084±0,005 | 47,04±10,75 |

*Na - number of different alleles; Ne - number of effective alleles; I - Shannon's information index; h – diversity; uh - unbiased Diversity.

Table 2 – Nei Genetic distance and identity between representatives of modern Kazakh based on mutations of variable regions (HVR1 and HVR2) of mtDNA

| Pairwise Population Matrix of Nei Genetic Distance // Identity | | | | |
|---|---|---|---|---|
| Scoring | | | | |
| 0,000 // 1,000 | | | | *Uly zhuz* |
| 0,003 // 0,997 | 0,000 // 1,000 | | | *Orta zhuz* |
| 0,009 // 0,991 | 0,006 // 0,994 | 0,000 // 1,000 | | *Kishi zhuz* |
| 0,006 // 0,994 | 0,006 // 0,994 | 0,008 // 0,992 | 0,000 // 1,000 | *Non zhuz* |
| *Uly zhuz* | *Orta zhuz* | *Kishi zhuz* | *Non huz* | |

Evolutionary connections were defined by the Neighbor-Joining method [24]. The phylogenetic tree was inferred using the UPGMA method and constructed in the MEGA7 program [25]. The figure 3 presents obtained phylogenetic tree. The optimal tree with the sum of branch length = 0.01216667 is shown.

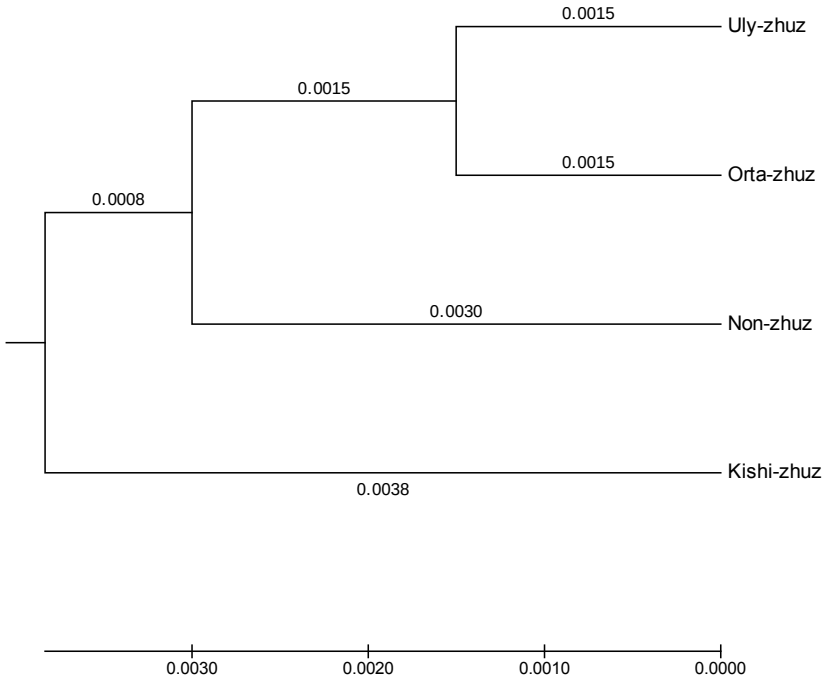


Figure 3 – Evolution relationships of modern Kazakh

The presented data show that the maternal lines of representatives of different zhuzes are characterized by genetic proximity despite of great genetic diversity. The Kishi zhuz maternal lines are more distant from representatives of other tribe unions (GD=0,0038). We suggest that this is due to the lower migration activity of the population of Western Kazakhstan in comparison with other regions of the Republic.

Thus, the analysis of mitochondrial DNA of modern Kazakhs with a wide geographic localization and tribal affiliation shows that the Kazakh's maternal lines are characterized by great diversity of mtDNA haplogroups, reflecting the historical migration of the population of Eurasia with the predominance of "Asian" and "European" components. The analysis of mutations of hypervariable regions of mtDNA regarding Zhuz-affiliation determines the genetic affinity of all Kazakh maternal lines.

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Алматы, Қазақстан

**ЭТНИКАЛЫҚ ҚАЗАҚТАРДЫҢ мтДНК БАҚЫЛАУ АЙМАҚТАРДЫҢ ТАЛДАУЫ**

**Аннотация.** Географиялық орналасуына және руына қарай қазіргі заманғы қазақтардың митохондриялық ДНҚ-на жасалған талдау барлық аналар линияларының "азиялық" және "европалық" топтарына қатысты Евразия халықтарының тарихи қоныс аударуын көрсететін мтДНҚ гаплотоптарының әртүрлілігімен сипатталады. Жүзге қатысты мтДНҚ (HVR1, HVR2) гипервариабелді аудандарының мутациясын талдау қазақтардың барлық аналар линияларының генетикалық туыстығын анықтайды.

**Түйін сөздер:** қазіргі заманғы қазақтар, мтДНҚ, HVR1, HVR2, гаплотоптар.

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**АНАЛИЗ КОНТРОЛЬНЫХ РЕГИОНОВ мтДНК У ЭТНИЧЕСКИХ КАЗАХОВ**

**Аннотация.** Проведенный анализ митохондриальных ДНК современных казахов с широкой географической локализацией и родовой принадлежностью свидетельствует, что материнские линии казахов характеризуются большим разнообразием гаплогрупп мтДНК, отражающим исторические миграции населения Евразии с преобладанием «азиатского» и «европейского» компонентов. Анализ мутаций гипервариабельных районов мтДНК (HVR1, HVR2) в отношении жузовой принадлежности определяет генетическую родственность всех материнских линий казахов.

**Ключевые слова:** современные казахи, мтДНК, HVR1, HVR2, гаплогруппа.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.5**
Volume 5, Number 329 (2018), 37 – 44

UDC 579.674:637.146.2
MRNTI 34.27.39, 65.63, 65.63.91

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# DEVELOPMENT OF FUNCTIONAL BEVERAGES ON THE BASE OF WHEY

**Abstract.** Nowadays, there are new facts on the connection of intestinal microbiome with diseases of not only the digestive tract. Because of violations in immune status and in composition of normal microbiome largely due to a decrease in food quality and safety, the humanity is experiencing an epidemic of opportunistic infections. In these conditions, the development, based on modern achievements of science and technology, fundamentally new original processes and technologies, which allow receiving innovative and functional products based on traditional and non-traditional raw materials that will contribute to the public health is of great importance. A special place in this respect belongs to curd and cheese whey, which is not inferior to the whole milk in terms of its biological value but mainly falls into the waste because of its taste qualities. The scientific data and rationale for the use of whey as a high-grade raw material for the production of beverages, improving the digestive function, immune system and metabol ic processes in the human body, regulating them through the use of lactic acid microorganisms and natural plant supplements containing biologically active substances, preventing the emergence of a number of pathological conditions of the body are given. Specific examples of the production of whey-based beverages with improved organoleptic properties for a wide range of consumers are shown.

**Key words:** whey, functional beverages, lactic acid bacteria, phyto-additives, organoleptic properties.

The need to create functional foods is caused by a significant deterioration in the health status of the population, which is largely due to the decline in food quality and safety [1, 2]. Nowadays, there are new facts on the connection of intestinal microbiome with diseases of not only of gastrointestinal tract, but also with obesity, diabetes, malignant tumors, allergic, autoimmune, cardiovascular diseases and other [3-7]. Currently, everyday products are added with a large number of various physiologically unjustified food additives that lead to "diseases of civilization" and to a violation in the composition of the normal microflora of the gastrointestinal tract. In addition, contamination of raw materials and foodstuffs by extraneous microorganisms and their metabolic products, which have a toxic effect on the human body, takes place at all stages of production. In these conditions, the development, based on modern achievements of science and technology, fundamentally new original processes and technologies, which allow receiving innovative and functional products based on traditional and non-traditional raw materials that will contribute to the public health is of special importance.

Because of violations in the composition of normal microbiome and the decrease of immune status, the humanity is experiencing an epidemic of opportunistic infections, one of the leading places among which belongs to mycoses. The most frequent mycotic infection in all age groups is candidiasis of the mucous membranes of the digestive organs. Yeast of the genus *Candida* is widely spread in nature and their constant contact with a person explains the significant prevalence of transient candidiasis in human population.

*Candida albicans* is a commensal fungus of the oral, gastrointestinal and genital tracts in up to 80% of healthy individuals [8, 9]. Under specific host and environmental conditions, *C. albicans* can transit from its commensal state to a parasitic state causing mucosal (oral and vaginal) candidiasis and life-

threatening systemic disease. Yeasts of the genus *Candida* are easily included in microbial associations, contributing to exacerbation of chronic diseases [10]. They complicate surgical interventions, are the cause of systemic intractable mycoses, mimic oncological and tuberculosis diseases [11]. Cure of candidiasis requires diligence and time, as the fungus can take various forms, encapsulate, develop immunity to drugs and revive after treatment [12-14]. All the foregoing calls for the urgent need for scientific development of ways to prevent and eliminate the imbalance of microbiota, using specially selected functional foods [15-17]. Currently, one of the priority areas in healthy nutrition in international practice is the creation of functional wellness products. Worldwide, there is a growing demand for natural non-toxic compounds with a wide spectrum of action against pathogenic and opportunistic micro-organisms, the use of which does not cause side effects. So, the actual task in this regard is the search for natural antibacterial and antimycotic agents.

Treatment of dysbiosis is largely based on the probiotic lactic acid bacteria and their metabolites. The consumer market of functional products is formed by 50-65% by lactic acid products suppressing putrefactive bacteria, preventing dysbiosis and intoxication of the body. Bacterial starter cultures used in such products are in fact unique probiotics adapted to the human digestive tract. At present, new functional properties of lactic acid bacteria, in addition to antimicrobial and antifungal ones, continue to appear: the ability to accumulate antioxidants, peptides, fibrinolytic activity, synthesis of polyglutamic acid, degradation of harmful components etc., which are the essential criteria for choosing starter cultures in increasing the biological value of dairy products and their directed physiological and biochemical properties [18-32].

A special place in the production of functional foods belongs to curd and cheese whey, a secondary product of the dairy industry. The whey mainly falls into the waste despite the fact that it contains up to 50% of milk solids, up to 250 different valuable compounds, about 20% of milk proteins, other nitrogenous, micro- and macro compounds, milk fat, mineral salts, lactose, vitamins, enzymes, and organic acids [33-39]. Whey proteins include more essential amino acids than caseins, which possess a biological value superior to that of chicken eggs that are a benchmark in nutritional evaluation of foods. The composition of milk whey indicates that it is a full-fledged kind of raw material, which is not inferior to the whole milk in terms of its biological value. The energy value of whey is 3.5 times lower than that of whole milk, which makes it expedient to use whey in the production of dietary food. Processing of secondary dairy raw materials, providing a closed production cycle, would significantly improve the efficiency and profitability of the food industry.

Methods for the production of various useful products, such as milk fat (whey cream), whey protein complex, lactose, have been developed on the basis of whey. The opportunity of extraction vitamins, peptides, amino acids, bacteriocins, bacterial pool, and water from the whey seems promising. Cued and cheese whey is the ideal medium for probiotic microorganisms, and on this paradigm, it is possible to reconsider the whole concept of obtaining dairy products. It is also the starting material for the synthesis of prebiotics, for example lactulose. On the basis of whey it is possible to implement the principles of biotechnology of synbiotics [39]. In this regard, in last few years, there has been an increase of interest in whey [41, 42]. The possibility of effective use of whey products in the treatment and prevention of diabetes, bowel diseases, hypertension, infections of integumentary and bone tissues, immunodeficiency, complications after surgical interventions has been clinically proven [43].

Unfortunately, the whey is not popular as a drink because of its taste, despite its useful properties. To increase consumer demand, the development of opportunities to regulate its organoleptic indicators is being carried out.

A popular way to increase the organoleptic parameters of whey is the addition of milk or cream, kefir, yogurt, and fruit juice, which greatly enriches the product. Fruits, berries and vegetable additives are used as phytocomponents [44-49]. The most popular functional foods on the market are beverages containing various fruit mixes, which give the drink a fruit ease and freshness. A special place is occupied among them by combined milk and vegetable products with increased nutritious and biological value. Drinks with milk and vegetable extracts can be classified as neuroceutical functional group, as they are characterized by high content of antioxidants, amino acids, vitamins, mineral compounds, polyphenols, have anti-stress and hypoglycemic effect, increase resistance and working capacity. The beneficial effect of lactic acid products is associated with their suppressive action against a number of microorganisms

including pathogens. This effect is due to the ability of lactic acid bacteria to produce lactic acid and other substances (hydrogen peroxide, acetic acid, benzoic acid, bacteriocins, etc.) that stop the development of pathogenic bacteria in the intestines, which usually leads to inhibition of putrefactive processes and the cessation of the formation of toxic decomposition products. Lactic acid not only gives certain taste qualities to the beverage, but also determines its dietary and preventive properties. The result of its action is activation of the release of digestive enzymes into intestinal tract and stimulation of their action. Lactic acid also increases the absorption of phosphorus and calcium in the body.

A number of technological solutions have been developed for the production of whey based beverages to improve digestive functions, immune system, metabolic processes in the human body, exert a bifidogenic effect, and prevent the emergence of a number of pathological conditions of the body – stress, atherosclerosis, myocardial infarction, malignant neoplasms, etc. [50-77]. A synergistic effect of herbs and extracts combinations was established [78].

The technology of new functional combined whey and vegetable nano-drinks for healthy nutrition based on whey with vitaminized additives in the form of nanostructured purees and phyto-additives in the form of phytoextracts has been scientifically proven and developed. To give the original taste and aroma to nano-drinks, they are added with additives in the form of phytoextracts from non-traditional spicy aromatic and medicinal raw materials (marjoram, basil, melilot, oregano, coriander seeds, lemon peel) and phytoextracts from natural spices, which, possessing antimicrobial activity, contribute to the products shelf life prolongation. It has been shown that the new nano-drinks exceed the known analogues in chemical composition and content of bioactive compounds (L-ascorbic acid, phenolic compounds, flavonol glycosides, tannins, catechins, etc.) and can be used as products with potential immunomodulating action [79]. In order to improve the organoleptic parameters, as well as adjust the micronutrient composition, and increase the nutritional and biological value of the final product based on a combination of whey with vegetable purees from table beet, carrots and pumpkin, fermentation of the drink with probiotic cultures was carried out. A common for all variants was a significant increase in the fermentation rate in comparison with the control, as well as intensification of the process with increasing mass fraction of puree. At the end of the fermentation time, the titrated acidity in whey samples with Jerusalem artichoke was 113-130°T, with carrots 108-121°T, with beets 104-119°T. The received data testify that the introduction of puree vegetable additives allows not only improving the organoleptic parameters of fermented whey-based beverages and balancing their micronutrient composition, but also intensifying the fermentation process due to the prebiotic effect. The greatest bifidogenic potential for *Bifidobacterium longum* had Jerusalem artichoke. Carrots and table beets had slightly less effect. The degustation evaluation of fermented samples showed that the ratio of puree and whey 25-30 : 75-80% was optimal from the point of view of taste qualities.

Based on the data obtained, the technology and recipe of whey beverages with pulp from individual vegetables and their mixtures, designed for functional nutrition, have been developed. The beverage had a pleasant sweet and sour taste, a homogeneous consistency characteristic for drinks with pulp, contained viable cells of bifidobacteria in an amount of $>10^6$ CFU/g, which allows them to be positioned as functional. The use of such drinks contributes to the multifaceted positive effects that pre- and probiotics exert on the activity of the gastrointestinal tract and the state of the whole organism [80].

To expand the assortment of food products with functional properties on the basis of whey, recipes for desserts were developed, which were optimized with the help of mathematical modelling [81]. At the same time, the optimal ratio of whey base and fruit and vegetable fillers was determined, which provided favourable taste qualities of the desserts. The results of experimental studies give the reason for recommending the introduction of developed desserts into industrial production as functional food products.

A group of gelled products with the addition of fruits and/or berries, as well as citric acid, corn starch, sugar, fragrances and colorants are also produced on the basis of whey [82-84].The introduction of these additives, as well as the use of clarification of whey in the production process are disadvantages that negatively affect the functional qualities of the processed products, lead to a decrease in the biological value of the jelly and to increase in production costs. Despite the great choice and attractiveness of modern colorants, flavors, fillers and products with their use, their application is physiologically unjustified, especially in children's nutrition, so competent consumers prefer environmentally friendly products based on natural components.

Structured whey-based products are very popular. It should be noted that, because of their high popularity, their assortment is intensively growing, mainly with the use of jelly-forming agents. For example, pectic substances, changing the consistency, give the product the desired properties. The prospects of using pectic substances for the production of functional foods based on whey are proved [85].

It is known that the addition of mono- (xylitol, sorbitol), poly- (pectins, dextrin, inulin) and oligosaccharides (monosaccharides linked together by glycosidic bonds), antioxidant vitamins (A, C, E), microelements (selenium), plant extracts containing bioflavonoids, polyunsaturated fatty acids and other biologically active substances to useful microorganisms and their metabolic products positively affect the functions of the digestive tract. The presence of dietary fibres that are not digested in the gastrointestinal tract but effectively improve digestive functions and stimulate the beneficial intestinal microflora is of particular importance. This allows us to consider that the combination of lactic fermentation products and plant additives is one of the most promising ways of creating functional food products with the desired properties.

However, the list of developments with the use of bioactive cultures of microorganisms, as well as products aimed at normalizing the intestinal microflora with preventive action against fungal microorganisms, is limited.

At present, a special role in functional nutrition is given to products that contribute to optimizing the microecological status of the human body, since eubiosis is the key to immunobiological stability and potentially to the health in general [86]. Synbiotic products meet these criteria to the greatest extent, because they promote the colonization of the digestive tract by probiotic microorganisms and increase the biological activity of its own positive microflora due to the presence of prebiotic ingredients in the product. The starting cultures immobilized on the sorbent, which are plant fibers, have an additional degree of protection, including resistance to bile [87], due to which they are better reactivated upon ingestion in the digestive tract. The process of reactivation will also be accelerated due to quorum sensing of closely located cells on the sorbent [88]. In addition, the biodegradable sorbent will also serve as a source of nutrition not only for introduced bacteria, but also for resident microflora representatives.

Particularly relevant is the use of propionic acid bacteria producing $B_{12}$vitamin, increasing the immune status of the human body, its anti-stress and antimutagenic properties, and preserving dairy products [89-91], as well as of yeast microorganisms, the cell walls of which actively absorb toxins and toxic metabolites, have a high lacto- and bifidogenic effect, acting not only as nutraceuticals, but also as parapharmaceuticals [92, 93], in the compositions of starter cultures.

A review of the existing scientific literature on the importance of curd and cheese whey as a secondary raw material for the production of food products with high levels of nutritional and biological value testifies to the inadmissibility of neglecting it and to an urgent need for its targeted use.

The work is carried out within the framework of the AP05132352 project financing under the budget program "Development of science", subprogram "Grant financing of scientific research" of the Ministry of Education and Science of the Republic of Kazakhstan.

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## СҮТ САРЫСУЫНЫҢ НЕГІЗІНДЕ ФУНКЦИОНАЛДЫҚ СУСЫНДАР ДАЙЫНДАУ

**Аннотация.** Қазіргі кезде ішек биоценозының тек қана асқазан-ішек тракты ауруларымен ғана емес байланысы жайында мәлімет беретін жаңа дәлелдемелер пайда болуда. Иммундық жүйе мен қалыпты микрофлора құрамының бұзылуларына байланысты, айтарлықтай дәрежеде азық-түлік өнімдерінің сапасы мен қауіпсіздігі төмендеуіне байланысты адамзат оппортунисттік инфекциялар індетін басынан кешіруде. Бұл жағдайларда ерекше маңызға қоғам денсаулығының күйін жақсартуға мүмкіндік беретін функционалдық міндетке ие инновациялық азық-түліктер, дәстүрлі және дәстүрлі емес шикізаттар негізінде алуға болатын ғылым мен техниканың заманауй жетістіктерінің базасында, мақсатты түрде жаңа түпнұсқалық процесстер мен технологиялар ие. Осыған байланысты маңызды орынға, өзінің биологиялық құндылығы жағынан табиғи сүттен қалыспайтын, бірақ дәмдік сапасы нәтижесінде қалдықтарға жатқызылатын сүт сарысуы ие. Адам организміндегі иммундық жүйе мен зат алмасу процестерін, асқорыту қызметтерін жақсартатын, сүтқышқылды микроорганизмдер мен табиғи өсімдік текті қоспаларды пайдалану арқылы реттеу, организмнің бірнеше патологиялық күйінің пайда болуының алдын алушы, сусындар өндірісіне арналған толық қанды шикізат ретінде сүт сарысуын пайдалану жөніндегі ғылыми мәліметтер мен дәлелдеулер келтіріледі. Тұтынушылардың кең аясы үшін тартымдылығын жоғарылатуға мүмкіндік беретін жақсартылған органолептикалық көрсеткіштеріне ие, сүт сарысуының негізіндегі сусындар өндірісінің нақтылы мысалдары келтірілген.

**Түйін сөздер:** сүт сарысуы, функционалды сусындар, сүтқышқылды бактериялар, фитоқоспалар, органолептикалық көрсеткіштер.

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## РАЗРАБОТКА ФУНКЦИОНАЛЬНЫХ НАПИТКОВ НА ОСНОВЕ МОЛОЧНОЙ СЫВОРОТКИ

**Аннотация.** В настоящее время появляются все новые факты, свидетельствующие о связи кишечного биоценоза с заболеваниями не только желудочно-кишечного тракта**.** Из-за нарушений иммунной системы и состава нормальной микрофлоры, в значительной степени из-за снижения качества и безопасности продуктов питания, человечество переживает эпидемию оппортунистических инфекций. В этих условиях особое значение приобретают разработки на базе современных достижений науки и техники принципиально новых оригинальных процессов и технологий, позволяющих получать на основе традиционного и нетрадиционного сырья, инновационные продукты функционального назначения, способствующие улучшению состояния здоровья населения. Особое место в этом плане занимает молочная сыворотка, которая не уступает цельному молоку по своей биологической ценности, но преимущественно попадает в отходы вследствие своих вкусовых качеств. Приводятся научные данные и обоснование использования молочной сыворотки как полноценного сырья для производства напитков, улучшающих функции пищеварения, иммунной системы и обменных процессов в организме человека, регулирования их путем использования молочнокислых микроорганизмов и натуральных растительных добавок, содержащих биологически активные вещества, предотвращающих возникновение ряда патологических состояний организма. Показаны конкретные примеры производства на основе молочной сыворотки напитков с улучшенными органолептическими показателями, способствующими повышению привлекательности для широкого круга потребителей.

**Ключевые слова:** молочная сыворотка, функциональные напитки, молочнокислые бактерии, фитодобавки, органолептические показатели.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.6**
Volume 5, Number 329 (2018), 45 – 57

UDC 665.52/.54+577.1. + 547.91

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# ESSENTIAL OILS FROM PLANTS OF THE GENUS *THYMUS L.* OF KAZAKHSTAN FLORA: CHEMICAL COMPOSITION AND PROSPECTS OF APPLICATION

**Abstract.** The in-house data on chemical composition of essential oils from 14 plants pecies of *Thymus* L. genus of the family *Lamiaceae Lindl*. in Kazakhstan flora have been generalized. The author conducted a comparative analysis of the obtained results with the published materials on essential oils from *Thymus* L. species. The article discusses biosynthetic pathways of the main components of *Thymus* L. species which have been confirmed by the results of chemical analysis of essential oils undertaken by the author. The screening data of essential oils from thymes for the biological activity are provided.

**Keywords:** *Thymus* L., essential oils, mono- and sesquiterpenoids, gas chromatography-mass spectrometry, biosynthesis.

**Introduction**. Nowadays, the arsenal of a pharmaceutical market has considerably expanded with highly effective natural medicines. Over 1000 species of essential oil-bearing plantsgrow in the flora of Kazakhstan. Some species from the families *Lamiaceae, Apiaceae* and *Asteraceae*are of great interest, they used to be overlooked earlier, or else there are only minor data on their chemical composition and biological properties. From this viewpoint, the family *Lamiaceae L.* is worth mentioningas it is one of the leaders in Kazakhstan flora. Thus, this family incorporates 233 species combined in 45 genera in the territory of Kazakhstan [1].

Plants of the genus *Thymus*L. are the most popular among them because they are a rich source of essential oils which is very widespread. The genus*Thymus* L.ranks first on a species diversitywith27 species growing in Kazakhstan [1]. The contemporary studies have shown that essential oil from thymes is active against many poly-resistant pathogens due to the presence ofa monoterpenic phenol thymol in their composition [2]. Taking into account a high antimicrobial, antioxidant, and antiviral activity of essential oils from thymes [2-5], plants of this genus can be considered as a prospective source of herbal raw materials for the medicines with a wide range of pharmacological activity, low toxicity, and high efficiency against strains, viruses, and microbes resistant to the main classes of antibiotics.

**The aim of the research** is to study the chemical composition of essential oils from *Thymus* L.species growing in Kazakhstan.

**Objects of research** aretheessential oils from *Thymus crebrifolius* Klok., *Thymus Dmitrivae* Gamajun., *Thymus karatavicus* A. Dm., *Thymus Lavrenkoanus* Klok., *Thymus Marschallianus* Willd., *Thymus minussinensis* Serg., *Thymus mugodzharicus* Klok. et Schost., *Thymus petraeus* Serg., *Thymus rasitatus* Klok., *Thymus roseus* Schipz., *Thymus serpyllum* L., *Thymus stepposus* Klok. et Schost., *Thymus sibiricus* (Serg.) Klok. et Schost., and*Thymus vulgaris* L.

**Research methods.** Plant material was collected in 2011-2017 in the East Kazakhstan, South Kazakhstan regions, and in Central Kazakhstan.

Essential oils were extracted by a hydrodistillation method on Klevendzher's apparatus from the air-dry mass of plant raw materials [6]. The weight of dry plant material varied from 20 to 100 g depending

on a sample. The hydrodistillation of each sample was carried out within 3 hours with hexane used as a solvent to collect essential oil. The quantitative content of essential oils was calculated in volume-weight percentage per the air-dry mass of plant material. The obtained essential oil was placed in amber glass bottles, hermetically sealed and stored at a temperature of +1-4 °C. The research was done on the organoleptic and physico-chemical properties of the extracted essential oils.

The chemical composition was investigated by the gas chromatography-mass spectrometry method on the Gas Chromatograph with Mass Selective Detector Agilent 7890/5975C (Table 1). HP-5MS 5% Phenyl Methyl Silox (30 m × 0,25 mm) column with a speed of helium carrier gas of 1ml/min was used. Evaporator temperature was 2300˚C. The gas chromatography column was maintained at a temperature of 40 ˚C within 10 min. with the temperature programmed up to 240 ˚C,and a temperature change speed of 2 ˚C/min, then it was sustained in the isothermal mode for 20 min. The sample input mode wasstream division 100:1. Sample volume was 0,2 μL. Conditions of mass spectrarecordwere 70 eV, the massrange was 10-350m/z. The quantitative content of constituents was calculated automatically based on the peakareas of the general ion chromatogram. The quantitative analysis was carried out by means of the internal normalization method on the peakareas without the correcting coefficients. The components were identified as per the mass spectra and the retention time using Wiley GC/MS library.

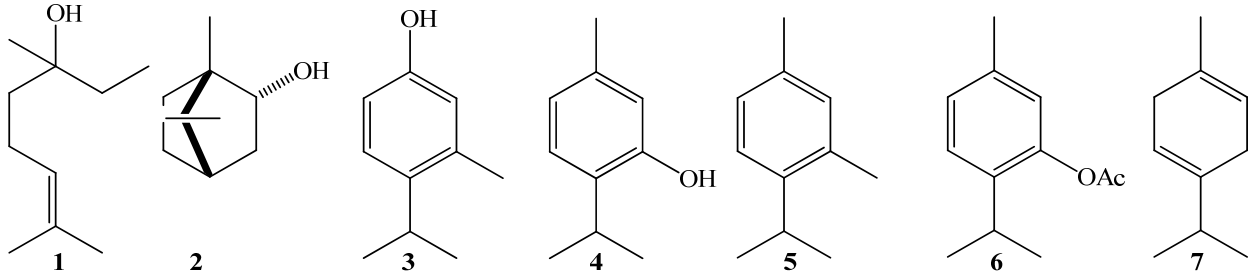
**Research results.** The genus *Thymus* L. (a thyme) is one of the largest and taxonomically complex in the family *Lamiaceae* Lindl. All studied species of *Thymus* L. grow in Kazakhstan [1].

*Thymus crebrifolius* Klok. isa semi-bush up to 4 cm high with a pleasant lemon scent. It is found on the precipices of temporary water way currents and rocks in regions of the Western Kazakh Uplands (Melkosopochnik) and Ulytau. It is an endemic plant. The raw material reserves of this species are noticed in the territory of Karaganda region [7]. The chemical composition of its essential oil has not been studied. The essential oil that we investigated for the first time represents the mobile liquid of a light yellow color with a pleasant lemon fragrance. Among the identified 74 components, the main are (in %) in *Thymus crebrifolius* Klok essential oil:linalool 31.9 (**1**), borneol – 9.6 (**2**).

*Thymus Dmitrivae* Gamajun. represents a dwarf semishrub up to 14 cm high, the distinctive features of this plant are thickish curved ligneous stipes sometimes with additional roots and also reddish leaves. It is encountered on the open stony slopes, on rockslides, andgravelfrom the mountains forest belt to the Alpine highlands of Zailiysky Alatau, the Kyrgyz Alatau, and the Western Tien Shan. We have studied the essential oil of this plant for the first time, the main component of which is 4-methyl-4-isopropylphenol 57.7% (**3**) among 17 identified.

*Thymus karatavicus* A. Dmitr. ex Gamajun. is an endemic plant. It grows on stony slopes and taluses of low mountains. It is found in Karatau and the Talas Alatau [1]. The are no data on the chemical composition of its essential oil. The investigated essential oil represents the yellowliquid with a pleasant scent andyield of 1.49%. We have identified 19 constituents, the main of them in*Thymus karatavicus* essential oil are (in %): thymol - 39.5 (**4**), *p*-cymene – 18.5 (**5**), thymol acetate– 13.0 (**6**) [8].

*Thymus Lavrenkoanus* Klok. represents a dwarf subshrub with a height of 3-12 cm and short corollasof pink-violet color. It grows on stony and steppe tall-grass slopes, and on the hill tops. It is found in Karaganda and the East Kazakhstan regions. It is an endemic plant. In the composition of*Thymus lavrenkoanus* Klok essential oil 100 components have been identified, the main of which are (in %): *p*-cymene - 32.2 (**5**), γ-terpinene - 7.5 (**7**), thymol - 26.0 (**4**).




*Thymus Marschallianus* Willd. is the most widespread species of thyme in the territory of Kazakhstan. The analysis of morphological features of *Thymus Marschallianus* Willd. has allowed us to define

the following characteristic signs: the oblong sessile elliptic leaves pubescent with rare cilia, more seldom - glabrous; the inflorescences are extended, short-verticillate; the corolla is pale violet with a short tube. It grows in steppes, edges, and ravineslopes. This species can be a substitute for *Thymus serpyllum* L. and *Thymus vulgaris* L. Besides, *Thymus Marschallianus* Willd. is widespread in the conditions of Central Kazakhstan. It also grows in steppes, on hillslopes, in the river floodplains in the European part of Russia, in the Caucasus, in Western and Middle Siberia, and in Central Asia. According to the performeddistribution and raw material stocks analysis of *Thymus Marschallianus* Willd.herb in the territory of Karaganda region, the overallarea of its thickets is estimated as 85,8 hectares withtheexploitable reservesof 40,6 tons, andthe volume of potential annual harvestingof raw materials of 17,52 tons. It is pertinent to collect plant materials once in 3 years in onearea [21].

There are numerous data on the chemical composition of *Thymus Marschallianus* Willd. essential oil in literature (table 1) which confirm its complex constituent structure [9-19].

Table 1 – Major components of *Thymus Marschallianus* Willd. essential oil.

| Place of growth | Essential oil components | Reference |
|---|---|---|
| China | γ -terpinene (18.0% to 22.4%), thymol (28.0% to 32.9%), *p*-cymene (7.7% to 25.4%) | 9 |
| Hungary | thymol - 32.9% | 10 |
| Kazakhstan | *p*-cymene, thymol, □-terpinene | 11 |
| Caucasus | geraniol – 30.3% | 12 |
| China | thymol – 32.9%, □-terpinene – 22.4%, carvacrol – 8.0%, *p*-cymene – 7.7% | 13 |
| Germany | caryophyllene, cadinene, nerolidol | 14 |
| Russia, Saratovregion | *p*-cymene -20.9%,thymol - 54.6% | 15-16 |
| Russia | borneol – 30.0%, □-pinene – 10.7%, sabinene –9.9%, thymol – 5.5% | 17 |
| Russia, Voronezh region | thymol – 16,5%, p-cymene 9.6% | 18 |
| Russia, Altai territory, Burlinregion | α-terpinenol acetate, *p*-cymene | 19 |
| Russia, Altai territory, Loktevsky region, 220 m above the sea level | *p*-cymene, limonene, □-terpinene | 19 |
| Russia, Altai territory, Ust-Koksin region | *p*-cymene, □-terpinene, thymol | 19 |
| Russia, Altai territory, Ust-Pristan region | □-terpinene , *p*-cymene, thymol | 19 |
| Russia, Altai territory, Loktevsky region, 430 m above the sea level | geraniol, geranyl acetate | 19 |
| East-Kazakhstan region, Zyryanovsk region | □-terpinene, *p*-cymene, thymol | 19 |

As is seen from table 1, the chemical composition of *Thymus Marschallianus* Willd. essential oil can be divided into 3 groups. The majority of the studied essential oils had a high content of the sum of thymol and carvacrol up to 80% and a noticeable content of borneol up to 13%, at the same time a high content of monoterpene hydrocarbons was also observed up to 45%. The second group of essential oils contained a rather low content of phenols (7.0-38.8%) in their structure, and □-terpineol (14.1-45.9%) and monoterpene hydrocarbons were identified as the major components. The third group of essential oil samples were marked by a high content of geraniol (33.7-70.2%) and geranyl acetate (5.5-13.3%), a small content ofneral (0.7-6.4%) and geranial (1.7-10.1%), as well as a low content of monoterpene hydrocarbons [20]. In the investigated essential oil we identified 111 components, the major ones are thymol 19.3 (**4**) and *p*-cymene 18.2 (**5**).

*Thymus minussinensis* Serg. is a plant with floriferous sprouts of 1(2)-6 cm high, with reddish, short, down-directed hairs, and a pink corolla5-6 mm long. It grows on dry-steppehillslopes and granite rocks. It is encountered in Akmola region, in the East Kazakh Uplands and Bektau-Ata Mountains. We have studied the chemical composition of *Thymus minussinensis* Serg. essential oil by the GC-MS method for

the first time. Twenty-three components have been found, the main of them are (%): *p*-cymene 22.5 (**5**), thymol 19.3 (**4**), □-terpinene 18.0 (**7**).

*Thymus mugodzharicus* Klok. et Schost. is anundershrub growing on stony slopes, steppe hills, and dry slopes of river valleys. We collected *Thymus mugodzharicus* Klok. et Schost in the Mugodzhar Hills during blossoming period in 2014. *Thymus mugodzharicus* essential oil contains 25 components of which the following prevail (in %): thymol - 37.6 (**4**), borneol 8.3 (**2**), □-terpinene 7.5 (**7**) [22].

*Thymus petraeus* Serg. is a mountain-steppe plant representing a prone vegetatively motionless subshrub of stlanictype. It is found in steppes of Altai and Krasnoyarsk regions, the Tyva Republic and a North-West part of China, with huge populations marked in the Republic of Khakassia [23]. In Kazakhstan it grows in mountain steppes and on the crushed rock slopes. It is seen in the Tarbagatai and Dzungarian Alatau. It is an endemic plant. There are scarce data in literature on the essential oil composition,of which the main components are linalyl acetate, γ-terpinene, *p*-cymene, thymol, andmyrcene [19,24]. In the researched oil we have found 59 components, the major of them are (in %)*o*-cymene 46.3 (**8**) andthymol 13.2 (**4**).

*Thymus rasitatus* Klok. is an endemic plant which grows on stony and steppe slopes, low mountains peaks, on granite taluses, and in the rockcracks of the Dzungarian Alatau, in Karkaraly, in the Irtysh and Balkhash-Alakulsk floristic regions, the East Kazakh Uplands [23]. We have studied the chemical composition of its essential oil for the first time, the main constituents are (in %): thymol 23.6 (**4**), *p*-cymene 21.2 (**5**), γ-terpinene 11.1 (**7**).

*Thymus roseus* Schipz. is a tinydwarf semishrub withviolet-rose or white floretshavinga pleasant fragrance. It grows on stony tops and slopes of mountainsand low-mountains, on granite rocks and rockslides. It is common in Western Siberia, Kazakhstan, and Mongolia. The data on its essential oil are sporadic. A.V. Tkachev investigated theessential oil from *Thymus roseus* Schipz growing in the Altai Republic (Russia) where the major constituents arethymol, *p*-cymene, γ-terpinene [19]. In the investigated essential oil we have defined 66 compounds, the major ones are (in %) *o*-cymene 14.1 (**8**), linalool 12.7 (**1**).

*Thymus sibiricus* (Serg.) Klok. et Schost. is a plant with floriferous branches 1,5-10 cm high, densely pubescent under the inflorescence with long and short downward hairs. It grows on the southern stony slopes, dry meadows, in pine woods on the sand. It is spread in Western Siberia, the Tarbagatai, and the Dzungarian Alatau. The main components of oil from*Thymus sibiricus* (Serg.) Klok. et Schost harvested in Buryatia are thymol (20.9%), □-terpinene (14.0%), *o*-cymene (42.3%) [26]. The major components of the researchedessential oil from *Thymus sibiricus*(Serg.) Klok. et Schost (in %) are linalool 25.2 (**1**) andgeranyl acetate 18.0 (**9**).

*Thymus serpyllum* L. is a dwarf subshrub up to 13 cm high usually with petiolate,elliptic leaves pubescent with long cilia on the edge; the inflorescences are of a densecephalanthium form; thecorolla is bright pink with a long tube. It is widespread in the whole territory of the CIS countries including Armenia, Kazakhstan, the Russian Federation, Ukraine,it is also found in the foothills of Tibet, in the north of India, and in North America. The aerial parts of *Thymus serpyllum* L. are widely used both in traditional and folk medicine of many countries of the world as a valuable herb. The plant therapeutic effects are due to the presence of various biologically active agents (flavonoids, tannins, macro- and minor constituents, essential oil)in its raw material. It is included as a medicinal raw material in the State Pharmacopoeia of Kazakhstan [8]. *Thymus serpyllum* L. is an extremely polymorphic genus related to the Siberian and Central Asian thymes which is split to a number of minorspeciesthat are geographically isolated or peculiar for certain localities. In this regard, the chemical composition of essential oils is also very diverse. For instance, as is seen from Table 2 thymol (**4**) and carvacrol (**10**) are the main components of essential oil from *Thymus serpyllum* L. growing in Albania, Armenia, Hungary, India, China, Pakistan, and Ukraine. Thymol (**4**) is the main component of the essential oil from*Thymus serpyllum* L. growing in Egypt, Japan, Iran, and Serbia, whereascarvacrol (**10**) is commonfor the essential oil from Italy, Poland, and Russia. Thymol (**4**) and carvacrol (**10**) are absent in the essential oils of *Thymus serpyllum* L. chemotypes growing in Belarus, Estonia, Finland (*T. serpyllum* L. ssp. *serpyllum* and *T. serpyllum* L. ssp. *tanaensis* (Hyl.) Jalas), Lithuania (*T. serpyllum* L. ssp. *Serpyllum* and *T. serpyllum* L. ssp. *serpyllum* var. *serpyllum*), Turkey, Sweden, and Poland (the Central part) (table 2).

Table 2 – Major constituents of *Thymus serpyllum* L. essential oil and its subspecies

| Place of growth | Constituents | Reference |
|---|---|---|
| 1 | 2 | 3 |
| Albania | phenols (47-74%), *p*-cymene (8.5-36.5%) | [27, 28] |
| Armenia | (1) thymol (81.5/76.1%), *p*-cymene, carvacrol, β-caryophyllene, α-terpineol,<br>(2) carvacrol (49.0-62.0%), thymol (21.5-29.7%), *p*-cymene, β-caryophyllene, α-terpineol | [27, 29] |
| Belorussia | γ-terpinene (21.4%), *p*-cymene (19.0%), thymol | [27, 30] |
| | camphene (1.75-12.62%), β-myrcene (2.26-14.61%), 1,8-cineole (up to 23.12%), camphor (4.24-27.59%), β-caryophyllene (1.12-22.64%), (-)-borneol (2.02-33.39%), caryophyllene oxide (3.79-28.7%), thymol (3.59%), carvacrol (up to 3.69%) | [31] |
| China | *T. serpyllum* L. var. *mongolicus* Ronn.<br>*p*-cymene (30.3%), thymol+carvacrol (20.0%), β-phellandrene (14.0%); | [27, 33-34] |
| | *T. serpyllum* L. var. *mongolicus* Ronn.<br>thymol (23.9%), 2,4,5-trimethyl benzyl alcohol (16.9%), *p*-cymene (16.3%), carvacrol (10.6%) | [27, 34] |
| Croatia | thymol (30.0%), carvacrol (49.4%), γ-terpinene (5.3%), | [35] |
| Egypt | thymol (62.02%), β-phellandrene (13.50%) | [36] |
| Estonia | (E)-nerolidol (70.1%), caryophyllene oxide (45.0%), myrcene (20.2%), (E)-β-caryophyllene (13.3%), germacrene D (12.4%) | [37] |
| | geranyl acetate (up to 46.4%), linalyl acetate (up to 31.4%), geraniol (up to 30.3%), myrcene (up to 20.2%) | [37] |
| Finland | *T. serpyllum* L. ssp. *serpyllum*<br>(1) monoterpene hydrocarbons (33%), 1,8-cineole (12.5-15.0%), germacra-1(10),5-dien-4-ol (3-12%), germacrene D (10.0-12.0%)<br>(2) monoterpene hydrocarbons (30%), 1,8-cineole (26%) | [27,38] |
| | *T. serpyllum* L. ssp. *tanaensis* (Hyl.) Jalas<br>(1) linalool (21.9-43.8%), linalyl acetate (8.9-17.6%),<br>(2) 1,8-cineole (17.2-27.6%), myrcene (15.4-22.4%), β-caryophyllene (6.8-19.1%) | [27,39-40] |
| | *T. serpyllum* L. ssp. *tanaensis* (Hyl.) Jalas<br>(1) linalool (52.2%), monoterpene hydrocarbons (13%)<br>(2) linalyl acetate (58.3%), monoterpene hydrocarbons (15%)<br>(3) monoterpene hydrocarbons (33%), 1,8-cineole (12.5-15.0%) | [27,38] |
| Hungary | carvacrol (39.5/45.9%), thymol, p-cymene (25.0%), linalool, nerol | [27, 41] |
| India | carvacrol (49.4%), *p*-cymene, thymol, zingiberene | [27, 42] |
| | thymol (57.6%), *p*-cymene (20.0%) | [27, 43] |
| | Uttarakhand Hills thymol (19.4-60.1%), γ-terpinene (0.3-13.8%), *p*-cymene (3.5-10.4%) | [44] |
| | Uttarakhand Himalaya thymol (37.27–55.56%), thymyl methyl ether (3.26–12.93%) | [45] |
| Iran | carvacrol (48.8%), thymol (13.8%), *p*-cymene (12.3%) | [46] |
| | γ-terpinene (22.7%), *p*-cymene (20.7%), thymol (18.7%), germacrene D (5.1%) | [47] |
| Italy | North East Italy carvacrol + carvacrol methyl ether (44.9%) | [48] |
| Lithuania | *T. serpyllum* L. s. l.: 1,8-cineole (16.3-19.0%), β-caryophyllene (9.6-11.3%), myrcene (9.7-10.7%) | [27, 49] |
| | *T. serpyllum* L.: α-pinene (6.3-25.6%), camphene (23.6-48.9%), β- myrcene (1.6-51.5%), 1,8-cineole (6.3-33.3%) | [50] |
| | *T. serpyllum* L. ssp. *Serpyllum* 1,8-cineole, germacrene B, (E)-β-ocimene, α-cadinol | [51] |
| | *T. serpyllum* L. ssp. *serpyllum* var. *serpyllum*<br>1,8-cineole (8.9-13.9%), caryophyllene oxide (6.5–12.5%), borneol (7.4–10.5%) | [52] |
| Pakistan | thymol (42.6%), *p*-cymene, carvacrol, borneol, | [27, 53] |
| | carvacrol (44.4%), *o*-cymene (14.0%), α-terpineol (6.47%), α-pinene (6.06%), β-caryophyllene (5.25%) | [54] |
| | thymol (53.3%), carvacrol (10.4%), *p*-cymene (8.8%) | [55] |
| | Muzaffarabad, the State of Jammu and Kashmir thymol (16.5-18.8%), borneol (1.6-3.1%), ledol (0.2-7.3%), safrole (1.1%), 1,8-cineole (14.0-18.0%), | [56] |

*Continuation of table 2*

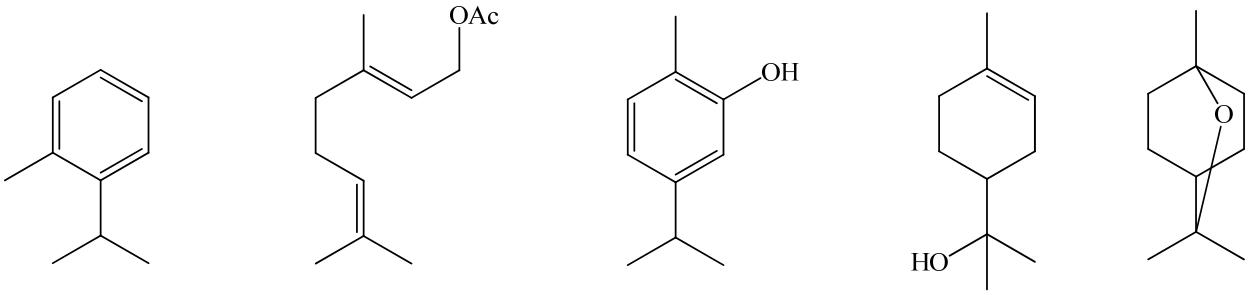
| 1 | 2 | 3 |
|---|---|---|
| Poland | Central Poland: camphene (8.07-13.91%), β-myrcene (6.53-17.97%), cyneole (1.41-11.64%), β-caryophyllene (1.06-9.02%), borneol (0.15-16.91%) | [57] |
| | the North-Western Poland: carvacrol (30.90–46.16%), γ-terpinene (5.72–9.09%), *p*-cymene (4.51–13.46%) | [58] |
| Russia | *T. serpyllum* L. s. l. village Kolyvan' (Kurijnski area, 150 m above sea-level) β-myrcene (4.0%), *p*-cymene (3.8%), 1,8-cineole (14.0%), cis-β-terpineol (8.2%), camphor (4.0%), *trans*-nerolidol (29.8%) | [59] |
| | *T. serpyllum* L. s. l. village Mendur-Sokkon (Ust-Kanski area, 500-750 m above sea-level) *p*-cymene (14.5%), 1,8-cineole (5.6%), γ-terpinene (17.2%), carvacrol (29.6%) | [59] |
| Serbia | *trans*-nerolidol (24.2%), germacrene D (16.0%), thymol (7.3%), δ-cadinene (3.7%), β-bisabolene (3.3%) | [60, 61] |
| | *trans*-caryophyllene (27.7%), γ-murolene (10.5%), α-humulene (7.5%), α-pinene (6.9%), 3-octanon (6.6%), thymol (5.6%), camphor (3.6%) | [61, 62] |
| Turkey | 2,4,6-trimethylanisol (73.41%), 3,5-dimethyl benzoic acid (5.38%), β- bisabolene (3.67%) | [63] |
| Ukraine | (1) thymol (50.0/35.1%), γ-terpinene (12.7/18.0%), *p*-cymene (8.6/14.1%), (2) carvacrol (48.4/55.2%), γ-terpinene (10.1/27.1%), *p*-cymene (8.0/7.1%) | [64] |

We have investigated in detail the composition of *Thymus serpyllum* L. essential oil., collected in 8 various regionsof Kazakhstan. The composition is mainly presentedbythymol (5.1-58.2%) and carvacrol (1.2-55.2%) and depends on the place of growth [64]. It is known that in the wild there are populations and even certain plants which essential oil has a distinctive composition very unlikethe typical one for this species.

For example, the so-called lemon *Thymus serpyllum* L. form belongs to such a group, which oil has a peculiar fragrance different from other samples dueto the present of a considerable amount of geraniol (to 60-70%). We can assume that a sample collected in the neighborhood ofAkmola region belongs to the lemon form. Trans-geraniol (55.9%) and lavandulyl acetate (28.5%) are biosynthesized in this essential oil.

*Thymus stepposus* Klok. et Schost. generally has linear leaves on very short leafstalks; the in florescence is elongated, verticillate; the corolla is violet with a longer tube. A.V. Tkachev considers that *Thymus stepposus* Klokov & Des. - Shost. is a synonym of *Thymus Marschallianus* Willd [19]; however, in the Flora of Kazakhstan it is included as a separate specieswith a number of distinctive morphological features [1]. The main components ofthe essential oil from this plant harvestedin Buryatia are thymol (20.9%), □-terpinene (14.0%), *p*-cymene (42.3%) [26]. In the plant essential oil from the north of Kazakhstan, the main constituents are trans-nerolidol (21.5%), 1,8-cineole (16.0%), camphor (10.3%), trans-□-ocimene (6.1%), camphene (4.2%), and borneol (2.9%) [66].

According to our data, the main components of *Thymus stepposus* Klok. et Schost. are (in %): thymol 57.7 (**4**), □□terpineol 25.2 (**11**), 1,8-cineole (**12**) – 8.9.




**8** **9** **10** **11** **12**

*Thymus vulgaris* L. is a typical representative of the vegetatively-fixed subshurbs remaining the main root system during the whole life cycle. It is widespread in the Western part the Mediterranean: on the Iberian Peninsula, in Southern France, in the North-West of Italy. The main commercial product is the essential oil produced from *Thymus vulgaris* L. cultivars. The oil composition is rather well studied and is subjectto a variability. Literature data confirm that the genus *Thymus* L. features a considerable intra-

species and cultivarpolymorphism both in regards to the morphological characteristics and the mass fraction of essential oil and its compositional structure which serves as a basis when determining the chemotype. The existence of several chemotypes within its world geographic rangehas been revealed.

Over 20 various chemotypes of *Thymus vulgaris* L. are described in the literature. [26]. Usually it contains more phenols: up to 60% of thymol and 2-10% of carvacrol; *p*-cymene (up to 20%), γ-terpinene (12%), and caryophyllene (2-10%), etc. are also present[67-73]. The essential oil that we have extracted from *Thymus vulgaris* L. contains 100 components, the main of them are (in %): thymol 58.6 (**4**), *o*-cymene 11.2 (**8**).

The majorityof terpenoid volatiles that we have found in the essential oils from the genus *Thymus* L. belongs to the monoterpene group. The essential oils from thymes usually contain over 90% of monoterpenes with aminor content of sesquiterpenes. About 300 mono- and sesquiterpenes are observed in *Thymus* L.essential oils., of which 34 were chosen as the most significant volatile components [27,74]. Thymol (**4**) is found in the essential oils of 77 taxons of *Thymus* L. Over a half of thyme taxons (89 taxons or 55%) belong to the phenolic and 73 (45%) - to the non-phenolic group [27]. As a matter of fact, thymol (**4**) and carvacrol (**10**) are also found in other plants but in a meagre amount. That is what makes the genus *Thymus* L. the most rich source of monoterpenoid phenols interesting for the search of thymol (**4**) and carvacrol (**10**).

Plants of the genus *Thymus* of Kazakhstan flora also accumulatethe aromatic alcohols of thymol (**4**) and carvacrol (**10**). The essential oils of the studied 10 speciescontainthymol (**4**) from 0.09% to 50.1%. Thymol (**4**) has been found in small amounts in the essential oilsfrom *Thymus Dmitrivae* Gamajun., *Thymus stepposus* Klok. et Schost., *Thymus crebrifolius* Klok. and in rather high amounts in *Thymus petraeus* Serg., *Thymus minussinensis* Serg., *Thymus Marschallianus* Willd., *Thymus rasitatus* Klok., *Thymus karatavicus* A. Dm., *Thymus mugodzharicus* Klok. et Schost.

A high content of monoterpene hydrocarbons *p*-cymene (**5**) in 56 taxons and □-terpinene (**7**) in 38 taxons of *Thymus* L. has also been noted irrespective of the presence of thymol (**4**) and carvacrol (**10**). All four monoterpenes are closely related by the biogenetic processes.

A number of researchers [26, 74-77] offered biogenetic schemes according to which the components of essential oils are formed by successive transformations, starting from geranyl pyrophosphate (figure 1) where the conversion of one terpene component to another is controlled by one gene coding the synthesis of the corresponding enzyme. If the required enzyme is absent, the sequence of the biosynthetic chain stops and the precursor accumulates. The primary accumulation of a precursor in the essential oil of thyme species determines the diversity of the biochemical composition of various representatives of the genus *Thymus* L., which is confirmed by the results of our studies of the chemical compositions of the extracted essential oils.

Among the monoterpene compounds, the dominant components are linalool, borneol, γ-terpinene, α-terpineol, 1,8-cineole.

The sesquiterpene fraction is represented by caryophyllene, γ-murrolene, germacrene D, β-bisabolene, γ-cadinene, σ-cadinene, α-bisabolene, caryophyllene oxide, but their content is minor. Moreover, all studied essential oils samples from 14 species contain caryophyllene (0.49-3.07%) and caryophyllene oxide (0.74-2.1%). All the actual data indicate the interrelation of these components in the biosynthetic process which proceeds according to the known scheme of geranyl diphosphate with the predominant formation of *p*-menthaneand pinane types. The predominant biosynthetic pathway of sesquiterpenes is the cyclization of farnesyl diphosphate with the subsequent formation of a germacryl cation followed by branching to caryophyllanes, humulans, etc.

Despite the fact that in general the oil composition of all samples is similar, some samples containt components in significant amounts that are absent in other samples. For instance, 1,8-cineole (**12**) is present only in the essential oilsamples from *Thymus stepposus* Klok. et Schost, *Thymus minussinensis* Serg, *Thymus mugodzharicus* Klok. et Schost., linalool is found in the essential oils of *Thymus Marschallianus* Willd, *Thymus roseus* Schipz., *Thymus crebrifolius* Klok., etc.

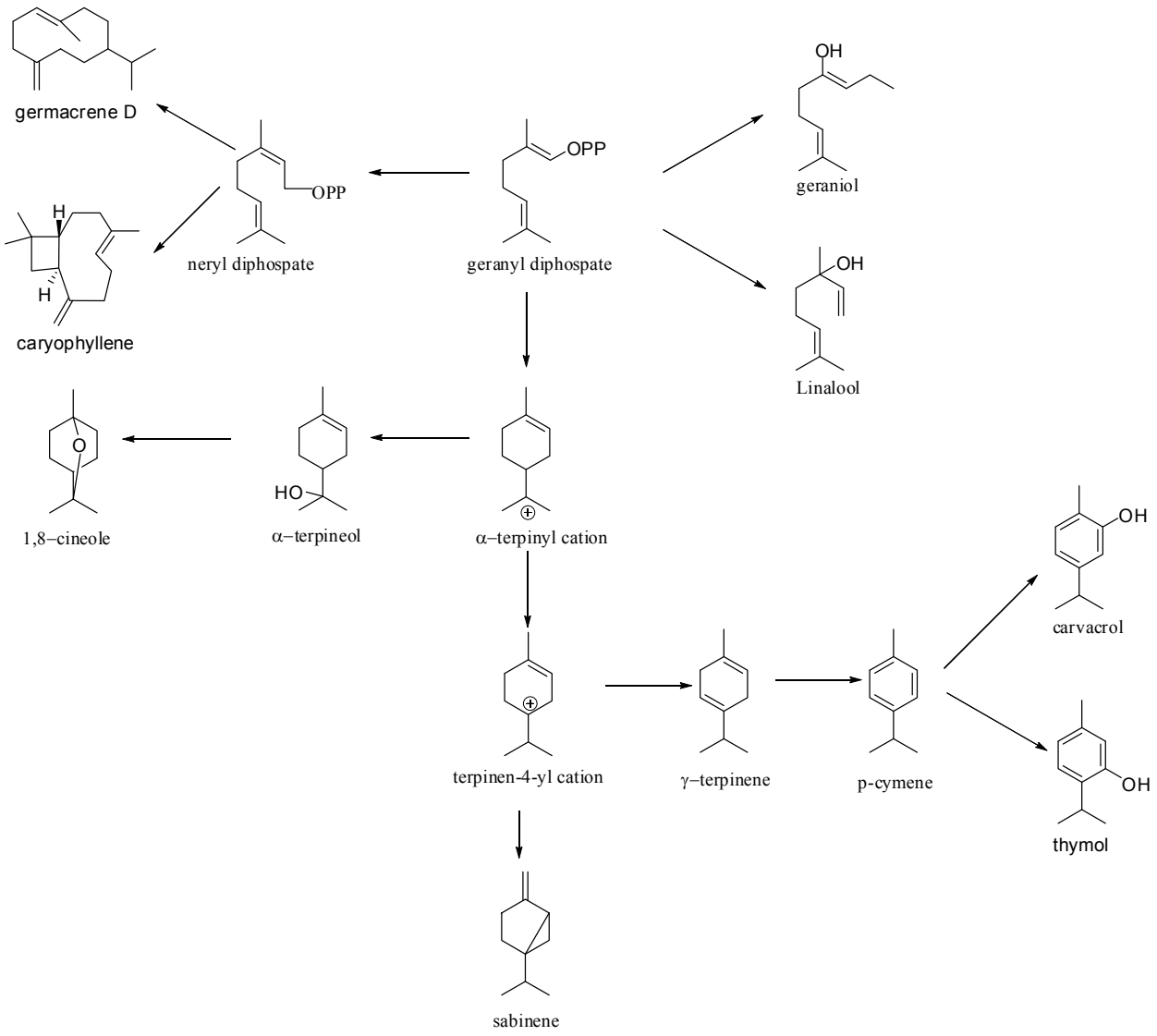



Figure 1 – The alleged scheme of biogenesis of the essential oils components in thymes

*Thymus Lavrenkoanus* Klok., *Thymus crebrifolius* Klok, *Thymus karatavicus* A. Dm. *Thymus rasitatus* Klok., and *Thymus petraeus* Serg. are the endemic species. *Thymus sibiricus* (Serg.) Klok.et Schost. is a plant that is difficult to identify by botanical features, as there are its hybrids with *Thymus Marschallianus* Willd. and other species. In the essential oil of *Thymus sibiricus* (Serg.) Klok. et Schost. monoterpenoids linalool (**1**) and geranyl acetate (**9**) have beendetermined. These monoterpenoids can be proposed as chemotaxonomic markers for *Thymus sibiricus* (Serg.) Klok. et Schost. The major component of essential oil from *Thymus Marschallianus* Willd., growing in different locations, is thymol (**4**), therefore, the species can be differentiatedby chemical composition of their essential oils, i.e. based on the chemotaxonomic markers.

Promising for isolation of new compounds are the essential oils of *Thymus crebrifolius* Klok., *Thymus Dmitrivae* Gamajun., *Thymus Lavrenkoanus* Klok., *Thymus petraeus* Serg., and *Thymus serpyllum* L. Based on the results of gas chromatography-mass spectrometry, in all thyme species were detected compounds witha functional hydroxyl group (borneol, terpineol-4, etc.) in their structure, molecules that have double bonds, and a system of conjugated bonds (thymol, cymene, etc.) in their structure which are responsible for the antioxidant activity. For the targeted search of new biologically active compounds, we have screened the essential oils extracted from *Thymus* species for analgesic, antioxidant, antimicrobial, antifungal, antiviral, and cytotoxic activities.

When screening samples of essential oils from plants of this species, it was revealed that they all exhibita weak and moderate antimicrobial activity against gram-positive and gram-negative strains [3,78]. The study of antimicrobial activity was carried out on the strains of gram-positive bacteria *Staphylococcus aureus, Bacillus subtilis*, gram-negative strain of *Escherichia coli*, and yeast fungus *Candida albicans* by the agar diffusion method (wells). Comparator drugsare Cefazolin for bacteria and Nystatin for yeast *Candida albicans*.

The results that we have obtained are in alignment with data on the antimicrobial activity of essential oil in the research of S.V. Kushnarenko [79], in which the intrinsic antimicrobial activity of the essential oil from *Thymus Marschallianus* Willd. is due to the high content of monoterpene phenols such as thymol and carvacrol. In theinvestigated sample of *Thymus Marschallianus* Willd., harvested in the Southern Altai, the content of thymol was 37.1%, carvacrol - 2.2% of the total essential oil mass.

We have studied the effect of essential oils on the larvae of marine crustaceans *Artemia salina* (Leach) under *in vitro*culture conditions to determine the cytotoxic activity potential. The cytotoxic activity range based on the median lethal dose$LD_{50}$, expressed in μg/ml, is as follows:all essential oilsamples subjectedto the research of cytotoxic activity revealedtheir activity against the larvae of marine crustaceans *Artemia salina*.

Essential oils of *Thymus petraeus* Serg, *Thymus rasitatus* Klok., *Thymus serpyllum* L. were screened for the analgesic activity. The investigated essential oils were studied at a dose of 50 mg/kg with intragastric injection. The comparator drug Metamizole sodium (Diclofenac) was tested at a dose of 50 mg/kg. The researched objects and the comparator were introduced 30 minutes prior to the injection of 0.75% solution of acetic acid. As a result of the study it was found that *Thymus rasitatus* Klok.E. sample has an analgesic effect, besides the changes are reliable compared to the control. The remaining samples did not reveal an analgesic activity.

The antioxidant properties of thymol, essential oils from *Thymus Marschallianus* Willd. and *Thymus petraeus* Serg. were evaluated by*in vitro* experiments on rat liver microsomes. The research results showed that all samples have pronounced antioxidant properties.

When comparing the antioxidant properties of the tested samples with the antioxidant effect of α-tocopherol, it was shown that thymol, essential oils of *Thymus Marschallianus* Willd. and *Thymus petraeus* Serg. have a more pronounced antioxidant activity which exceeds the action of vitamin E by almost 90% [4]. The conducted experiments show that all investigated objects had a dose-dependent antioxidant effect on the processes of peroxidation, with the highestantioxidant effect observed in thymol which inhibited LPO processes by 83% at a protein concentration of 2 μg/mg.

The screening of essential oils for the antiviral activity was carried out on the model of influenza virus (strain A/Almaty/8/98 (H3N2). In the research, a comparative study of the virus-inhibiting and virucidal activities of the investigated drugs with the commercial preparations Amizon and Geviran was made. It was shown that Amizon and Geviran cannot inhibit the replication of the virus A/Almaty/8/98 (H3N2) in a dose range up to 3.2 mg/kg. When studying the ability to suppress the infectious activity of the virus A/FPV/Rostock/34 (H7N1), it was found that essential oils from *Thymus rasitatus* Klok. And *Thymus petraeus* Serg. exceed the activity of commercial drugs Amizon and Geviran by over 1.0 lg [5].

The most interesting for further research and isolation of individual components with an antimicrobial effect are the essential oils from *Thymus vulgaris* L., *Thymus Dmitrivae* Gamajun., *Thymus sibiricus* (Serg.) Klok. et Schost., *Thymus crebrifolius* Klok., *Thymus roseus* Schipz.exhibiting the pronounced antibacterial action against gram-positive strains (*St. aureus, Ba. subtilis*). Whereas, samples of essential oils from *Thymus lavrenkoanus* Klok., *Thymus vulgaris* L., and *Thymus sibiricus* (Serg.) Klok. et Schost. showed a pronounced antibacterial activity against gram-negative bacteria (*E. coli*).

In addition, the essential oils from *Thymus vulgaris* L., *Thymus Dmitrivae* Gamajun., and *Thymus crebrifolius* Klok. have a pronounced cytotoxicity and are promising substances for these archof compoundswith potential antitumor activity. As a result of conducted research it was confirmed that a sample of essential oil from *Thymus rasitatus* Klok. has an analgesic effectwith thereliable changes as compared to the control.

**Conclusions.** The majoressential oilcomponents of the studied 14 species of*Thymus* L. are thymol (**4**), carvacrol (**10**), *p*-cymene (**5**), γ-terpinene (**7**), linalool (**1**), geraniol and its acetate (**9**), and other components that can be viewed as a renewable material for the synthesis of new compounds.

Thymol (**4**), carvacrol (**10**), *p*-cymene (**5**), and γ-terpinene (**7**) are the main ones in 12 studied essential oils. This fact evidences the interrelation of these components in the biosyntheticprocess. As is shown in Figure 2, γ-terpinene (**7**) is a precursor of *p*-cymene (**5**), and with further addition of the OH group, either thymol (**4**) or carvacrol (**10**) is formed depending on the position. The study of chemical composition of *Thymus* L. essential oils has also a theoretical value since it gives opportunity toinvestigate the biosynthesis of mono- and sesquiterpenoids in nature.

The obtained results significantly expand the knowledge of chemical composition and biological activity of the extracted essential oils from plants of the genus *Thymus* L.,updateinformation on the dynamics of mono- and sesquiterpenoids accumulation and show the dependence of their content on the growth conditions. Essential oils from the following species are considered prospective for isolation of new compounds: *Thymus crebrifolius* Klok., *Thymus Dmitrivae* Gamajun., *Thymus lavrenkoanus* Klok., *Thymus petraeus* Serg., and *Thymus serpyllum* L.

Thus, the essential oils from*Thymus* L. plants of the family *Lamiaceae*of the flora of Kazakhstan, which contain a complex of biologically active substances and exhibit a wide spectrum of pharmacological action, are undoubtedlyof interest for further study and creation of new effective drugs on their basis.

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## ЭФИРНЫЕ МАСЛА РАСТЕНИЙРОДА *THYMUS* L. ФЛОРЫ КАЗАХСТАНА: ХИМИЧЕСКИЙ СОСТАВ И ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ

**Аннотация.** Обобщены собственные данные по химическому составу эфирных масел 14 видов растений видов *Thymus* L. семейства *Lamiaceae Lindl*. флоры Казахстана. Проведен сравнительный анализ полученных автором результатов с опубликованными материалами по эфирным маслам видов *Thymus*. В статье обсуждаются пути биосинтеза основных компонентов в видах *Thymus* L, которые подтверждены результатами исследования автором компонентных составов эфирных масел. Приведены данные по скринингу эфирных масел тимьянов на биологическую активность.

**Ключевые слова:** тимьян, эфирные масла, моно- и сесквитерпеноиды, хромато-масс-спектрометрия, биосинтез.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.7**
Volume 5, Number 329 (2018), 58 – 62

UDC 612.014.49;591.1:574
GRNTI 34.39.53

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# ANALYSIS OF MORBIDITY OF ADOLESCENT POPULATION OF PRIARALIA

**Abstract.** Analysis of statistical data showed that in the period from 2006 to 2016, the number of respiratory diseases in children aged 15 to 17 living in the Kyzylorda region decreased to the minimum values for Kazakhstan. The number of adolescents with blood diseases, hemopoietin organs and immunity disorders has been doubled, many noted the presence of iron deficiency anemia, an increase in the number of digestive system diseases by 30%, the nervous system by 40%, eye diseases and its adnexa by 52 %, compared with the average republican indicators for the same period. At the same time, teenagers living in rural areas of Kyzylorda region registered 46% more cases of blood diseases and immune reactivity, 24.1% more children with iron deficiency anemia, 10% more children suffering from diseases of the nervous system and 52 % more adolescents with diseases of the digestive system, compared with adolescents living in urban conditions in the Aral Sea region. Only in terms of health of the eyes and its appendages, the number of rural adolescents was 30% less than the number of urban children with impaired and disturbed visual function.

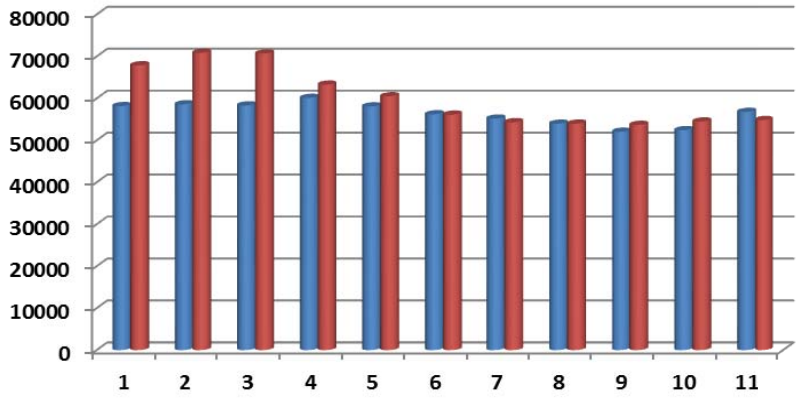
**Key words:** Priaralye, teenagers, health, disease.

**Introduction.** Because of the intensive development of irrigation since 1960 in Kazakhstan and Central Asia, the run off to the lower reaches of the Syrdarya and Amudarya rivers has been steadily decreasing. As a result, there was a steady decline in the level of the Aral Sea, which led to the desertification of river deltas, the deterioration of the state of ecosystems. The active processes of soil salinity due to increased groundwater mineralization and salt-dust removals from the exposed bottom of the Aral Sea, the drop in groundwater levels outside irrigation systems and the absence of horizontal water exchange led to the development of aridization and desertification processes in this region [1].

The change in hydrological conditions caused a sharp decline in soil fertility and degradation of vegetation. Lowering the level of groundwater has led to deterioration in the water supply of the surrounding regions. Environmental problems caused global and regional climate changes, due to the intensification of the greenhouse effect, an increase in the concentration of carbon dioxide in the atmosphere, salt-dust removals and disturbed human living conditions in the Aral Sea area [2].

**Analysis of the incidence of adolescent population in Kyzylorda region.** In connection with the developing ecological disadvantage of the region, there was a significant increase in the overall morbidity of the Aral Sea area population, exceeding the average republican indicators. The 2002 year in Kyzylorda region the total morbidity was 71538 cases per 100 thousand of population with the average republican value of this indicator 57518, which is almost 25% of the increase. In the period 2006-2007 the total morbidity of Kyzylorda region residents was 18-20% higher than the average republican indicators, in 2008-2010, this indicator was higher by 10%, in the period from 2011 to the present, the data on the general incidence of the population of the Aral Sea area show the average republican level (figure 1).

In the period 2006-2007, the incidence rate of the adolescent population (79210.5) in Kyzylorda region corresponded to the average republican level (77,403.5) with insignificant fluctuations in the direction of growth. In the structure of morbidity, the leading position of respiratory diseases (15595.7),

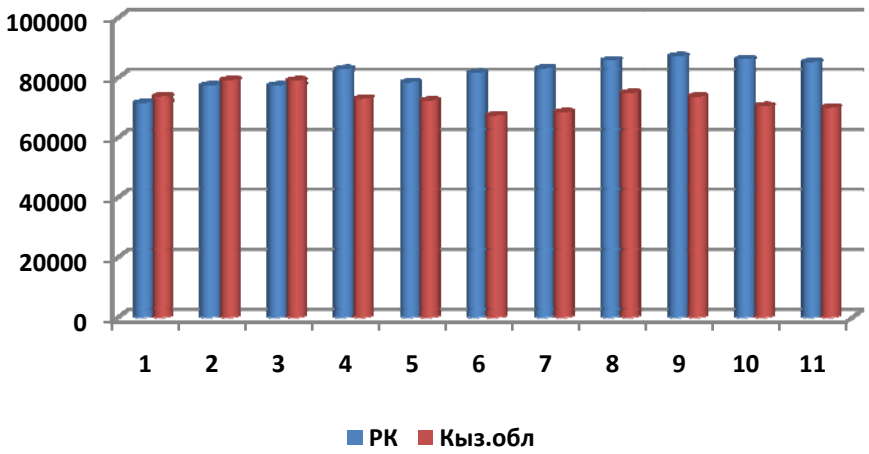



Where 1-11 is the period from 2006 to 2016 (blue - Republic of Kazakhstan, red- Kyzylorda region)

Figure 1 – The dynamics of the overall incidence of the population of the Republic of Kazakhstan and Kyzylorda region for the period 2006-2016 (per 100 thousand populations)

diseases of the digestive organs (22581 cases per 100 000 people of this population) was revealed, which is 3.3 times higher than the average republican indicator (6773.9). The high incidence rate of adolescent population with blood diseases, hematopoietic organs and immunity (8691.4) with iron deficiency anemia (8677.0) is shown. There was a tendency to an increase in diseases of the urinary system (6354.1), diseases of the eye and its appendages (4870.8), the ear and mastoid process (3696.2), diseases of the nervous system (2662.7) [3].

Analysis of statistical data for the period 2015-2016 on the incidence of adolescents from 15 to 17 years of Kyzylorda region showed that the total incidence is 69962.3 cases per 100 thousand of the corresponding population, which is 18% less than the average republican indicator (85228.8 in the Republic of Kazakhstan) and by 11.6% less than in 2006-2007 (figure 2).




Where 1-11 is the period from 2006 to 2016 (blue - Republic of Kazakhstan, red- Kyzylorda region)

Figure 2 – The indicators of the overall incidence of adolescents in the Kyzylorda region in comparison with the average republican data for the period 2006-2016. (per 100 thousand population)

In the structure of diseases in the region, the teenage population retained leading positions in the incidence of respiratory diseases (19426,1), which is 24.5% more than in 2006-2007, digestive apparatus diseases (9240.6), 32% the average republican indicator for 2016 (6997.4) and 59% less than in 2006-2007. It was found out that 45% more sick teenagers in rural areas (10509.4 cases) than in the city (7218.0). It was also found out that the number of adolescents with eye diseases and its appendages (8205.8) increased by 52% in the region, as compared to the data for the same indicator for the Republic of Kazakhstan [4].

Statistics show that over the past 10 years, the teenage part of the population of Kyzylorda region has decreased by 8% the incidence of blood diseases, hematopoietic organs and immunity (7976.8), iron deficiency anemia (6898.6), compared with the corresponding data for 2006-2007. However, in relation to the average republican indices of 2015-2016, the incidence of children with blood diseases in the region was 2 times higher than in the Republic of Kazakhstan. High indicators were also revealed in the incidence of diseases of the nervous system in adolescents (3263.8), which is 9% higher than the national indicator (2989.1) and 22.5% higher than the corresponding indicator in the period 2006-2007, while the incidence rural schoolchildren was 10% more than urban. The incidence of congenital anomalies (malformations), deformities and chromosomal abnormalities in the period 2015-2016 in the teenage population of the region (144.9) was significantly lower than the average republican values (325.2) [3-9].

Thus, a comparative analysis of the incidence of children aged 15 to 17 years living in the Kyzylorda region for the period 2006-2016 a high incidence of children with blood diseases, hematopoietic organs and immunity disorders, iron deficiency anemia, the number of which exceeded the average republican indicators by 2 times. So, if in the RK the number of such diseases was 3792.2 cases, respectively, for 100 thousand adolescents, in children from 15 to 17 years old living in Kyzylorda region, suffering from anemia and blood and immune system diseases is 7976.8 cases, that 2 times more than the average republican indicators. At the same time, an increase in the number of children with blood diseases and immune reactivity living in rural areas by 46% was found, with signs of iron deficiency anemia by 24.1%, compared with the data of the RK [3-9].

An increase in respiratory diseases by 28-30% has been revealed in the region, in comparison with the data of 2006-2007. Nevertheless, when compared with the average republican data, over the past 10 years, the number of respiratory diseases in both the adult population and schoolchildren aged 15 to 17 living in the Kyzylorda region was consistently 40-50% lower than in other regions of Kazakhstan. So, in 2016, the incidence in the region was 19426.1 diseases per 100,000 adolescents against 39679.6 respiratory diseases, on average in the country.

A 30% increase in diseases of the digestive system in children aged 15-17 is shown, compared with the average republican values, which leads Kyzylorda region to the third place in Kazakhstan, after the Almaty and Pavlodar regions. At the same time, according to the data of 2015-2016, the number of diseases of the digestive system and those living in rural areas exceeded by 52% the number of urban teenagers with similar problems.

In addition, the analysis of statistics 2015-2016 shows that the diseases of the nervous system in adolescents of the Aral Sea area have a pronounced tendency to increase and constitute 4635.1 diseases per 100 thousand people, which shows the third place in Kazakhstan, after Pavlodar and Almaty region and 40% more than the average republican indicators. At the same time, the number of children living in rural areas and suffering from diseases of the nervous system is 10% higher than in urban areas (village 3377.4 and city 3082.7).

Particularly significant growth was found in the incidence of eye and adnexa in adolescents in the Kyzylorda region, whose rates exceed the average republican data by 52%, which is 8205.8 per 100,000 of the population against 5395.1 average republican values. It is noted that the incidence of diseases of the eye and its appendages in adolescents aged 15 to 17 living in rural areas of Kyzylorda region is 30% (7028.3) less than the incidence of urban children with a similar visual function disorder (10082.7 diseases per 100 thousand people of the corresponding population). It should be noted that for this disease the region also ranks third in the Republic after the Aktobe and Pavlodar regions [3-9].

Analysis of the morbidity of the growing population of the Aral Sea region living in an ecologically crisis region over the past 10 years has made it possible to identify the leading groups of diseases that.

**Conclusion.**

1. Comparative analysis of statistical data on the incidence of adolescent population in the Kyzylorda region for the period from 2006 to 2016 showed an increase in the incidence of respiratory diseases, diseases of the nervous system, eye diseases and its adnexa.

2. Over the past 10 years, the incidence rate of blood diseases, hematopoietic organs and immunity disorders, iron deficiency anemia, digestive organs in the adolescent part of the region's population has decreased, compared to 2006-2007.

3. Incidence of children aged 15 to 17 years living in rural areas of Kyzylorda region, respiratory diseases, blood diseases and immune reactivity is higher than in the city.

4. Comparative analysis of statistical data of Kyzylorda region with average republican data on the incidence of children from 15 to 17 years showed that in 2015-2016, in the region the number of adolescents with eye diseases and its appendages has significantly increased, leading positions on the incidence of blood diseases, blood-forming organs and immunity disorders, and diseases of the nervous system have been preserved.

*The work was carried out within the framework of the science project: "Physiological and genetic assessment of adaptive reserves and general resistance of the organism in children of school age living in different regions of Kazakhstan."*

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## АРАЛ МАҢЫНДАҒЫ ЖАСӨСПІРІМДЕРДІҢ АУРУЛАРЫ ЖАЙЛЫ САРАПТАМА

**Аннотация.** Статистикалық мәліметтер бойынша, 2006-2016 жылдар аралығында Қызылорда облысында 15-17 жас аралығындағы балалардың тынысалу жүйесі ауруларының кездесуі Қазақстан бойынша алғанда минимальді көрсеткішке дейін төмендеген. Жасөспірімдердің қан және иммунитеттің бұзылуы аурулары саны 2 есе ұлғайғаны анықталды. Олардың көпшілігінде осы жылдары аралығында Республика бойынша орта көрсеткішпен салыстырғанда теміртапшылығы анемиясы, асқорыту жолдары ауруларының 30%, жүйке жүйесі - 40%, көру жүйесі мен көз аурулары - 52% арытықандығы анықталды. Сонымен бірге, Қызылорда облысының ауылдық аймақтарында тұратын жасөспірімдердің қалада тұратын жасөспірімдермен салыстырғанда 46% қан аурулары мен иммундық ауруларының белең алғандығы, балалардың 24,1% теміртапшылығы анемиясы, 10% жүйке жүйесі аурулары және 52% асқорыту жолдарының жиі кездесетіндігі анықталды. Тек көру жүйесі мен көз аурулары бойынша ауылдық жерде тұратын жасөспірімдер қалалық жеткіншектерге қарағанда 30 30% төмен екендігі анықталды.

**Түйін сөздер:** Арал, жасөспірімдер, денсаулық, аурулар.

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## АНАЛИЗ ЗАБОЛЕВАЕМОСТИ ПОДРОСТКОВОГО НАСЕЛЕНИЯ ПРИАРАЛЬЯ

**Аннотация.** Анализ статистических данных показал, что в период с 2006 по 2016 годы количество заболеваний органов дыхания у детей от 15 до 17 лет, проживающих в Кызылординской области, снизилось до минимальных значений по Казахстану. Выявлено увеличение в 2 раза числа подростков с болезнями крови, кроветворных органов и нарушений иммунитета, у многих отмечено наличие железодефицитной анемии, рост числа заболеваний пищеварительной системы - на 30%, нервной системы - на 40%, заболеваний глаз и его придаточного аппарата - на 52%, по сравнению со среднереспубликанскими показателями за аналогичный период. При этом, у подростков, проживающих в сельской местности Кызылординской области, зарегистрировано на 46% больше числа заболеваний крови и иммунной реактивности, на 24,1% больше оказалось детей с железодефицитной анемией, на 10% больше детей, страдающих болезнями нервной системы и на 52% больше подростков, заболевших болезнями пищеварительной системы, по сравнению с подростками, проживающими в городских условиях Приаралья. Только по показателям здоровья глаз и его придатков число сельских подростков оказалось на 30% меньше числа городских детей с нарушениями и расстройством зрительной функции.

**Ключевые слова:** Приаралье, подростки, здоровье, заболевание.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.8**
Volume 5, Number 329 (2018), 63 – 66

UDC 543.632.9

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# BIOLOGICALLY ACTIVE SUBSTANCES FROM PLANT *SUDAEDA VERA* AND THEIR ANESTIZING ACTIVITY

**Abstract.** The article presents the results of a complex study of the chemical compositions of conditional phytopreparations obtained from the aerial part of the *Suaeda Vera* family of the *Chenopodiaceae* collected during the flowering period in the Ili region of the Almaty region of the Republic of Kazakhstan.

The structures of the compounds characteristic for the given plant and providing some aspects of their therapeutic activity. Examined and proven, in particular high-performance liquid chromatography from an alcohol extract obtained from the aerial part of *Suaeda Vera*, apigenin and rutin, flavanoids characteristic of plants of the family *Chenopodiaceae* and having proven anti-inflammatory, antioxidant and immunostimulating activity, are also found amino acids, tannins, carbohydrates, phenols, alkaloids, saponins, triterpenoids typical for plants common in arid zones.

The drug in question showed significant analgesic activity in an in vivo test on laboratory animals, while the diclofenac sodium, well known in medical practice, served as a comparative drug.

The work on the study of the plant continues.

**Key words:** *Chenopodiaceae, Suaeda Vera*, standardization, phytopreparation, content of BAS, activity.

**Introduction.** The purpose of this work is to identify biologically active substances from certain plants growing in arid zones of Kazakhstan and to study the activity of a conventional phytopreparative obtained from this plant.

One of the research tasks was the study of the phytochemical compositions of the conditional phytopreparations obtained from the above-ground part of *Suaeda Vera* [1-7]. The choice of objects is related to:

- The wide distribution of representatives of the genus *Suaeda* on the territory of the Republic of Kazakhstan, which determines their industrial reserves;
- Unpretentiousness, endurance, easy adaptation to the environment;
- The expediency of harvesting the aerial part of plants, since it takes about a year for vegetative restoration, whereas in the case of harvesting roots - two years;
- The optimality of the methods of obtaining conditional phytopreparations in the form of dry residues, cost-effectiveness and environmental safety of the technology.

Thus, *Suaeda Vera*, indeed is a promising plant, to create domestic phytopreparations, obtained from plant raw materials, growing in the arid zone of Kazakhstan.

In this paper, we studied some hydrolysable phenolic compounds contained in 85% ethanol extract isolated from the aerial portion of the *Suaeda Vera* plant of the *Chenopodiaceae* family.

From the plant under investigation, a conditioned phytopreparation was obtained.The indicators of good quality of the conditional phytopreparation: humidity, total ash, 10% insoluble ash in hydrochloric acid and sulfate ash, are determined in accordance with the methods described in the State Pharmacopoeia of the 1st edition of [8].

From the plant under investigation, a conditioned phytopreparation was obtained. During the extraction, the plant material studied showed a high level of extraction.

An important indicator of the good quality of raw materials is the mineral composition, which contains the following elements: K. Na, Mg, Ca, Fe, C, Si, P less often and in a smaller amount of Cu, Mn, Al, etc. [9-14].

**Methods.** At the initial stage, we obtained an 85% water-alcohol extract from the aerial part of the *Suaeda Vera* plant, according to the following procedure:

The air-dried raw material was subjected to extraction by infusion with 85% aqueous ethanol at room temperature for 3 days. Extraction is repeated twice. The combined extract is concentrated on a rotary evaporator until ethanol is completely removed.

Methods of two-dimensional and one-dimensional paper chromatography using specific developers as well as by TLC in various solvent systems found that 85% hydroalcoholic extract of the major groups of biologically active substances aboveground mass of the test plants are substances of phenolic character which previously attributed to oxidized forms of flavonoids (aglycone - quercetin, izoramnentinu, hrizo-eriolu, flavonolovym glycosides), carbohydrates (fructose, galactose, glucose, xylose, rhamnose), phenols (pirokate in, pyrogallol, resorcinol, hydroquinone), carotenoids, phenolic, amino and fatty acids [15-26].

Further, by high-performance liquid chromatography with an ultraviolet detector at a wavelength of 254 nm in a methanol / 5% acetic acid solvent system in a ratio of 40:60 with a Zorax CB C-18 column 150 * 4.6 mm at a flow rate of 0.5 ml/min. The weight of the sample 0.001 g in 5 ml of the solvent from the phytopreparation was isolated a number of substances, after comparison with the obtained data with standard samples; we managed to identify apigenin and rutin.

In our work, the analgesic activity of the 85% *Suaeda Vera* extract was determined on the scientific and technological basis of JSC "International Research and Production Holding Fhitochemistry "in a chemical peritoneal stimulus test on white mongrel mice. By the following method. A 0.75% solution of acetic acid was administered intraperitoneally in an amount of 0.1 ml per 10 g of animal weight. 30 minutes prior to the administration of acetic acid, the subjects under study were intragastrically administered at a dose of 5 mg/kg. Immediately after the introduction of the stimulus, the cortex was counted for 30 minutes.

The analgesic effect of the sample was determined by the ability to reduce the number of "cramps" during 10, 15, 20 and 30 minutes, compared with the corresponding values in the control group [30]. Comparison drug "Diclofenac sodium", which was tested at a dose of 8 mg/kg.

**Results and discussion.** *Suaeda Vera* found: flavonoids, amino acids, tannins, carbohydrates, phenols, saponins, triterpenoids.

Using high-performance liquid chromatography with a spectrometric detector using standard samples in 85% extract obtained from the aerial part of the *Suaeda Vera* plant, we identified, identified, and quantitated routines and apigenin belonging to the flavonoid class. The data are presented in table 1.

Table 1 – Flavonoids identified in the aerial part of *Suaeda Vera* using standard samples

| Number of compound | Name of compound | Molecular formula | Retention time, min | Qantity, % |
|---|---|---|---|---|
| 1 | Apigenin | $C_{15}H_{10}O_5$ | 11,294 | 0,21 |
| 2 | Routine | $C_{27}H_{30}O_{16}$ | 9,303 | 0,03 |

Table 2 – Results of the determination of the anesthetic activity of the extract from the aerial part of *Suaeda Vera*

| Name of sample, dose | | Reducing the number of "vinegar cramps" and the difference from those shown in the control | | | |
|---|---|---|---|---|---|
| | | 10 min | 15 min | 20 min | 30 min |
| Control | – | 28±8,1 | 50,5±4,7 | 64,8±7,5 | 91,0±12,4 |
| Diclofenac sodium | 8 mg/kg | 23,5±5,6 | 41,3±5,0 | 56,3±5,2 | 65,3±7,9 |
| *Suaeda vera* | 5 mg/kg | 29±8,6 | 43,0±10,8 | 55,8±10,3 | 71,3±16,0 |

In addition, by in vivo method in laboratory mice, we determined the biological activity of 85% alcohol extract from the aerial part of *Suaeda Vera*, as a result, it was revealed that the extract of the plant under study has some anesthetic effect. Data on anesthetic action are presented in table 2.

In general, comparable in the level of exposure to sodium diclofenac, with a comparable effect achieved with a lower dose of the drug administered, 5 mg/kg of *Suaeda Vera* extract against 8 mg/kg of diclofenac sodium.

**Conclusion.** As a result of the study of the chemical composition and biological activity of 85% of the extract obtained from the above-ground portion of the *Suaeda Vera* plant of the *Chenopodiaceae* family, we found that the investigated object contains minor flavanoids: rutin and apigenin, plant BAS classes such as phenolic acids, amino acids, free organic acids, polysaccharides, carbohydrates, phenols and carotenoids. Anesthetic activity of 85% alcohol extract was determined and it is proved that it is comparable in effectiveness with the drug Diclofenac sodium.

The work on further study of the chemical composition and biological activity of the plant to study the plant Suaeda Vera continues.

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## *SUAEDA VERA* ӨСІМДІГІНІҢ БИОЛОГИЯЛЫҚ БЕЛСЕНДІ ЗАТТАРЫ ЖӘНЕ ОНЫҢ АУРУДЫ БАСУ ҚАБІЛЕТТІЛІГІ

**Аннотация.** Мақалада Қазақстан Республикасы, Алматы облысы, Іле ауданынан гүлдеу кезінде жиналған *Chenopodiaceae* тұқымдасы, *Suaeda Vera* өсімдігінің жер беті бөлігінен алынған шартты фитопрепараттың химиялық құрамының кешенді зерттеу нәтижелері жүргізілген.

Зерттелетін өсімдікке тән заттар қарастырылып, терапевтік белсенділік көрсететін қосылыстардың құрлысы келтірілген. Жоғарғы сұйықты хроматография әдісінің көмегімен *Suaeda Vera* өсімдігінің жертүсті бөлігінен алынған спирттік экстрактіден апигенин және рутин анықталған, бұл заттар *Chenopodiaceae* тұқымдасына тән болып есептеледі, сонымен қатар өсімдікте аминқышқылдар, көмірсулар, фенолдар, тритерпендер, сапониндер, алкалоидтар және тері илегіш заттар анықталған, олар қабынуға, тотығу үрдісіне және иммунстимулдеуші қасиет көрсетеді.

Алынған препарат зертханалық жағдайда *in vivo mecm* кезінде ауруды басушы белсенділік көрсеткен, салыстырмалы препарат есебінде медициналық практикада белгілі натрий дихлофенагі алынған.

Өсімдікті зерттеу жұмысы жалғасуда.

**Түйін сөздер:** Алабұта тұқымдас (*Chenopodiaceae*) өсімдік: *Suaeda Vera,* стандарттау, фитопрепарат, ББЗ құрамы, белсенділік.

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## БИОЛОГИЧЕСКИ АКТИВНЫЕ ВЕЩЕСТВА ИЗ РАСТЕНИЯ РОДА *SUAEDA VERA* И ИХ АНЕСТИЗИРУЮЩАЯ АКТИВНОСТЬ

**Аннотация.** В статье представлены результаты комплексного исследования химических составов условных фитопрепаратов, полученного из надземных частей *Suaeda Vera* семейства *Chenopodiaceae*, собранные в период цветения в Илийском районе Алматинской области Республики Казахстан.

Рассмотрены и доказаны структуры соединений характерных для данных растении и обеспечивающих некоторые аспекты их терапевтической активности, в частности методом высокоэффективной жидкостной хроматографии из спиртового экстракта полученного из надземной части *Suaeda Vera* выделены апигенин и рутин являющиеся флаваноидами характерными для растений семейства *Chenopodiaceae* и имеющие доказанную противовоспалительную, антиоксидантную и иммуностимулирующую активность также обнаружены аминокислоты, дубильные вещества, алкалоиды, углеводы, фенолы, сапонины, тритерпеноиды.

Рассматриваемый препарат показал значительную анальгетическую активность при тесте *in vivo* на лабораторных животных, препаратом сравнения при этом выступал хорошо известный в медицинской практике диклофенак натрия.

Работа по исследованию растения продолжается.

**Ключевые слова:** растения семейства Маревые (*Chenopodiaceae*): *Suaeda Vera,* стандартизация, фитопрепарат, содержание БАВ, активность.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.9**
Volume 5, Number 329 (2018), 67 – 70

UDC 347.998.74

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# NEW TRENDS OF MEDICAL MEDIA IN TRAINING AND PRACTICE

**Abstract.** According to the authors, the solution of emerging conflicts in the field of medicine can be solved with the help of mediators. Mediation is used to resolve problems and disagreements in the sphere of labor relations, professional disputes, problems in the construction industry, education and health care, conflicts in the domestic sphere. Public and private organizations and companies are adopting mediation to resolve internal and external conflicts in their daily activities. Courts of law and legal advice consider mediation as an opportunity to resolve contradictions arising from the treatment. Consequently, professionals in various fields increasingly have to act as initiators of mediation on voluntary terms.

**Keywords:** mediation, medicine, conflicts, negotiations, procedure, dispute, decision.

**Introduction.** Mediation is a special technology for resolving a conflict through negotiations with the participation of a specially trained mediator-mediator. Mediation is widespread in world practice. In Europe and the US, the use of mediation in settling a wide variety of conflicts has long been considered very effective and at the same time low-cost.

In mediation, one of the fundamental principles is voluntariness of participation and equality for parties actively involved in the dispute resolution process. They are and remain the "owners" of the conflict. "Empowering" the development and decision-making, the parties themselves, the mediator promotes them in the joint search for a viable, mutually satisfying solution. "Empowerment" by the parties is one of the key features and at the same time the advantages of mediation as a modern method of dispute settlement, which contributes to its relevance. The dissemination of mediation, its integration into the legal culture is one of the manifestations of sensitive reaction of legal practice to the demands of the modern world. At the same time, professional lawyers are responsible for informing and educating citizens about the possibilities of using ARS and mediation in particular. Challenges of the time in relation to the legal profession require the redefinition of the role of all its representatives, and thus the redefinition of the existing traditional dispute settlement system to some extent. Depending on the legal profession, the role, capabilities, approaches and tools for this mission can and should be different.

The meaning of complexity arises from the principle of the integrity of the educational process and is being implemented at the various levels.

**Main part.** On the one hand it is the unity of professional and vocational training for employment; the unity of the classroom and extracurricular work on the subject, the unity of the individual and collective work of students, their self-cognitive activity and work under the guidance of a teacher.

Advantage of mediation:

- Resolution of the conflict without trial on a voluntary and equal basis by the parties themselves, saving time, money, emotional forces and energy.
- The conflict is strictly confidential.
- The decision is made only by the parties themselves, taking into account the satisfaction of the interests of each party to the dispute.

In civilized countries, a method of settling conflicts or disputes through a mediator, that is, an independent mediator, whose assistance consists in the search for alternative conditions in the resolution of the conflict by the parties themselves has long been used. The practice of mediation shows that most of the disputes do not reach the court or end in court thanks to the help of professional mediators.

According to the Law of the Republic of Kazakhstan "On Mediation", the mediation procedure has the right to conduct a mediator, i.e. an independent natural person involved by the parties to conduct mediation on a professional and unprofessional basis in accordance with the requirements of the Law (Article 9). [Thus, the existing mechanism, on the one hand, does not presuppose the necessary conciliation procedures for the parties to the dispute on the other hand, does not contain genuine guarantees that the mediation will be properly conducted.

An alternative to this concept could be additions based on the positive experience of implementing the associated model in some foreign countries.

In the framework of experiments on working out mechanisms of interaction between courts and mediators, reconciliation rooms were organized directly in the courts, where practicing mediators could advise the parties on the possibility of conciliation proceedings on their dispute and invite them to use the services of a specific organization or professional mediator. As a rule, such counseling was conducted by mediators on a free basis and only at the first stages of the project implementation, since it does not directly relate to the activity of the mediator, is time-consuming and conducted on a gratuitous basis.

At later stages of the projects, as a rule, the parties explained their right to mediation to judges, many of whom received appropriate training. The experiments showed a positive dynamics in the growth of the number of consultations and ongoing mediation procedures, which required the preparation of additional professional mediators and their involvement in ongoing projects. The increase in the number of mediation procedures conducted has also proved the viability of the chosen model. However, if a large number of courts, professional mediators and organizations responsible for the procedure are involved in judicial mediation practice, there will be a need for more coordinated coordination and direction of the parties to the dispute for mediation. Here, one can combine the first experience of "reconciliation rooms" with the institution of "judicial coordinators", known to some foreign countries.

Establishment of judicial coordinators in courts would significantly improve the effectiveness of implementing the associated model of forensic mediation. On the one hand, they would assume the responsibility for advising the parties on the possibility of using mediation, would be engaged in providing the parties to the dispute with the necessary information about mediation and mediators active in the settlement on the court site.

On the other hand, they can become a contact person for private mediators and organizations, interact with the regional offices of SRO mediators, maintain judicial registers of mediators, monitor and collect statistics related to mediation.

The creation of the post of judicial coordinator would have made it possible to spare judges the need to explain to the parties the advantages and bases of mediation, to assess the suitability of the dispute for mediation settlement (mediabelnost).

The parties to the dispute would have the opportunity to obtain all the necessary information related to the conciliatory procedure that are in effect at the trial by professional mediators, organizations responsible for quality control of procedure and attracting mediators to disciplinary responsibility. The judicial coordinator could become a key figure for the development of judicial mediation on the associated model.

As judicial coordinators, persons who have completed training under the state program of training professional mediators and who have a higher legal education could act. This will allow the judicial coordinator not only to understand the intricacies of the legal relations existing between the parties, but also be able to analyze the conflict and give a full consultation on the procedure for mediation and its possibilities. At the same time, the judicial coordinators themselves should not engage in the conduct of the mediation procedure. They only coordinate the procedure for referring the parties to mediation and their return to court with the corresponding result. They are also a contact person in court for the parties and the mediator on all issues related to the procedure of mediation in a judicial dispute.

Inclusion of a mediator in the court register does not mean acceptance of the court for his activities, but relieves the judges from the need to verify the availability of the mediator's documents on the

completion of training under the state program for training professional mediators and fulfilling other statutory requirements.

The verification of these data will be carried out once by the judicial coordinator when the data on the judicial mediator is included in the court register, which will greatly simplify the work of the courts and their interaction with the judicial mediators. Even if the idea of creating a position of judicial coordinators is not supported by the judicial community, the creation of judicial registers of mediators united in the federal register of judicial mediators will allow judges to direct the parties to more specific and systematized information sources and, accordingly, will simplify the procedure for sending parties to mediation.

In addition, you can also provide for a certain amount of government fees for including data on the mediator in the register of forensic mediators. The funds received in this way can be used to pay for the work of judicial coordinators. The inclusion of data on the mediator in the register of a certain court should occur only if the mediator exercises his practice at the location of the court.

It is necessary to clarify the rules concerning the timing of independent mediation. As is known, in case of extrajudicial mediation, an agreement on mediation concluded by the parties long before the appearance of disputable legal relations has wide application. However, in view of the requirements of §§ 1, 2, Art. 23 of the Law with mediation outside the civil process, the conclusion of a mediation agreement before the dispute arises becomes simply meaningless.

**Conclusion.** It is necessary to clarify the provisions of the Law regarding the timing of mediation. For extrajudicial and judicial mediation in the sphere of civil, labor, family and other legal relations, par. 1, 2, Art. 23 of the current Law, as a general rule, a period of 30 calendar days from the date of concluding a mediation agreement is established (in cases of necessity, by mutual decision of the parties or the court, the period for mediation may be extended to 30, but not more than 60 calendar days in aggregate). Mediation during criminal proceedings must be completed within the terms of pre-trial and judicial proceedings established by the criminal procedure law.

As is known, with mediation conducted by arbitration courts, as well as extrajudicial mediation in general, an agreement on conducting mediation, concluded by the parties long before the appearance of disputable legal relations, has wide application. However, in view of the requirements of §§ 1, 2, Art. 23 of the Law with mediation outside the civil process, the conclusion of a mediation agreement before the dispute arises becomes simply meaningless. In this regard, it is necessary to legislatively allow for the out-of-court mediation the possibility of concluding a mediation agreement before the emergence of disputable legal relations.

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## НОВЫЕ ТЕНДЕНЦИИ МЕДИЦИНСКОЙ МЕДИАЦИИ В ОБУЧЕНИИ И НА ПРАКТИКЕ

**Аннотация.** По мнению авторров решение возникающих конфликтов в области медицины, можно решить при помощи медиаторов. Медиация применяется для разрешения проблем и разногласий в сфере трудовых отношений, профессиональных споров, проблем в строительной отрасли, сфере образования и здравоохранения, конфликтов в бытовой сфере. Государственные и частные организации и компании берут на вооружение медиацию для урегулирования внутренних и внешних конфликтов в своей повседневной деятельности. Судебные инстанции и юридические консультации рассматривают медиацию, как возможность разрешения противоречий возникающие в результате лечения. Следовательно, профессионалам в различных областях все чаще приходится выступать в роли инициаторов медиации на добровольных условиях.

**Ключевые слова:** медиация, медицина, конфликты, переговоры, процедура, спор, решение.

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## ОҚЫТУ ЖӘНЕ ПРАКТИКАДАҒЫ МЕДИЦИНАЛЫҚ БАҚ-ТАРДЫҢ ЖАҢА БАҒЫТТАРЫ

**Аннотация.** Авторлардың пікірінше, медицина саласындағы пайда болған қақтығыстарды шешу медиаторлардың көмегімен шешілуі мүмкін. Медиация еңбек қатынастары, кәсіптік даулар, құрылыс индустриясының проблемалары, білім беру және денсаулық сақтау салаларындағы проблемалар мен келіспеушіліктерді, отандық саладағы қақтығыстарды шешу үшін қолданылады. Мемлекеттік және жекеменшік ұйымдар мен компаниялар күнделікті қызметінде ішкі және сыртқы қақтығыстарды шешу үшін медиацияны қабылдайды. Құқық және құқықтық кеңес соттары медиацияны емдеуден туындайтын қарама-қайшылықтарды шешуге мүмкіндік ретінде қарастырады. Демек, түрлі салалардағы мамандар ерікті түрде медиацияның бастамашысы ретінде әрекет етуі керек.

**Түйін сөздер:** медиация, медицина, қақтығыстар, келіссөздер, рәсім, дау, шешім.

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**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308 **https://doi.org/10.32014/2018.2518-1629.10**
Volume 5, Number 329 (2018), 71 – 77

UDC 579.23

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# THE STRUCTURE OF THE MICROBIAL CENOSIS OF PHYLLOSPHERE OF FRUIT CROPS AFFECTED BY FIRE BLIGHT IN SOUTHERN KAZAKHSTAN

**Abstract.** The structure and diversity of microbial cenosis of the apple and pear phyllosphere in the zones of industrial horticulture of Kazakhstan, where fruit trees were affected by fire blight, was studied. The study was carried out in Zhambyl, South Kazakhstan and Almaty regions. 47 samples (shoots, leaves, fruits) from the phyllosphere of healthy and infected organs of fruit trees were collected. In total 216 microbial isolates were selected. Taxonomic identification of microbial species based on cultural and morphological traits was carried out. The isolates were grouped into the following genera: bacteria (142 isolates): *Erwinia, Pseudomonas, Bacillus, Lactobacillus, Paenibacillus;* fungi (37 isolates): *Monilia, Venturium, Aspergillus, Podosphaera, Penicillium, Fusarium, Trihothecium, Mucor, Verticillium, Alternaria*; yeast and yeast-like microorganisms (37 isolates): *Cryptococcus, Rhodotorula, Pullularia, Saccharomyces*. Bacteria have been found to predominate in the microbiocenosis. In all samples infected with fire blight, bacteria of the genera *Erwinia* and *Pseudomonas* were detected.

Screening of potential bacterial antagonists to *E. amylovora* showed that some of the *Bacillus, Pseudomonas* and *Paenibacillus* species have demonstrated inhibitory effect. The diameter of inhibition zones have been ranged from 9 mm to 48 mm. *Bacillus amyloliquefaciens* demonstrated maximal antagonistic activity (48 mm).

**Keywords:** microbial cenosis, *Erwinia amylovora*, fire blight, bacteria-antagonists, biocontrol.

**Introduction.** Fire blight is one of the most harmful diseases caused by gram-negative bacteria *Erwinia amylovora,* affecting several species of the *Rosaceae* family. This disease is found in most of the world's regions and can cause significant losses in important fruit crops, such as apple and pear [1]. Orchards protection from this disease is associated with the implementation of fire blight management. Strategy to increase the fitness of a biological control agent upon delivery to the field is the use of copper-based preparations or antibiotics in combination with agrotechnical techniques [2]. However, formulations containing copper are not effective enough, and the use of antibiotics, which are also used for human and animals' treatment, is banned in many countries [3-5]. Such requirements derive from the risk of positive selection of antibiotic resistant strains of *E. amylovora* and the negative impact on the environment [5-7]. For this purpose, biological control of fire blight using microbial antagonists is considered as alternative to chemical control.

Associated with fruit trees, epiphytic microorganisms play an important role in their development, participating in the supply of plant nutrients, phytohormones, vitamins and other growth factors. Many of these microorganisms produce compounds that inhibit pathogenic microflora (toxins, antibiotics, siderophores), and also contribute to the appearance of induced resistance to phytopathogens in partner plants [3]. In this regard, the identification of new wild isolates from the phyllosphere of plants with inhibitory effect against the fire blight *E. amylovora* pathogen, adapted to local climatic and ecological conditions, as well as the biological traits of the pathogen, are of particular relevance. Such type of novel

strains has potential for creation on its basis complex biopreparations with fire blight controlling and phytoregulatory properties.

The objectives of this work were to study the structure of microbial cenosis of the phyllosphere of fruit crops infected by fire blight in southern Kazakhstan and to identify novel wild bacterial antagonists for the biocontrol of fire blight disease.

We have shown in our previous studies that non-pathogenic strain *Streptomyces canofumeus* is effective against *E. amylovora* [8, 9].

**Materials and methods.** Samples of infected and healthy apple and pear organs (shoots, leaves, fruits) selected from the industrial horticulture areas of Zhambyl, South Kazakhstan and Almaty regions of Kazakhstan.

The samples were collected in compliance with the rules of transportation of biological material, excluding external contamination and ensuring the safety of the original microflora of the samples [10]. The microbial community structure and diversity of the apple and pear phyllosphere, phenotypic and morphological traits such as colony color and cell motility as well as physiological fingerprints of microbial isolates were performed using conventional bacteriological methods [11-13]. The isolates were identified according to Satton D. et al. and Bergey's Manual of Systemic Bacteriology [14, 15]. Gram staining was performed as previously described by Claus [16].

All isolates were examined for their ability to inhibit the growth of *E. amylovora* by agar-diffusion-test [17]. This test was repeated with three replicates and the diameter of inhibition zones was assessed.

**Results and discussion.** 47 samples of infected and healthy organs of apple and pear plants from orchard cenosis of Zhambyl, South Kazakhstan and Almaty regions, were selected.

The studies of the structure of microbiocenosis of the apple and pear phyllosphere in Southern Kazakhstan revealed that bacteria (142 isolates) were numerically dominated. The number of other groups of microorganisms was lower: fungi – 37 isolates and yeast – 37 isolates. The structure and diversity of epiphytic microorganism's community in the phyllosphere of fruit crops in the observed orchard microbiocenosis is presented in tables 1 and 2.

Taxonomic identification of isolated pathogenic and concomitant microflora by conventional bacteriological methods has demonstrated that the structure of the examined microbiocenosis was represented by the following taxonomic groups.

Table 1 – The structure of epiphytic microorganism's community isolated from the affected apple and pear trees in Southern Kazakhstan

| Region | Number of samples, pcs | Number of isolates, pcs. | | | |
|---|---|---|---|---|---|
| | | Total | Bacteria | Fungi | Yeast |
| Zhambyl oblast | | | | | |
| Zhambyl | 8 | 42 | 30 | 5 | 7 |
| Baizak | 10 | 23 | 13 | 6 | 4 |
| South Kazakhstan oblast | | | | | |
| Sairam | 5 | 38 | 26 | 7 | 5 |
| Tolebi | 7 | 24 | 15 | 3 | 6 |
| Almaty oblast | | | | | |
| Karasai | 6 | 37 | 28 | 3 | 6 |
| Talgar | 6 | 33 | 20 | 8 | 5 |
| Enbekshikazakh | 5 | 19 | 10 | 5 | 4 |
| Total | 47 | 216 | 142 | 37 | 37 |

Table 2 – The diversity of epiphytic microorganism's community isolated from the infected apple and pear trees in Southern Kazakhstan

| Region | Epiphytic microorganisms | | |
|---|---|---|---|
| | Bacteria | Fungi | Yeasts |
| Zhambyl oblast | *Erwinia amylovora*<br>*Pseudomonas syringae*<br>*Bacillus polimixa*<br>*Bacillus amyloliquefaciens* | *Monilia fructigena*<br>*Trichoderma asperellum*<br>*Alternaria sp*<br>*Penicillium glaucum*<br>*Podosphaera leucotriha*<br>*Verticillium attenuatum* | *Cryptococcus albidus*<br>*Rhodotorula rubra*<br>*Pullularia pullulans* |
| South Kazakhstan oblast | *Pseudomonas syringae*<br>*Erwinia amylovora*<br>*Bacillus polimixa* | *Monilia fructigena*<br>*Trichoderma asperellum*<br>*Aspergillus sp*<br>*Mucor sp*<br>*Aspergillus niger*<br>*Podosphaera leucotriha* | *Cryptococcus albidus*<br>*Pullularia pullulans*<br>*Saccharomyces cerevisiae* |
| Almaty oblast | *Lactobacillus plantarum*<br>*Erwinia amylovora*<br>*Bacillus polimixa*<br>*Bacillus amyloliquefaciens*<br>*Paenibacillus polimixa*<br>*Pseudomonas syringae* | *Monilia fructigena*<br>*Fusarium oxysporum*<br>*Trichoderma asperellum*<br>*Fusarium oxysporum*<br>*Podosphaera sp*<br>*Mucor sp*<br>*Penicillium glacum*<br>*Aspergillus fumigatus* | *Cryptococcus albidus*<br>*Rhodotorula rubra*<br>*Pullularia pullulans*<br>*Saccharomyces cerevisiae* |

Bacterial community was represented by 5 genera: *Erwinia, Pseudomonas, Bacillus, Lactobacillus, Paenibacillus*; fungi by 10 genera: *Monilia, Venturiua, Aspergillus, Penicillium, Fusarium, Trihothecium, Mucor, Verticillium, Alternaria* (figures 1, 2). The causative agent of powdery mildew – *Podosphaera* fungus, was determined only by microscopic analysis, as far as it is an obligate pathogen, and its morphological and cultural traits and testing for antagonistic activity was not possible to study. Yeasts were represented by 4 genera: *Cryptococcus, Rhodotorula, Pullularia, Saccharomyces.*

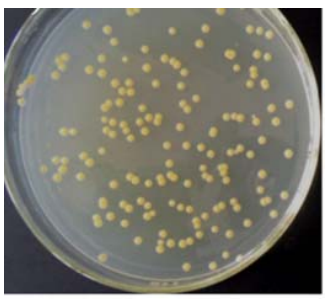
*Erwinia amylovora*

*Bacillus polimixa*

*Bacillus amyloliquefaciens*

*Lactobacillus plantarum*

*Paenibacillus polimixa*



*Pseudomonas syringae*

Figure 1 – Colonies of bacteria isolated from the apple and pear phyllosphere

*Monilia fructigena* | *Aspergillus sp* | *Alternaria sp* | *Trichoderma asperellum* | *Fusarium oxysporum*

Figure 2 – The main types of fungi isolated from the phyllosphere of apple and pear

Due to the fact that the samples were collected in orchards, where fire blight was previously recorded, *Erwinia amylovora* and *Pseudomonas syringae* were found in all studied samples in close symbiosis (figure 3).

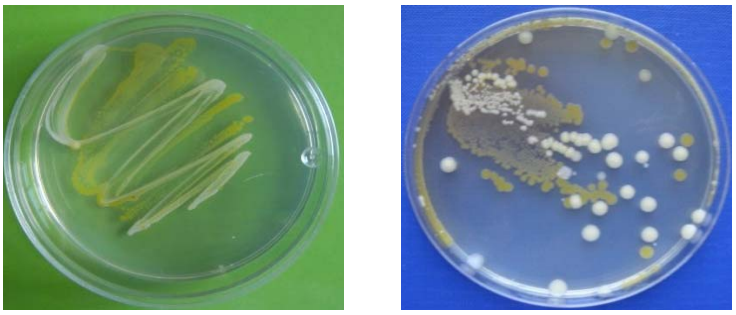


Figure 3 – *Erwinia amylovora* and *Pseudomonas syringae* bacterial colonies on agar plates

Initial screening *in vitro* conditions of epiphytic microorganisms isolated for the ability to inhibit the growth of *E. amylovora* was carried out by agar-diffusion-test. The results of the screening showed that some species of *Bacillus, Pseudomonas* and *Paenibacillus* genera demonstrated antagonistic activity against *E. amylovora*. The diameters of inhibition zone have been depended on the species and ranged from 9 mm to 48 mm. The maximum diameter of inhibition zone (48 mm) was exhibited by *B. amyloliquefaciens* (figure 4).

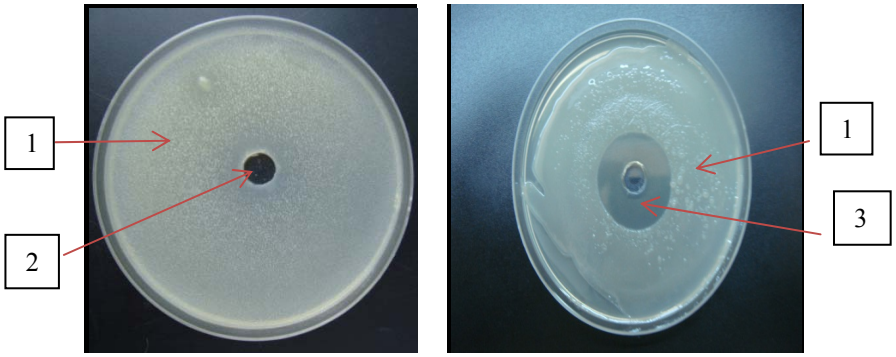



Figure 4 – Inhibition of the *E. amylovora* growth:
1- *E. amylovora,* 2 - sterile water, 3 - *B. amyloliquefaciens*

The studied strains of fungi and yeasts have not exhibited antibacterial activity towards *E. amylovora*.

Thus, as a result of the present study it was found that epiphytic microflora of orchard's cenosis of Zhambyl, South Kazakhstan and Almaty regions of Kazakhstan is characterized by a large variability,

both in structure and diversity. In all collected samples *E. amylovora* was isolated in close symbiosis with *P. syringae*, which is the causative agent of bark necrosis. Symptoms of diseases caused by *P. syringae* are similar to fire blight, although there is a difference – in case of bark necrosis there are no "hooks" on young shoots typical for fire blight [18].

The efficacy of novel bacterial strains isolated from the apple and pear phyllosphere in the zones of industrial horticulture of the South of Kazakhstan to control *Erwinia amylovora* was evaluated under *in vitro* conditions. *B. amyloliquefaciens* $MV_{40}$ demonstrated high antagonistic activity against the pathogen in agar-diffusion-test. The efficacy of epiphytic bacteria *B. amyloliquefaciens* FZB42, *B. amyloliquefaciens* LMR2 against fire blight has also been reported by Chen et al. (2009) and Ait Bahadou et al. (2018) [19, 20]. It was shown that the antagonistic activity of *B. amyloliquefaciens* FZB42 strain may be due to the production of polyketide of dipyridine and dipeptide bacilysin compounds [19].

In our further studies, it is planned to study active metabolites with inhibitory effect to *E. amylovora*. The novel strain *B. amyloliquefaciens MB40* may be considered as potential candidates for development microbial formulation efficient against fire blight disease.

**Funding.** This study was supported and funded by the Ministry of Education and Science of the Republic of Kazakhstan (Grant no. APO5131543).

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## ҚАЗАҚСТАННЫҢ ОҢТҮСТІК АЙМАҚТАРЫНДА БАКТЕРИЯЛЫҚ КҮЙІКПЕН ЗАҚЫМДАЛҒАН ЖЕМІС ДАҚЫЛДАРЫНЫҢ ФИЛЛОСФЕРАСЫНЫҢ МИКРОБТЫҚ ЦЕНОЗЫНЫҢ ҚҰРЫЛЫМЫ

**Аннотация.** Бұрын жеміс ағаштары бактериялық күйікпен зардап шеккен, Қазақстанның өнеркәсіптік бау-бақша шаруашылығы аймағында алма және алмұрт филлосферасының микробтық ценозының құрылымы мен алуан түрлілігі зерттелді. Зерттеу жұмыстары Жамбыл, Оңтүстік Қазақстан және Алматы облыстарында жүргізілді. Жеміс ағаштарының сау және зақымдалған мүшелерінің филосферасынан 47 үлгі (өркендер, жапырақтар, жемістер) алынды. Олардан жалпы 216 микробтық изоляттар бөлініп алынды. Дақылды-морфология сипаттамасы негізінде микроағзалар дақылдарының таксономиялық идентификациясы зерттелді. Изоляттар келесі туыстарға топталған: бактериялар (142 изоляттардан құралған): *Erwinia, Pseudomonas, Bacillus, Lactobacillus*, *Paenibacillus;* саңырауқұлақтар (37 изоляттардан құралған): *Monilia, Venturium, Aspergillus, Podosphaera, Penicillium, Fusarium, Trihothecium, Mucor, Verticillium, Alternaria;* ашытқы және ашытқы тәрізді микроағзалар (37 изоляттардан құралған): *Cryptococcus, Rhodotorula*, *Pullularia*, *Saccharomyces.* Микробоценоздың құрамында ең басым болғаны бактериялар. Барлық зақымдалған мүшелерден бөліп алынған үлгілерді зерттегенде *Erwinia* және *Pseudomonas* туысына жататын бактериялар кездесетіні анықталды.

*Bacillus, Pseudomonas* және *Paenibacillus* туысының өкілдерін *E. amylovora* қарсы антагонисттік белсенділіктерін тексеруге жүргізілген скрининг нәтижелері көрсеткендей, жекелеген түрлерге байланысты патогеннің өсуін шектеуге қабілеттілігін көрсетті. Патогеннің өсу аймағын шектеу диаметрі 9 мм-ден 48 мм құраған. Ең жоғарғы антагонисттік белсенділікті *Bacillus amyloliquefaciens* (48 мм) танытты.

**Түйін сөздер:** микробтық ценоз, *Erwinia amylovora*, жеміс дақылдарының бактериялық күйігі, антагонист-бактериялар, биобақылау.

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## СТРУКТУРА МИКРОБНОГО ЦЕНОЗА ФИЛЛОСФЕРЫ ПОРАЖЕННЫХ БАКТЕРИАЛЬНЫМ ОЖОГОМ ПЛОДОВЫХ КУЛЬТУР В ЮЖНЫХ РЕГИОНАХ КАЗАХСТАНА

**Аннотация.** Исследована структура и разнообразие микробных ценозов филлосферы яблони и груши в зонах промышленного садоводства Казахстана, где ранее наблюдалось поражение плодовых деревьев бактериальным ожогом. Исследования проводились в Жамбылской, Южно-Казахстанской и Алматинской областях. Из филлосферы здоровых и пораженных органов плодовых деревьев было отобрано 47 образцов (побеги, листья, плоды). В целом, выделено 216 микробных изолятов. На основе культурально–морфологических характеристик проведена таксономическая идентификация культур микроорганизмов. Изоляты были сгруппированы в следующие роды: бактерии (142 изолята): *Erwinia, Pseudomonas, Bacillus, Lactobacillus*, *Paenibacillus;* грибы (37 изолятов): *Monilia, Venturium, Aspergillus, Podosphaera, Penicillium, Fusarium, Trihothecium, Mucor, Verticillium, Alternaria;* дрожжи и дрожжеподобные микроорганизмы (37 изолятов): *Cryptococcus, Rhodotorula*, *Pullularia*, *Saccharomyces.*Бактерии доминировали в составе микробоценозов. Во

всех исследованных образцах, отобранных из пораженных органов, присутствовали бактерии родов *Erwinia* и *Pseudomonas*.

Проведенный скрининг на антагонистическую активность к *E.amylovora* показал, что отдельные виды родов *Bacillus*, *Pseudomonas* и *Paenibacillus* продемонстрировали ингибирующее действие. Диаметры зоны подавления роста патогена составляли от 9 до 48 мм. Максимальную антагонистическую активность проявил *Bacillus amyloliquefaciens* (48 мм).

**Ключевые слова:** микробный ценоз, *Erwinia amylovora*, бактериальный ожог плодовых культур, бактерии-антагонисты, биоконтроль.

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**ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)**

http://www.biological-medical.kz/index.php/ru/

Редактор *М. С. Ахметова, Т. М. Апендиев, Д. С. Аленов*
Верстка на компьютере *Д. Н. Калкабековой*

Подписано в печать 11.10.2018.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
5,2 п.л. Тираж 300. Заказ 5.

*Национальная академия наук РК*
*050010, Алматы, ул. Шевченко, 28, т. 272-13-18, 272-13-19*