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RESEARCH OF THE SPECIES COMPOSITION OF THE INTESTINAL MICROBIOM WITH THE USE OF TARGET SEQUENCY GENERATION 16S pRNA

Abstract. The intestinal microbiome is an extracorporeal organ and is characterized by a complex hierarchical structure that performs a variety of functions, depending on its quantitative and species composition. Violation of its balance can lead to various pathological conditions (atherosclerosis, diseases of the cardiovascular system, inflammatory bowel disease, type 2 diabetes mellitus, etc.).

In order to study the species ratio of bacteria in the intestine, the characteristics of bacterial species and enterotypes, a molecular genetic study of the 16S rRNA gene of microorganisms was carried out using the next generation technology (NGS).

Using the semiconductor sequencing method, the first results of the analysis of the species composition of the intestinal microbiome of 33 patients were obtained. Five main phyla were identified: Actinobacteria (4.9%), Bacteroidetes (37%), Firmicutes (42%), Proteobacteria (16%) and Vericomicrobia (0.02%). Found 298 basic taxonomic units.

The analysis showed that bacteria are present in small numbers in the bacterial population, which are indicators of a healthier metabolic status of the intestine.

When phylogenetic analysis of the bacterial population was carried out, 2 enterotypes were identified: in 58% of patients, 1 enterotype of Bacteroides, in 42% of patients 2 enterotype of Prevotella.

Metagenomic analysis of the species ratio of bacteria showed that a decrease in the species diversity of bacteria was observed in the intestine. There is a decrease in bacteria responsible for immunity, a high proportion of bacteria predisposing to the development of type 2 diabetes mellitus, metabolic syndrome and inflammatory bowel diseases.

Keywords: intestinal microbiome, 16S rRNA gene, gut microbiota.

The development of next-generation sequencing technologies has significantly improved our understanding of the species ratio of the bacterial population in the human intestine.

Actively carried out work on the identification, description and quantification of bacterial populations of the gastrointestinal tract, the relationship between the species ratio of bacteria and the prevalence of diseases. The knowledge gained will allow the development of new diagnostic and prognostic therapeutic strategies.

Intestinal microbiome is a unique organ, the formation of which begins from the 24th week of pregnancy from the mother with single colonies of Escherichia coli and lactobacilli [1]. For a long time, it believed that colonization of the gastrointestinal tract by microorganisms occurs after birth. However, recent studies have shown that bacteria are present in the placenta, amniotic fluid, umbilical cord blood, meconium [1, 2, 3]. The composition of the intestinal microbiome depends on the environment and delivery methods and on breastfeeding [4-6].

It is believed that the final formation of the enterotype of the microbiome begins at 18 months [4, 5, 7].

By about 2-3 years, the microflora undergoes the latest changes, an “adult” microbiota is formed, 60-70% of which will slightly change throughout life [3,7,8].

Improper nutrition of the mother during pregnancy or in a child in early childhood can lead to depletion and a defect in the gut microbiota.

A microbiome of the human intestine consists of approximately 1.5 kg of cells, most of which are bacterial, and a minority belongs to archaea and eukaryotes. In western populations, phyla Bacteroidetes and Firmicutes, as a rule, dominate the intestines, while other phyla make up 10% or less [14].

The microbiome of the human intestine consists of approximately 1.5 kg of cells, most of which are bacterial, and the minority belongs to archaea and eukaryotes, contains up to 1000 species of bacteria encoding about 5 million genes. In the normal microbiota, both commensals and opportunistic microorganisms are found.

Microbiota is necessary for the proper growth of the body, the development of immunity and nutrition. Microorganism communities are in close interaction with our body, performing many functions necessary for the physiology and survival of the body [5,9,10,11]. Disorders of microbiome homeostasis play an important role in the development of inflammatory bowel diseases, atherosclerosis, obesity, metabolic syndrome (MS), type 2 diabetes mellitus (DM) [2,6,7,9].

The aim of our study: to study the species composition of the intestinal microbiome using targeted semiconductor sequencing of the 16s pPHK gene.

Materials and methods. OBJECT OF STUDY. The study involved 33 patients sent by a gastroenterologist to study the species composition of the microbiome by the method of targeted semiconductor sequencing of the 16SrRNA gene of microorganisms using the next generation technology (NGS).

Total DNA was extracted from 250.0 mg of a homogenized wet fecal sample using the PureLinkTM Microbiome DNA Purification Kit (TermoFisher Scientific, USA) DNA isolation kit according to the manufacturer's instructions. Sequencing of the 16S rRNA gene was carried out on a new-generation semiconductor sequencer Ion Gene Studio S5 Plus (TermoFisher Scientific, USA) in the laboratory of personalized genomic diagnosis of the “Medical Centre Hospital of the President’s Affairs Administration of the Republic of Kazakhstan”.

DNA libraries (the set of nucleotide sequences of the genomic DNA of the studied samples) were prepared in accordance with the Ion 16STM Metagenomics Kit protocol (Termofisher Scientific, USA).

The preparation of the library took place in several stages:

1. Obtaining a PCR product by amplification of the hypervariable region 16S, followed by purification and measuring the concentration of the PCR product.
2. Directly preparing the library by ligation with barcoding, cleaning the ligated adapter library.
3. The concentration of the obtained library was measured on a QS 12K Flex analyzer.

The concentration of DNA libraries was determined on a QuantStudioTM 12K Flex system using the Ion Library TaqMan® Quantitation Kit (Termofisher Scientific, USA). Figure 1 shows an example of measuring library concentration.

The sequence of amplified fragments was carried out in the Ion PGM ™ system, bioinformatics analysis of the results was carried out using the Ion Reporter ™ software, the Ion 16S ™ Metagenomics Kit analysis module.

Using a combination of two primer pools allows a wide range of bacteria in a mixed population to be identified by sequence of bases. Figures 2 and 3 show examples of bioinformatics analysis and a Crohn’s diagram.

Results. Metagenomic analysis showed that the fecal mass consist of5 main phyla: Actinobacteria, Bacteroidetes, Firmicutes, Proteobacteria, and Vericomicrobia were found in a bacterial population. The proportion of each phyla in the total bacterial population is different. The smallest amount falls on Phyl Vericomicrobia (0.02%), the main filaments are Bacteroidetes (37%) and Firmicutes (42%). The results are presented in table.

A total of 298 bacterial species were identified in 33 patients in the intestinal microbiome. Of these, 79% of the bacterial population is represented by 38 to 82 species. In 21% (7 patients), intestinal microbiomes are represented by a small number of bacteria (from 20 to 30 species).

Figure 1 – Melting curves of samples in dilutions of 1: 100 and 1: 1000 relative to standards when measuring library concentration

Phylum	Class	Order	Family	Genus	Species	% ID	Count	DB counters	F:R %	% of total reads	% of valid reads	% of mapped reads	% of mapped reads per primer
							32474	**8761 : 23713**		**22.32**	**43.27**	**100**	**100**
Actinobacteria							335	216 : 119		0.23	0.45	1.03	1.03
	Actinobacteria						251	216 : 35		0.17	0.33	0.77	0.77
		Bifidobacteriales					97	81 : 16		0.07	0.13	0.3	0.3
			Bifidobacteriaceae				97	81 : 16		0.07	0.13	0.3	0.3
				Bifidobacterium			97	81 : 16		0.07	0.13	0.3	0.3
					(genus level ID only)		16	0 : 16		0.01	0.02	0.05	0.05
					(slash calls)		12	12 : 0		0.01	0.02	0.04	0.04
					catenulatum	99.55 - 99.55	50	50 : 0	0 : 100	0.03	0.07	0.15	0.15
					ruminantium	100 - 100	19	19 : 0	0 : 100	0.01	0.03	0.06	0.06
		Coriobacteriales					154	135 : 19		0.11	0.21	0.47	0.47
			Coriobacteriaceae				154	135 : 19		0.11	0.21	0.47	0.47
				(family level ID only)			19	0 : 19		0.01	0.03	0.06	0.06
				(slash calls)			33	33 : 0		0.02	0.04	0.1	0.1
				Collinsella			102	102 : 0		0.07	0.14	0.31	0.31
					aerofaciens	99.35 - 100	102	102 : 0	100 : 0	0.07	0.14	0.31	0.31

Figure 2 – An example of the result of bioinformatic analysis of a microbiome based on Ion Reporter software

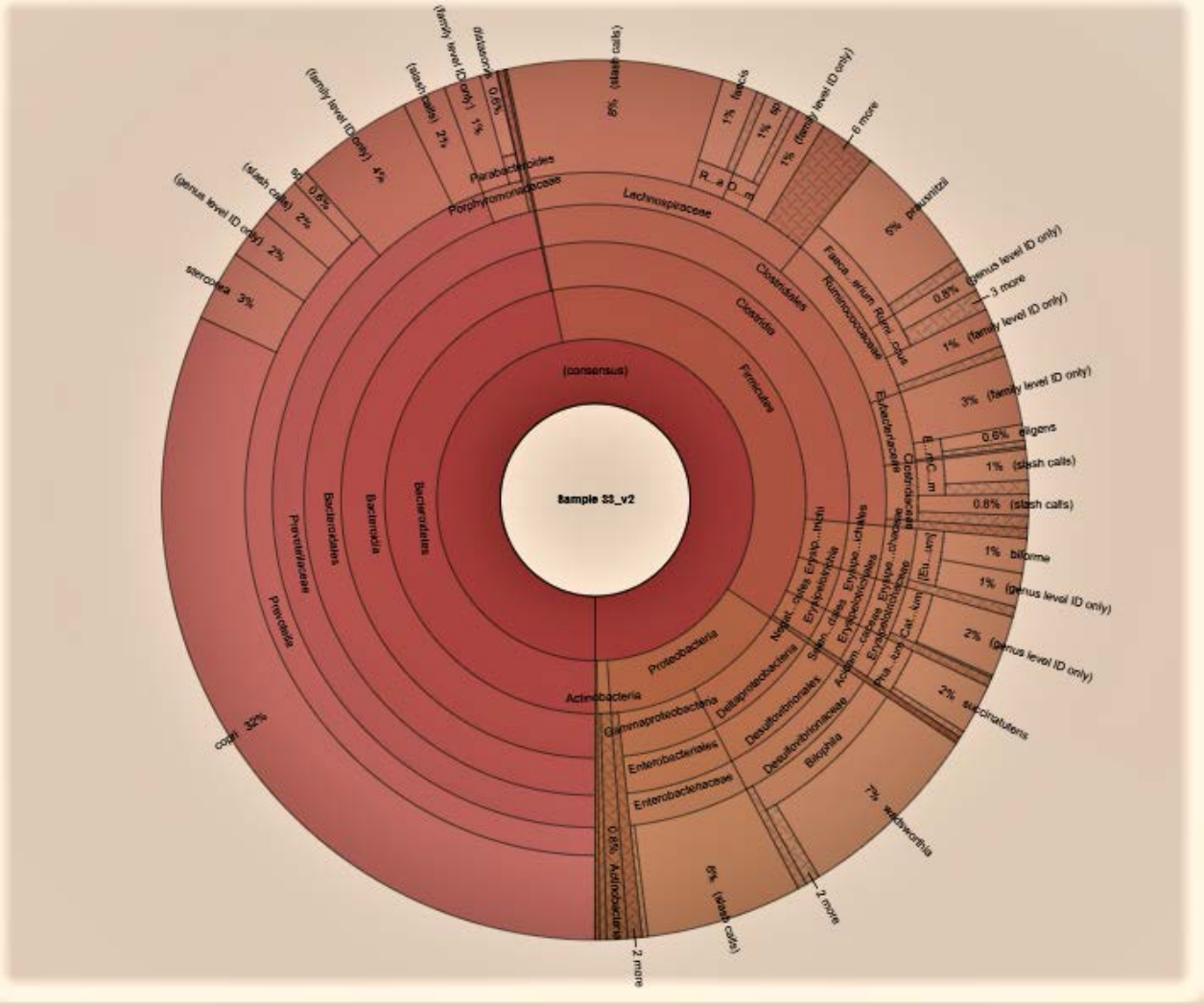

Figure 3 – Phylogenetic metagenomic classification of taxonomic units (Crohn's diagram)

The ratio of bacterial species in the intestinal microbiome

Phyla	Class	Order	Family	Genus	Species	Share, %
Actinobacteria	1	3	3	13	34	4,9
Bacteroidetes	1	1	4	10	46	37
Firmicutes	4	5	9	52	164	42
Proteobacteria	4	4	4	17	29	16
Vericomicrobia	1	1	1	1	1	0,02

The proportion of Actinobacteria phyla is 4.9%, but the structure is heterogeneous. Only 19% of patients in the bacterial population identify three taxonomic groups Actinomycetales, Bifidobacteriales and Coriobacteriales, in 70% of the patients the bacteria Bifidobacteriales and Coriobacteriales are present in the microbiome, and in 11% of the patients, the Actinobacteria class is represented only by the bacteria of the Coriobacteriales order.

Phylogenetic analysis revealed that in the bacterial population, Bifidobacteriales were found in the microbiota in 85% of patients. However, their number in the structure is heterogeneous, a wide range is observed from 0.01 to 16.62%, only in the microbiome of 4 patients their number was from 8% to 16%.

Phyla Bacteroidetes werefound in 31 patients. Cluster analysis of the phyla showed that in the bacterial population it accounts for 37%. Phyla is represented by 10 genus and 20 species of bacteria. The

main taxonometric groups Bacteroides / Odoribacter / Parabacteroides / Prevotella / Alistipes have been identified.

When carrying out a phylogenetic analysis of the bacterial population of 33 patients, 2 enterotypes were identified: in 58% of patients - Bacteroides, in 42% - Prevotella.

One of the main commensal bacteria in the gut microbiome is Phyl Firmicutes [8, 12, 13]. So in the bacterial population, intestinal microbiome phyla was diagnosed in 33 patients and makes up 42% of the entire bacterial population. Phylogenetic analysis of the Firmicutes phyla showed that it consists of 4 classes, 5 orders, 9 families, 52 genus, and 164 species.

A metagenomic analysis of the structure of the Proteobacteria phyla showed that it consists of 4: classes, 4 orders, 4 families, 17 genera, and 29 species. Phyla Proteobacteria occupies 16% of the entire bacterial population of the studied individuals.

The fifth phyl Vericomicrobia is represented by one bacterial species, Akkermansia muciniphila. This type of bacteria in the intestinal microbiome was found in only 8 patients. The phyla share in the total bacterial population is 0.02%.

Discussion. According to European researchers, intestinal microbiomes mainly consist of bacterial types such as Firmicutes (60–65%), Bacteroidetes (20–25%), Proteobacteria (5–10%) and Actinobacteria (3%) [1, 14, 15]. The ratio of phyla is greatly influenced by the place of residence, food culture. Active work is underway to study the general population of bacteria in the human intestine. Several groups have studied the commonality of intestinal microbiome. One of the first observations was that the human intestinal flora mainly belongs to only two types of Firmicutes (mainly represented by Clostridia) and Bacteroidetes, with fewer bacteria belonging to Proteobacteria and Actinobacteria [1, 16].

The data obtained on the species composition of the bacterial population of the Actinobacteria phyla show a decrease in bio-bacterial species in the intestine, which is associated with the occurrence of gastrointestinal tract disorders, and in 81% of patients there is a violation of intestinal homeostasis, an imbalance in the microsystem, which leads to the onset of the disease.

In the structure of phyla Propionibacteria, Rothia, which are indicators of a healthier metabolic status of the intestine, were detected in the structure of the phyla not detected, i.e., an analysis of the structure showed a decrease in the species diversity of bacteria.

Phyla Bacteroidetes, the predominant genus in the human intestine, plays an important role in numerous metabolic processes and can provide a certain level of protection against the multiplication of pathogenic microbes in the intestine. Bacteria are involved in the process of fermentation of carbohydrates, protein utilization, and biotransformation of bile acids. Actively decompose carbohydrates, contribute to the production of vitamins C, B2, B5, H. [2, 15].

According to the composition of the bacterial population of Phyla Bacteroidetes, the researchers proposed to identify certain enterotypes [18] regardless of location, health status or age. Three enterotypes are distinguished in the bacterial population by the dominance of representatives of the genus: Bacteroides, Prevotella, Ruminococcus. However, there are no clear criteria for determining enterotypes [17, 18].

Bacteroides enterotype bacteria are characterized by activity against the decomposition of carbohydrates, contribute to the production of vitamins C, B2, B5, H. It is assumed that patients with this enterotype will be less likely to suffer from atherosclerosis or it will manifest at a later date. The Bacteroides enterotype is typical for people who eat large amounts of meat and animal fats[13].

Enterotype - Prevotella, bacteria in the intestines do not process sugar and carbohydrates well, provide the body with vitamin B1 and folic acid. But with this enterotype, the load on the intestinal mucosa can increase. The risk of obesity and the development of metabolic syndrome, cardiovascular disease are characteristic. In the process of life, bacteria are able to destroy the protective mucous membrane, predisposing to defects in the intestinal mucosa, ulcerative colitis and inflammatory bowel diseases [19, 20].

Enterotype - Ruminococcus. These bacteria increase the absorption of carbohydrates, as well as blood sugar. Representatives of this enterotype synthesize folic acid and vitamin B1. This enterotype is most common in countries where plant foods predominate in the diet.

The obtained data on the species composition of the bacterial Bacteroidetes phyla population in the intestine showed that 2 enterotypes, Bacteroides, Prevotella, were isolated. Probably, the prevalence of two enterotypes is associated with the peculiarities of Kazakh nutrition, the predominance of meat and

fatty foods in the diet. The presence of a large percentage of Prevotella bacteria indicates a predisposition of patients to inflammatory processes in the intestine (Crohn's disease, ULC).

An increase in the population of Firmicutes phyla bacteria contributes to an increase in body weight, the onset of type 2 diabetes mellitus, cardiovascular pathology and inflammatory bowel diseases. Patients with a predominant bacterial population of Firmicutes are more likely to suffer from atherosclerosis or this pathology manifests itself at an earlier age [20].

It is known that an increase in the number of Firmicutes representatives and a decrease in the number of Bacteroidetes leads to the development of a metabolic syndrome [18]. When studying the Bacteroidetes / Firmicutes ratio in 63.6% of patients, the taxonomic groups of Firmicutes phyla bacteria prevail in the bacterial structure.

The obtained data on the species ratio of Firmicutes phyla show that patients are predisposed to the development of obesity and insulin resistance, i.e. Type 2 diabetes. The prevalence of Firmicutes phyla bacteria can be explained by the predominance of a high-fat diet in nutrition, which leads to inflammation of the intestinal mucosa and to a decrease in lactobacilli.

Phyla Proteobacteria, the most numerous group of bacteria (1534 species are described), is a heterogeneous group, this group includes both symbionts of eukaryotes and a large number of pathogenic and conditionally pathogenic microorganisms [21].

Phyla Proteobacteria is divided into five classes: alpha, beta, delta, gamma and epsilon proteobacteria. When analyzing the species composition of the intestinal microbiome of 33 patients, it was found that there are 4 classes of bacteria in the microbiota: Alphaproteobacteria, Betaproteobacteria, Deltaproteobacteria, Gammaproteobacteria, no Epsilon proteobacteria class was found in any patient. Pathogenic bacteria were found in a number of patients, Haemophilus parainfluenzae, 18% Echerichia coli were found in 40%, Klebsiella pneumonia in 12%, and Mannheimia varigena in 13%.

The results of the phylogenetic analysis of the Proteobacteria phyla show that there is a decrease in the species diversity of bacteria, but at the same time, metagenomic analysis allows the detection of pathogenic bacteria using accessible methods that are difficult to find.

The bacterium Akkermansia muciniphila, a filial representative of Vericomicrobia, is considered an important indicator of metabolic intestinal health [12,22]. Bacteria should be widely present in the human intestine, their share should be 1-4% of the bacterial population in the colon. Akkermansia muciniphila is a mucin-degrading bacterium that produces short-chain fatty acids that have beneficial effects on intestinal cells and immunity[12,18,22]. A low indicator of the presence of bacteria in the colon in the studied patients indicates inflammatory processes in the intestine, probably due to the peculiarities of the nutrition of the mother and child in the first 18 months of life, the culture of nutrition.

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16S рРНК ГЕНІҢІҢ ТАРГЕТТІК СЕКВЕНДЕУІН ПАЙДАЛАНА ОТЫРЫП ІШЕК МИКРОБИОМЫНЫҢ ТҮР ҚҰРАМЫН ЗЕРТТЕУ

Аннотация. Ішек микробиомы экстракорпоральдық органға жатады және оның сандық және түрлік құрамына байланысты әртүрлі функцияларды орындайтын күрделі иерархиялық құрылыммен сипатталады. Оның балансының бұзылуы әртүрлі патологиялық жағдайлардың туындауына әкелуі мүмкін (атеросклероз, жүрек-қантамыр жүйесінің аурулары, ішектің қабыну аурулары, 2 типті қант диабеті және т.б.).

Ішектегі бактериялардың түрлік ара қатынасын, бактериялық түрлер мен энтеротиптердің ерекшеліктерін зерттеу мақсатында келесі буын технологиясын (NGS) қолдана отырып, микроорганизмдердің РНК 16s генін молекулалық-генетикалық зерттеу жүргізілді.

Жартылай өткізгіш секвендеу әдісін пайдалана отырып, 33 пациенттің ішек микробиомының түрлік құрамын талдаудың алғашқы нәтижелері алынды. 5 негізгі фил сәйкестендірілді: Actinobacteria (4,9%), Bacteroidetes (37%), Firmicutes (42%), Proteobacteria (16%) және Vericomicrobia (0,02%). 298 негізгі таксономиялық бірлік табылды.

Талдау бактериялар популяцияда ішек метаболизмінің неғұрлым сау статусының индикаторлары болып табылатын бактериялар аз мөлшерде көрсетілгенін көрсетті.

Бактериялық популяцияның филогенетикалық талдауын жүргізу кезінде 2 энтеротип анықталды: 58% пациентте -1 Bacteroides энтеротипі, 42% - 2 Prevotella энтеротипі.

Бактериялардың түрлік ара қатынасын метагеномдық талдау ішекте түрлі бактериялардың әртүрлілігінің азайғанын көрсетті. Иммунитетке жауап беретін бактериялардың төмендеуі, 2 типті қант диабетінің, метаболизмдік синдромның және ішектің қабыну ауруларының дамуына бейім бактериялардың жоғары үлесі байқалады.

Түйін сөздер: ішек микробиомы, 16s рРНК гені.

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ИССЛЕДОВАНИЕ ВИДОВОГО СОСТАВА МИКРОБИОМА КИШЕЧНИКА С ИСПОЛЬЗОВАНИЕМ ТАРГЕТНОГО СЕКВЕНИРОВАНИЯ ГЕНА 16S рРНК

Аннотация. Микробиом кишечника является экстракорпоральным органом и характеризуется сложной иерархической структурой, которая выполняет разнообразные функции, зависящие от ее количественного и видового состава. Нарушение ее баланса может приводить к возникновению различных патологических состояний (атеросклероз, заболевания сердечно-сосудистой системы, воспалительные заболевания кишечника, сахарный диабет 2 типа и др.).

С целью изучения видового соотношения бактерий в кишечнике, особенностей бактериальных видов и энтеротипов было проведено молекулярно-генетическое исследование гена 16S рРНК микроорганизмов с применением технологии следующего поколения (NGS).

Используя метод полупроводникового секвенирования были получены первые результаты анализа видового состава микробиома кишечника 33 пациентов. Идентифицировано 5 основных филов: Actinobacteria (4,9%), Bacteroidetes (37%), Firmicutes (42%), Proteobacteria (16%) и Vericomicrobia (0,02%). Обнаружено 298 основных таксономических единиц.

Анализ показал, что в популяции бактерий в малом количестве представлены бактерии, которые являются индикаторами более здорового метаболического статуса кишечника.

При проведении филогенетического анализа бактериальной популяции идентифицировано 2 энтеротипа: у 58% пациентов -1 энтеротип Bacteroides, у 42% - 2 энтеротип Prevotella.

Метагеномный анализ видового соотношения бактерий показал, что в кишечнике наблюдается снижение видового разнообразия бактерий. Отмечается снижение бактерий, отвечающих за иммунитет, высокая доля бактерий, предрасполагающая к развитию сахарного диабета 2 типа, метаболического синдрома и воспалительных заболеваний кишечника.

Ключевые слова: микробиом кишечника, ген 16S рРНК.

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INTRODUCTION AND STURDYING OF PROSPECTIVITY OF HYBRID IRIS VARIETY IN MANGYSTAU ARID CONDITIONS

Abstract. The article describes the results of the introduction study of variety of Irises in the Mangyshlak experimental botanical garden (further MEBG) collection. The purpose of our research is targeted introduction researches, a comprehensive study of decorative qualities and the selection of varieties that are promising for the green building of Mangystau region.

The study of biological features and the definition of a comprehensive assessment of the decorative characteristics of variety of irises were carried out according to generally accepted methods of R.A. Karpisonova, V.N. Bylova, E.L. Tyshchenko and Yu.V. Timkina, Reshetnikova L.F. and using the MEBG Regional Integrated Scale.

The introduction of *Iris* L. in Mangyshlak Botanical Garden began in 1978. The modern collection of floral and ornamental plants of MEBG is represented by 98 varieties of hybrid iris. To assess the promising qualities of hybrid iris varieties, we have selected 20 varieties from the collection of flower and ornamental plants of the MEBG, introduced from 2009 to 2014.

During assessing the promising qualities of iris varieties, 11 diagnostic features were considered: drought resistance, phytophagy resistance, resistance of the flower to the effects of external environmental factors, color, size, flower shape, flowering time, height and strength of flower stalk, and reproductive ability.

According to the results of the research, 1 variety of iris (Add It Ap) of medium perspectivity (51-60 points) with low decorative qualities was revealed.

6 varieties are classified as promising (less than 70 points) for cultivation in Mangystau conditions: Michael Paul, White Queen, Cry Baby, Pumpion Iron, Indian Pow Wow, Fires Form.

From the studied taxons, 9 varieties with high prospects (71 -80 points) were identified: Kiwi Capers, Swish, May Magic, Margarita, Marina Raskova, Bronze Bell, Butterfly Bower, Grace Sturtevant, Ilsan.

4 varieties were assigned as very high-potential (81-90 points) for Mangystau: Bazaar, Port Wine, Tomeco, Star Shine.

Keywords: introduction, Iris, varieties, complex scale, perspective, conditions of Mangystau.

Introduction. At the modern stage of green building it is required to pay especial attention not only to the resistance of plants against negative environmental factors and to decorative effect as well. One of the directions of scientific works of Mangyshlak experimental botanical garden is domestication of new promising introductive types and varieties of plants and development of planting assortment in Mangystau, which is characterized by especially harsh soil & climatic conditions: hot dry summer, dust storms, hot dry winds, constant water deficit, almost snowless winter with frequent cold winds [1].

The most popular plants in flower decoration of the cities and towns are irises. Along with the high decorative qualities they are winter-hardy, distinguished by abundant annual flowering and high coefficient of vegetative propagation [2, 3].

In the landscaping of towns and cities of Mangystau region the irises are mainly presented in old variety, which are well adapted to local conditions, but not differ in color and shape of flower. The purpose of our researches is targeted introductive researches, comprehensive studying of decorative qualities and selection of varieties promising for green building of Mangystau region.

Object and methods of research. The researchers are performed within the frame of granted project "Introduction of promising variety and form of ornamental plants in Mangystau conditions to save their biodiversity and widespread introduction into green building practice"

The targets for researches was served short-growing, medium-grown and tall-growing of *Iris hybrida* hort. varieties from collection of ornamental plants of Mangyshlak experimental botanical garden. To establish the features of seasonal growth and plant development and data collection, characterizing their resistance in new conditions when introduction, the phenological observations on methodology accepted by botanical garden session [4, 5] and agrotechnical care according to regional recommendations of botanical garden [6] were carried out to iris varieties.

Rootstalk were planted on checks in size 2 x 3m, with planting step from 0,1 to 0,2m. During the growing season the plants regularly watered in two or three times a week [7].

Studying of biological features and definition of the comprehensive assessment of decorative characteristics of iris varieties were carried out by generally accepted methodology: R.A.Karpisinova [8, 9], V.N. Bylova [10], Y.L.Tyshchenko and Yu.V. Timkina [11], Reshetnikova L.F. [12] and using the regional comprehensive scale developed in Mangyshlak experimental botanical garden [13, 14].

Results and discussions. Introduction of *Iris* L. in Mangyshlak experimental botanical garden began in 1978. The rootstalks *Iris germanica hort. of varieties* Aegir', 'Ai', 'Maori King', 'Oberon', 'Lime Light' was firstly brought from Karagandy botanical garden (Karagandy), and in 1979-80 seeds of *Iris setosa, Iris pseudacorus, Iris spuria, Iris halophila* from the botanical garden of Institute of Botany of AS Lithuanian SSR (Kaunas). In 1984-88 rootstalks of 2 types (Siberian and leather like iris), 7 varieties ("Galina Ulanov", 'Pink Formal', 'Pride o fDover', 'Sabre', 'Solid mahogany', 'Unicorn', 'Wabash') and 2 forms (dwarf blue iris and dwarf yellow iris) of iris were involved from Karagandy and botanical garden of Almaty [14, 15].

Most variety of iris were introduced from 2009 to 2016: 2 variety - 'Bronze Bell', 'Bazaar' from Zhezkazgan botanical garden (2009) , 13 varieties - 'White Qween', 'Lotario' 'Indian Pow Wow', 'Buttercup Bower', 'Grace Sturtevant', 'Ilsan', 'La Beaute', 'May Magic', 'Margarita', 'Port Wine', 'Tomeco', 'Marina Raskova', 'Royal Ruffles' from Altay botanical garden (2009, 2014) ; in 2013 7 dwarf varieties- 'Pumpin Iron', 'Add It Ap', 'Kiwi capers', 'Cry Baby', 'Michael Paul', 'Swish', 'Firestorm' from main botanical garden of Moscow [17-20].

In recent years the collection of ornament plants are replenished by new varieties, not previously represented in collection. In 2018 within the frame of granted project at the territory MEBG the new section for monocultural hybrids is created. For first introduction testing in autumn 2017 the rootstalk of 33 varieties of hybrid iris was involved from Central botanical garden of Belarus (Minsk) and Botanical garden of Lomonosov MSU (Moscow). The new varieties of iris were involved into MEBG collection from Altay botanical garden – 20 varieties in October 2018, and 21 variety of iris from Main botanical garden named after V.Tsitsin (Moscow) in spring, 2019. Therefore, 74 new variety of irises involved into collection for 2017-2019. All new invasive plants are successfully growing. The modern collection of ornament plants of MEBG is represented by 98 varieties of hybrid iris.

To assess the promising qualities of variety of hybrid iris we have selected 20 varieties from the collection of ornament plants of MEBG, introduced from 2009 to 2014.

11 diagnostic features were considered during assessment of promising qualities of iris varieties: drought resistance, phytophagy resistance, resistance of the flower to the effects of external environmental factors, color, size, flower shape, flowering time, height and strength of flower stalk, reproductive ability and diagnostics based on success of renewal of plants in vegetative way culture.

Upon the result of obtained data, it is found that all varieties of irises in arid conditions of Mangystau are distinguished by high drought resistance. The plant weakly responds to dry hot period, has normal terminal shoots, characteristic for taxon of leaves color, turgor of leaf apparatus may decrease during the day at maximum temperature and solar radiation, but quickly recovers in evening & morning hours.

On the basis of "Phytophagy resistance", plant susceptibility of pathogens at the end of the growing season and damage to plants by pests was considered. During research in all varieties of irises there was no damage of vegetative and generative organs.

The variety of iris which not respond to environmental factors for morphological signs of flower structure obtains high score. They are Port Wine, Tomeco, Grace Sturtevant, Pumpion Iron, Indian Pow

Wow, Ilsan, Kiwi Capers, Bronze Bell, Bazaar. Other varieties during low air humidity and high temperature the petal color is fade in and the flowers are become deformed.

The collection includes variety of different colors: single-colored, bicolored, duplex ink, broken. Bicolored varieties have the different colors of outer and internal particles of perianth, and duplex ink varieties are distinguished by strength of colors of outer and internal particles of perianth. The variety with “broken” color of perianth particle is random dyeing in strokes, splashes or stripes : In iridescent varieties the one tonality shade into a nother.

The highest mark is given to the varieties which have the clear bright color, from 2 and more colors: Margarita, Kiwi Capers, Tomeco, Marina Raskova, Pumpion Iron, Cry Baby.

Most large-sized flowers (till 16 cm in dia) are detected in tall-growing irises: May Magic, Margarita, PortWine, Tomeco, BronzeBell, Bazaar.

During assessment of flower shapes the availability of waviness, corrugation of perianth segments was observed. 4 varieties of low growing irises group obtained high mark: PrettyShish, Indian Pow Wow, Kiwicapers, Fires Form, from high irises the following varieties mentioned: May Magic, Star Shine, Port Wine.

The height of flower stalk of irises varieties depends on variety features and soil and climatic conditions. The following varieties are designated on the height of flower stalk in the collection: low growing (25-35 cm) – Indian Pow Wow, Pumpion Iron, Add It Ap, Kiwi Capers and etc., medium growing (35-70 cm) – Marina Raskova, White Queen, Grace Sturtevant; high growing (70-100 cm) May Magic, Margarita, Port Wine, Tomeco, Buttercup Bower and others. According to the results of flower stalk strength assessment the highest point was given to the following varieties: Marina Raskova, May Magic, Margarita, Port Wine, Buttercup Bower.

In Mangystau conditions 85 % of studied varieties, the flowering duration is 10-13 days. Only in varieties White Queen, Indian Pow Wow, Pumpion Iron, Add It Ap the flowering continues to 9 days.

In Mangystau conditions the number of simultaneously open flowers in flower shooting reaches up to 5 flowers. The high mark from low growing irises is given to IndianPowWow (3 flowers simultaneously open flowers); from medium growing group: GraceSturtevant (3 flowers) and 4 varieties from high growing irises group: MayMagic, Margarita, Star Shine, Bazaar, that having from 4 to 7 simultaneously open flowers in flower stalk.

During assessing the ability to vegetative propagation, the natural productivity of varieties is taken into consideration, considering their net reproduction for 3 years annually formed innovations [21]. The variety of low growing irises has more intensive root stalks formation (above 15 sections for 3 year) in compare with medium growing and high growing irises (8-11 particles). The highest score in intensity of vegetative propagation was obtained by 3 low growing variety of irises, that formed more than 15 particles for 3rd year of planting Indian Pow Wow, Kiwicapers, Add It Ap. From the medium growing irises group 1 variety (White Queen), and from high growing irises 6 varieties (Bazaar, Buttercup Bower, Star Shine, Port Wine, May Magic, Margarita) formed 8000-10 particles for 3rd year of planting.

As a result of our evaluation of introduced variety of irises, the studied assortment on use prosectivity in ornamental flower gardening was divided into 4 groups: medium, increased, high and sky high.

Under the results of researches 1 variety of iris was detected – Add It Ap of the medium prospectivity (51-60 points), has low decorative qualities.

6 varieties having medium decorative qualities in flower stability to external factors, in size and forms of flowers is defined as increased prospectivity (less than 70 points) for cultivation in Mangystau conditions. They are Michael Paul, White Queen, Cry Baby, Pumpion Iron, Indian Pow Wow, Fires Form.

9 varieties of studied taxons are defined as high promising (71-80 points), which have decorative qualities such as bright, two-color paint, original form and large size of flower, resistance of flower stalk, ability to vegetative propagation. This group of perspective includes 9 variety from 3 groups of irises: Kiwi Capers, Swish, May Magic, Margarita, Marina Raskova, BronzeBell, ButterflyBower, Grace Sturtevant, Ilsan.

4 varieties which have complex of value character on flower resistance to external factors, bright color, original flower form, abundant and long-term florescence are assigned as very high perspective (81-90 points) for Mangystau. They are Bazaar, Port Wine, Tomeco, Star Shine.

These varieties of irises on prospectivity level are described below.

From “medium prospectivity” group:

'Add It Ap' is drought resistant. Damaging by disease and pests is average. In the sun the edges of petal are faded and paled.

Color type of flower is one-color, iridescent. The color of the perianth segments are following: internal - yellow, the edges are brighter, the external ones are yellow, with wine-purple specks, orange beard, blue at the tips. The flowers are average, 7-8 cm in height; the perianth segments are slightly corrugated. The height of the flower stalk is 23-25 cm. There are 4 flowers in the inflorescence. Duration of flowering is 8 days. Overgrowth ability is average.

From “increased proscpectivity” group:

Michael Paul. Drought resistant and phytophagous resistant. In hot sun, petal edges do not fade away and do not lose color.

The type of flower color is monochrome. The color of the flower is rich purple, velvety, the beard is dark blue. The flowers are medium, 6-7 cm in height, the edges of the perianth segments slightly wavy. The height of the flower stalk is 20-25 cm. There are 3-4 flowers in the inflorescence. Flowering is abundant, the duration is 12 days. Overgrowth ability is medium.

White Queen. Drought resistant. Damaging by diseases and pests is medium. In hot sun, petal edges fade away and turn yellow.

Color type is monochrome. Perianth segment color is white, beard is yellow. The flowers are large, 9-10 cm in height, the edges of the perianth segments are even. Flower stalk is 65-75 cm in height, durable. The inflorescence contains 3 flowers. Flowering is abundant, duration is 13 days. Overgrowth ability is high.

Cry Baby. Drought-resistant. Damaging by disease and pests is low. In the sun, the edges of the petals fade slightly.

The type of flower color is monochrome. Coloring of perianth segments pale blue, almost white, there are large olive-yellow spots at the base of the outer segment, beard is blue. The flowers are medium, 7-8 cm in height, the edges of pertianth segments slightly corrugated. The flower stalk is in height 23-27 cm. The inflorescence consists of 4 flowers. Flowering is abundant, duration is 14 days. Outgrowth ability is average.

Pumpin Iron. Drought and phytophagous resistant. In hot sun, petal edges do not fade and do not lose color.

The color of the flower is two-color, the inner segments are red-violet, the outer ones are dark cherry with a red-violet border, and the beard is purple. The edges of the perianth segments are slightly corrugated. The flower stalk 25-28 cm in height. There are 3 flowers in the inflorescence. The flowers are average, 7-8 cm in height. Flowering is abundant, duration is 12 days. Outgrowth ability is average.

Indian Pow Wow. Drought resistant, phytophagous resistant. In hot sun, petal edges fade away slightly and turn pale.

Color type of flower with “broken” color. Inner perianth segments are creamy with brown splashes, outer are dark brown, with yellow stripes and brown splashes, beard is blue. The edges of the perianth segments are corrugated. Flower stalk height is 31-35 cm. There are 3 flowers in the inflorescence. The flowers are average, 6-7 cm in height. Flowering is abundant, duration is 12 days. The outgrowth ability is high.

‘Firestorm’. Drought resistant, phytophagous resistant. In hot sun, petal edges fade away slightly and turn pale.

Color type of flower with “broken” color. Inner perianth lobes are purple-wine with a dull yellow lumen in the center, outer ones are yellow with a wine-purple speck and border. Perianth segments edges are weakly crinkled. Flower stalk is 23-25 cm in height. Ther are 3 flowers in the inflorescence. The flowers are average, 6-7 cm in height. Duration of flowering is 11 days. Growth ability is average.

From “high prospectivity” group:

'Kiwi Capers' is drought resistant, phytophagous resistant. In hot sun, petal edges turn slightly pale.

The type of flower color is monochrome. Color of perianth segments is pink, beard is bright orange. Perianth segment edges are weakly crinkled. Flower stalk height is 23-25 cm. There are 3-4 flowers in the inflorescence. The flowers are average, 7-8 cm in height. Flowering is abundant, duration is 14 days. Growth ability is average.

Swish is drought-resistant. Damaging by diseases and pests is low. In hot sun, petal edges do not fade and do not lose color.

The type of flower color is monochrome with “broken” color. The color of perianth segments is brown-yellow, copper-brown along the edge and brown with specks in the center, beard is orange. Perianth segment edges are weakly crinkled. Flower stalk is 25-28 cm in height. The inflorescence contains 3-4 flowers. The flowers are average, 6-7 cm in height. Duration of flowering is 12 days. Growth ability is average.

May Magic is drought-resistant. Damaging by diseases and pests is low. In hot sun, petal edges do not fade and do not lose color.

Color type flower is double-tone ink. Coloring of perianth segments is pale pink-lilac, beard is yellow. The edges of the perianth segments are corrugated. Flower stalk height is 80-90 cm. There are 6-7 flowers in the inflorescence. The flowers are very large, 10-12 cm in height. Duration of flowering is 11 days. The outgrowth ability is high.

‘Margarita’ is drought resistant. Damaging by diseases and pests is average. In hot sun, petal edges do not fade and do not lose color.

The type of flower coloring is two-color. The color of the inner petals is white, the outer is purple, and the beard is blue. The edges of the perianth segments are corrugated. Flower stalk is 80-90 cm in height. There are 7-9 flowers in the inflorescence. The flowers are large, 9-11 cm in height. Duration of flowering is 12 days. The outgrowth ability is high.

Marina Raskova is drought resistant. Damaging by diseases and pests is average. In hot sun, petal edges do not fade and perianth edges is pale.

The flower color type is monochrome with “broken” color. The internal petals are pink, outer is dark-pink, mottled with lilac strokes, the beard is red. Perianth segment edges are weakly crinkled. The flower stalk height is 65-75 cm. There are 5-7 flowers in the inflorescence. The flowers are large, 8-10 cm in height. Duration of flowering is 13 days. Outgrowth ability is average.

‘Bronze Bell’ is drought resistant. Damaging by diseases and pests is low. In hot sun, petal edges do not fade and do not pale.

The flower color type is monochrome. Coloring of perianth segments is copper-brown, beard is dull orange. The edges of the perianth segments are smooth. The flower stalk is 75-80 cm in height. It has 6 flowers in inflorescence. The flowers are very large, 10-12 cm in height. Duration of flowering is 12 days. Outgrowth ability is high.

‘Buttercup Bower’ is drought resistant. Damage by diseases and pests is average. In the sun, they do not fade; the edges of the petals slightly lose their color.

Color type flower is double tone ink. The inner segments are yellow, the outer ones are white with a broad bright yellow border, and the beard is yellow. The edges of the perianth segments are corrugated. The flower stalk is 85-90 cm in height. There are 5-7 flowers in the inflorescence. The flowers are very large, 10-14 cm in height. Duration of flowering is 15 days. Outgrowth ability is high.

‘Grace Sturtevant’ is drought resistant. Damaging by diseases and pests is low. In the sun they do not fade and do not lose color.

The type of flower color is monochrome with “broken” color. The inner segments are brown, the outer ones are maroon-brown, yellow with wine-purple specks in the center. Perianth segments edges are even. Flower stalk height is 60-65 cm. There are 5 flowers in the inflorescence. The flowers are large, 8-9 cm in height. Flowering is abundant, duration is 12 days. Outgrowth ability is high.

Ilsan’ is drought resistant and phytophagous resistant. The petals are resistant in the sun.

The type of flower color is monochrome with “broken” color. The inner segments are mauve, the outer ones are dark maroon-red with a dark grid on a light background at the base, the beard is yellow. The edges of the perianth segments are weakly corrugated. The flower stalk is 80-85 cm in height. The inflorescence has 4-5 flowers. The flowers are large, 8-10 cm in height. Flowering is abundant, duration is 13 days. Outgrowth ability is high

From “Sky High prospectivity” group :

‘Bazaar’ is drought resistant. Damaging by diseases and pests is low. In hot sun, they do not fade and do not lose color.

The flower color type is double tone ink. The internal segments are light blue, the outer ones are dark purple, with purple veins in the center. The edges of the perianth segments are weakly corrugated. The flower stalk height is 60-65 cm. The inflorescence has 5 flowers. The flowers are large, 8-9 cm in height. Flowering is abundant, duration is 13 days. Outgrowth ability is high.

‘Port Wine’ is drought resistant. Damaging by diseases and pests is low. In the sun, the petals do not fade and do not lose color.

Type of flower color is monochrome. Perianth segments edges are purple-black, beard is dark-blue. Perianth segment edges are even. The flower stalk is 70-75 cm in height. The inflorescence has 6-7 flowers. The flowers are large, 8-9 cm in height. Flowering is abundant, duration is 12 days. Outgrowth ability is high.

‘Tomeco’ is drought resistant. Damaging by diseases and pests is low. In the sun, the petals do not fade and do not lose color.

The type of flower color is monochrome. Coloring of perianth segments are dark brown, beard is yellow. Perianth segments edges are corrugated. The flower stalk is 80-85 cm in height. There are 6-8 flowers in inflorescence. The flowers are large, 10-11 cm in height. Flowering is abundant, the duration is 15 days. Outgrowth ability is high.

‘StarShine’ is drought resistant, phytophagous resistant. In hot sun, petal edges do not fade and do not lose color.

The type of flower color is monochrome. Coloring of perianth segments is white, the base is yellow , beard is yellow. The edges of the perianth segment are finely corrugated. Flower stalk height is 77-83 cm. There are 5-7 flowers in the inflorescence. The flowers are very large, 9-11 cm in height. Flowering is abundant, duration is 14 days. Outgrowth ability is high.

Conclusion. Based on many years tests conducted at Mangyshlak Experimental Botanical Garden for the cultivation and reproduction of irises, both cultivated varieties and wild species, we can conclude that Mangyshlak has favorable climatic conditions that allow to grow irises without shelter for the winter. Irises can adapt to the most difficult soil and climatic conditions, which indicates of their unusual plasticity. The use of irises in the landscaping of the peninsula presents no problems and contributes to the enrichment of the floral and decorative range. By applying them for landscaping, you can create colorful flower spots where other more demanding plants feel oppressed.

Thus, the developed regional scale allows for a more objective and directed selection of the best varieties of irises for use in ornamental gardening, depending not only on their group membership, but also on indicators of biological stability, decorative qualities and reproductive performance. As a result of a comprehensive assessment, 9 highly promising and 4 very high promising iris varieties were identified that allow to create decorative floral compositions of various types in the Mangystau arid, and thereby replenish the range of ornamental perennial plants with new varieties.

Н. И. Дүйсенова, А. А. Иманбаева

ҚР БжҒМ «Маңғыстау эксперименталдық ботаникалық бақ» РМК, Ақтау, Қазақстан

АРИДТІ МАҢҒЫСТАУ ЖАҒДАЙЫНДА ГИБРИДТІ ҚҰРТҚАШАШТАР СҰРЫПТАРЫН ИНТРОДУКЦИЯЛАУ ЖӘНЕ ПЕРСПЕКТИВТІЛІГІН ЗЕРТТЕУ

Аннотация. Мақалада Маңғыстау эксперименталдық ботаникалық бағы (әрі қарай МЭББ) коллекциясындағы құртқашаштар сұрыптарының интродукциясын зерттеу нәтижелері сипатталған. Жұмыстың зерттеу мақсаты гибридті құртқашаштар сұрыптарын мақсатты интродукциялау, ол сұрыптардың сәндік сапасына кешенді зерттеу жүргізіп, Маңғыстау облысының жасыл құрылыс саласына қолданылу үшін перспективті сұрыптарын бөлу.

Құртқашаштар сұрыптарының биологиялық ерекшеліктері мен сәндік белгілерін кешенді бағалау үшін жалпы мақұлданған әдістер: Р.А. Карписонова, В.Н. Былов, Е.Л. Тыщенко және Ю.В. Тимкина, Решетникова Л.Ф. және МЭББ аймақтық кешенді шкаласы қолданылды.

МЭББ *Iris* L. интродукциялау жұмыстары 1978 жылдан бастау алады. Қазіргі таңда МЭББ гүлді-сәндік өсімдіктер коллекциясында гибридті құртқашаштардың 98 сұрыпы бар. Құртқашаштар сұрыптарының перспективтілігін анықтау үшін коллекциядағы 2009-2014 жылдар аралығынада жерсіндірілген 20 сұрыпы таңдап алынды.

Құртқашаштар сұрыпының перспективтілік сапасын бағалау кезінде 11 диагностикалық белгілер қарастырылды: құрғақшылыққа төзімділігі, фитофаготөзімділігі, гүлдерінің сыртқы ортаның қолайсыз жағдайларына төзімділігі, гүлдерінің реңі, өлшемі, пішіні, гүлдеу ұзақтығы, гүлсағағының ұзындығы және мықтылығы, гүлдеу қабілеті және көбею дәрежесі.

Зерттеу нәтижесі бойынша құртқашаштың 1 сұрыпына (Add It Ap) «орташа перспективтілік» тән болды, яғни сәндік сапасы төмен.

«Көтеріңкі перспективтілік» (70 балдан төмен) дәрежесі Маңғыстау жағдайында 6 сұрыпқа тән: Micheal Paul, White Queen, Cry Baby, Pumpion Iron, Indian Pow Wow, Fires Form.

Зерттелінген таксондардың ішінен 9 сұрып – Kiwi Capers, Swish, May Magic, Margarita, Марина Раскова, Bronze Bell, Butterfly Bower, Grace Sturtevant, Ilsan «жоғары перспективтілік» (71-80 балл аралығы) сипатқа ие болды

Маңғыстау жағдайында «өте жоғары перспективтілік» (81-90 балл) дәрежесі 4 сұрыпқа – Bazaar, Port Wine, Tomeco, Star Shine тиісті болды.

Түйін сөздер: интродукция, құртқашаш, сұрып, кешенді шкала, перспективтілік, Маңғыстау жағдайы.

Н. И. Дуйсенова, А. А. Иманбаева

РГП «Мангышлакский экспериментальный ботанический сад» КН МОН РК, Актау, Казахстан

ИНТРОДУКЦИЯ И ИЗУЧЕНИЕ ПЕРСПЕКТИВНОСТИ СОРТА ИРИСА ГИБРИДНОГО В АРИДНЫХ УСЛОВИЯХ МАНГИСТАУ

Аннотация. В статье представлены результаты интродукционного изучения сортов ирисов в коллекции Мангышлакского экспериментального ботанического сада (далее МЭБС). Целью наших исследований является целенаправленные интродукционные исследования сорта ириса гибридного, комплексное изучение декоративных качеств и выделение сортов, перспективных для зеленого строительства Мангистауской области.

Изучение биологических особенностей и определение комплексной оценки декоративных признаков сортов ирисов проводили по общепринятым методикам: Р.А. Карписоновой, В.Н. Былова, Е.Л. Тыщенко и Ю.В. Тимкиной, Решетниковой Л.Ф. и с помощью региональной комплексной шкалы МЭБС.

Интродукция *Iris* L. в МЭБС началась с 1978 года. Современная коллекция цветочно-декоративных растений МЭБС представлена 98 сортами ириса гибридного. Для оценки перспективных качеств сортов ириса нами были выбраны 20 сортов из коллекции, интродуцированных с 2009 по 2014 года.

При оценке перспективных качеств сортов ириса учитывали 11 диагностических признака: засухоустойчивость, фитофагоустойчивость, устойчивость цветка к воздействию внешних факторов среды обитания, окраска, размер, форма цветка, продолжительность цветения, высота и прочность цветоноса, репродуктивная способность и успешности возобновления растений.

По результатам исследований выявлен 1 сорт ириса (Add It Ap) «средней перспективности» (51-60 баллов), имеющий низкие декоративные качества.

К «повышенным перспективным» (менее 70 баллов) для культивирования в условиях Мангистау отнесено 6 сортов: Micheal Paul, White Queen, Cry Baby, Pumpion Iron, Indian Pow Wow, Fires Form.

Из изученных таксонов выявлено 9 сортов с «высокой перспективностью» (71 -80 баллов): Kiwi Capers, Swish, May Magic, Margarita, Марина Раскова, Bronze Bell, Butterfly Bower, Grace Sturtevant, Ilsan.

К «очень высокоперспективным» (81-90 баллов) для Мангистау отнесено 4 сорта: Bazaar, Port Wine, Tomeco, Star Shine.

Ключевые слова: интродукция, ирис, сорта, комплексная шкала, перспективность, условия Мангистау.

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STUDY OF QUALITATIVE COMPOSITION OF THE ATMOSPHERIC AIR MICROPARTICLES AND THE LEVEL OF ALMATY POPULATION MORBIDITY BY PULMONARY DISEASES

Abstract. A qualitative assessment of atmospheric microparticles in winter in the city of Almaty was carried out and the prevalence of the incidence of the population with respiratory diseases was studied. Physico-chemical methods for studying ultra-small solid particles and analysis of official information on the incidence of the population were used. It was found that microparticles are a heterogeneous structure and consist of combustion products of carbonaceous materials, biogenic compounds and metals. Biological reactions of the body with the arrival of solid particles can be associated not only with their size, but also physico-chemical characteristics, such as inorganic and organic composition, which depends on the source of pollution. About half of cases in the structure of the incidence of the population of the Republic of Kazakhstan belongs to diseases of the respiratory system. Almaty city among other subjects of administrative units of the Republic of Kazakhstan takes the leading position on the incidence of the population with respiratory diseases.

Key words: microparticles, ultra-small solid particles, air pollution, transport, morbidity, respiratory diseases.

Introduction. In recent years, the problem of air pollution in the cities began to be considered in the context of a global strategy for sustainable development [1-4].

In the center of the Eurasian continent at the foot of the mountains of Zailiysky Alatau, there is the city of Almaty - the largest city in Kazakhstan and Central Asia with a population of about 2 million people. The city is characterized by a small number of industrial enterprises and heavy traffic, where vehicles are the main source of air pollution – 80 % harmful emissions [5].

The increase in morbidity and, as a result, mortality of urban population is associated with the impact of pollutants from road transport, burning of gasoline and diesel fuel, wear of brakes, tires, pavement and road dust [6].

Vehicle emissions are a significant source of ultrafine particles (ultrafine particles - UFP), defined as particles with an aerodynamic diameter of less than 100 μm [7-9]. There are the following types of ultra-small solid particles depending on their diameter: fine particles – particles with an aerodynamic diameter equal to or less than 2.5 μm (PM2.5) and coarse particles – with a diameter of 2.5 to 10 μm (PM2.5-10) [10-11]. Biological reactions of the body to the arrival of solid particles depend not only on their size, but also on the physico-chemical characteristics, such as inorganic and organic composition, dependent on the source of pollution. Currently, over 20 real-time sensors have been installed in the city of Almata, which determine the concentration of PM2.5 [12].

The purpose of the study was to make a qualitative assessment of atmospheric microparticles from various traffic points in the winter in Almaty city and the level of spread of pulmonary diseases.

Methods. The qualitative content of ultra-small particles was determined in the winter of 2018 by collecting dust and snow along the main transport highways in various administrative district of Almaty, where there are no industrial facilities. Samples were collected for 10 days at the intersection of the streets in clear, windless weather. Paper filters installed in a horizontal position in an amount of at least 3 pieces per study point at a distance of 3-5 m from the edge of the road and 2 m from the ground. After the expiration of the exposure, the filters were cut into small pieces of about 5-6 cm2, then placed in a sterile bottle with 1 liter of sterilized distilled water, sonicated for 1 minute. The resulting aqueous solutions in a volume of 100 ml were passed through a system of polycarbonate IsoporeTM polypropylene (Millipore, USA) filters of different diameters to produce ultrafine particles (UFP) with a diameter of less than 100 μm and separating them in size: 0-5 μm, 5-10 μm, 10-30 μm. Further, in the obtained filtered solutions, the combustion products of the fuel and the heavy metals were determined.

The top layer of snow from a depth of up to 10 cm and an area of 1 m^2 was collected in 1 liter sterile containers, which were pre-washed twice with distilled water to prevent secondary contamination by anthropogenic aerosols. Samples were turned off at a centrifuge at 1500 rpm for 15 minutes. The supernatant was stored at minus 20 °C until use. Microscopy was performed using a Leica light microscope. Two sampling points were identified in the studies:

– "Upper part of the city" (Abai-Nazarbayev, Dzhambul-Pushkin);

– "Lower part of the city" (Pushkin - Raiymbek).

The pH of the solutions was determined on pH-meter PH3210 Set Tw; using the conductor TetraCon 325/Cond 3110 SET2 – electrical conductivity. Acid oxides, phosphates, lead and cadmium were determined according to conventional techniques on a SpectroquantSpectroPharo 100 spectrophotometer.

Results and Discussion. Figure 1 shows the stages of particle collection, sample preparation and particle microscopy results.

Microscopic study of aqueous solutions of dust and snow passed through filters of different diameters showed inclusions of black color of various forms, classified by us as ultra-small solid particles (figure 1).

The study of acidity indices revealed that water extracts of dust (before separation into fractions) and snow have acidic indices – 4.73-5.57. The lowest pH values were characteristic for snow samples (tables 1 and 2). The electrical conductivity of the snow was almost twice as large as the water solutions of dust, which is probably due to the cumulative capacity of snow. The obtained values of electrical conductivity indices for snow samples were practically identical to each other from different surveyed collection points, which was also characteristic for samples of aqueous dust solutions. When comparing the test samples with each other, there were no significant differences in the concentrations of sulfates, nitrates and nitrites. It should be noted that sufficiently large values of nitrite indices were noted for snow samples, but they were less than the maximum permissible concentration (MPC). On the contrary, for all samples, the MPC levels of nitrates were observed to be 4.0-5.8 times higher. Indicators of phosphorus oxide for aqueous solutions of dust were in the ranges 5.3-5.9 mg/dm^3 and were 1.5 and 1.7 MPC. For snow samples, the phosphorus oxide values were greater, and were 7.73-7.90 mg/dm^3 and 2.21 and 2.26 times the MPC, respectively. Concentrations of lead and cadmium in all the investigated samples of dust and snow significantly exceeded the normalized values. In aqueous solutions of dust, lead concentration was 116.7 MPC, cadmium 142.3 MPC, and in snow samples lead concentrations were 186.7 MPC, cadmium 184.3 MPC (tables 1, 2).

Depending on the size of the particles, different levels of heavy metals in aqueous solutions of dust and snow from different parts of the city are observed (table 3). Thus, it was revealed that in practically all samples tested the highest level of lead and cadmium is observed in aqueous solutions of solid particles with a size of 0-5 μm in comparison with particles of a larger size. This is due to the fact that smaller particles have a larger contact area. At the same time, the dependence of the metal content in the samples from the city area is traced: in the "lower" part of the city the content of metals is higher in comparison with the "upper" part of the city.

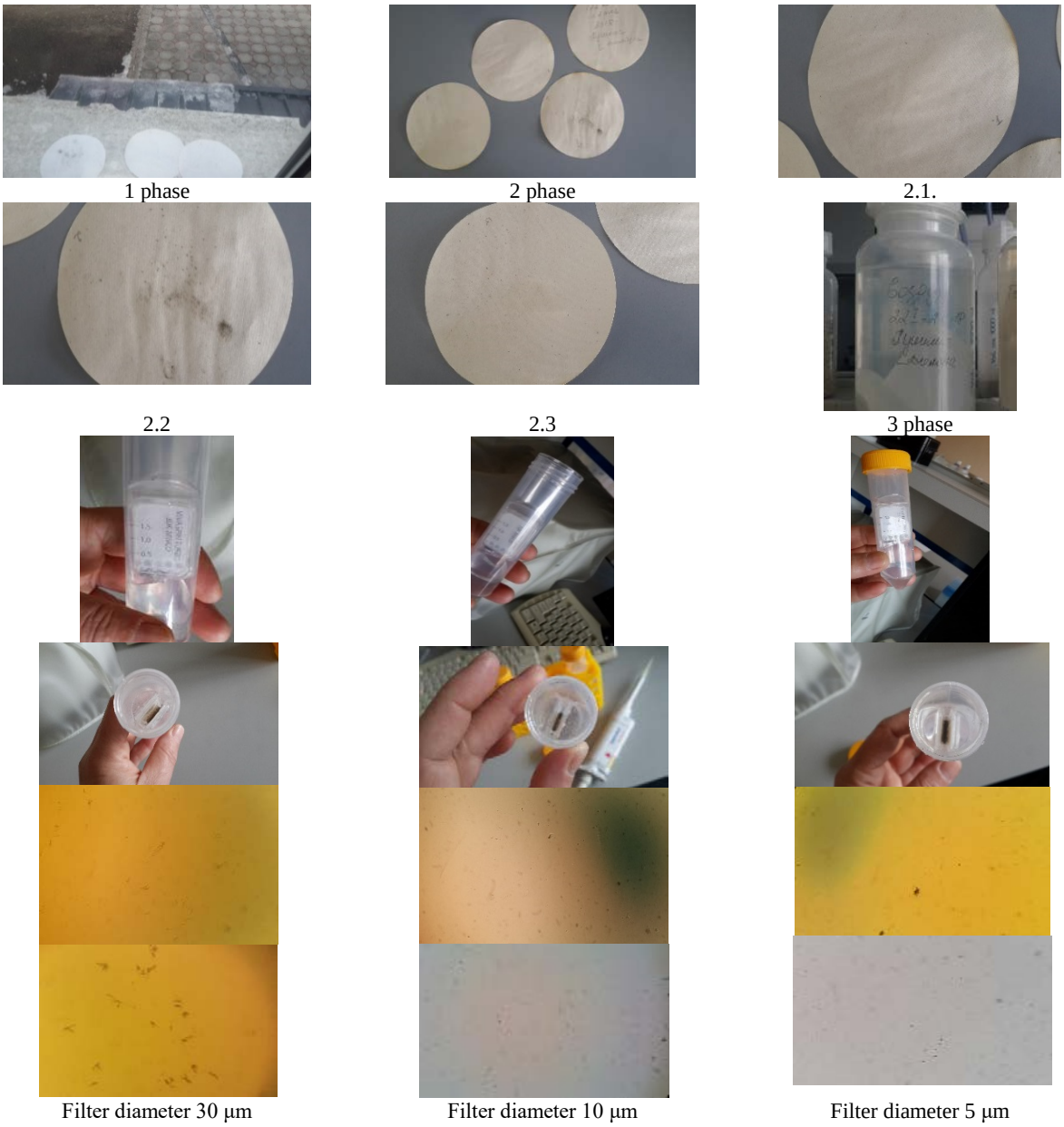

Figure 1 – Stages of particle collection, sample preparation and results of microscopic examination of ultra-small solid particles

Table 1 – Concentration of acid oxides and heavy metals in aqueous solutions of dust from different districts of Almaty, M ± m

Measured indicators	Indicators of the concentration of acid oxides and heavy metals in aqueous solutions of dust from different districts of Almaty		The values of MPC for the measured indicators, mg/dm^3
	"Upper part of the city" (Dzhambul-Pushkin)	"The lower part of the city" (Pushkin - Raiymbek)	
pH	5,56 ± 0,21	4,96 ± 0,23	–
Electrical conductivity, μS/cm	75,83 ± 2,99	68,53 ± 0,57	–
SO_4^{-2} , mg/dm^3	65,60 ± 1,94	69,66 ± 1,23	500,0
NO_2^- , mg/dm^3	15,06 ± 1,89	12,66 ± 0,31	3,0
NO_3^- , mg/dm^3	26,63 ± 0,30	27,46 ± 0,59	45,0
PO_4^{-2} , mg/dm^3	5,30 ± 0,30	5,90 ± 0,55	3,5
Pb^{-2} , mg/dm^3	3,50 ± 0,16	4,26 ± 0,34	0,03
Cd^{-2} , mg/dm^3	4,30 ± 0,16	5,86 ± 0,21	0,001

Table 2 – Concentration of acid oxides and heavy metals

in aqueous snow solutions from different districts of Almaty, M ± m

Measured indicators	Indicators of the concentration of acid oxides and heavy metals in aqueous solutions of snow from different districts of Almaty		The values of MPC for the measured parameters, mg/dm^3
	"The upper part of the city" Abay - Nazarbayev	"The lower part of the city" (Pushkin - Raiymbek)	
pH	4,73 ± 0,14	5,23 ± 0,18	–
Electrical conductivity, μS/cm	134,56 ± 0,98	144,20 ± 2,33	–
SO_4^{-2} , mg/dm^3	65,13 ± 0,73	67,36 ± 0,90	500,0
NO_2^- , mg/dm^3	17,40 ± 0,20	12,30± 0,16	3,0
NO_3^- , mg/dm^3	33,4 ± 0,85	35,30 ± 0,68	45,0
PO_4^{-2} , mg/dm^3	7,90 ± 0,45	7,73 ± 0,35	3,5
Pb^{-2} , mg/dm^3	5,60 ± 0,26	5,53 ± 0,46	0,03
Cd^{-2} , mg/dm^3	6,76 ± 0,39	6,16 ± 0,16	0,001

Table 3 – Metal content in samples of water solutions of dust and snow in different parts of Almaty depending on the size of solid particles, M ± m

District of the city	Measured pollution indicators		Dimensions of solid particles, μm		
			0-5	5-10	10-30
"Upper part of the city" (Dzhambul-Pushkin)	Air	Pb^{2+}	3,7 ± 0,4	2,8 ± 0,4*	2,4 ± 0,2*
		Cd^{2+}	3,9 ± 0,5	3,3 ± 0,6*	3,6 ± 0,3
"The lower part of the city" (Pushkin - Raiymbek)	Air	Pb^{2+}	4,0 ± 0,6	3,4 ± 0,1*^{o}	3,0 ± 0,1*^{o}
		Cd^{2+}	5,0 ± 0,6^o	3,4 ±0,7*	3,5 ± 0,5*
"The upper part of the city" (Abay - Nazarbayev)	Snow	Pb^{2+}	5,0 ± 0,4	3,5 ± 0,5*	3,5 ± 0,5*
		Cd^{2+}	5,9 ± 0,4	3,4 ± 0,6*	3,3 ± 0,2*
"The lower part of the city" (Pushkin-Raiymbek)	Snow	Pb^{2+}	5,0 ± 0,4	4,3 ± 0,7	4,3 ± 0,6^o
		Cd^{2+}	6,2 ± 0,4	4,5 ± 0,6*^{o}	3,0 ± 0,5*

Note: for $P \leq 0.05$ (the Mann-Whitney U test).
* - in comparison with the particle size; ^{o} - compared to the place of sampling.

Table 4 shows the incidence rates of respiratory diseases in the structure of the overall morbidity of the population of the Republic of Kazakhstan on the basis of statistical data of the single site of the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan www.stat.gov.kz. There is a trend of increasing respiratory rate in the past five years by almost 2 % and they make up on average 40 % of cases. In this case, the incidence of respiratory diseases among children is more than 60 % with an increase of 2 % over the past 5 years.

Table 4 – Morbidity of the population with respiratory diseases of the Republic of Kazakhstan in the structure of the overall incidence

Diseases of the respiratory system in the structure of the general morbidity by the main groups of diseases by years, %	2012 year	2013 year	2014 year	2015 year	2016 year
Morbidity of the adult population	41,6	41,8	41,5	42,0	43,5
Morbidity of children aged 0-14 years	59,8	60,1	59,7	60,0	61,8

The city of Almaty holds a leading position on the incidence of respiratory diseases among other administrative units of the Republic of Kazakhstan with an increase of 80 912 cases over the past five years (figure 2).

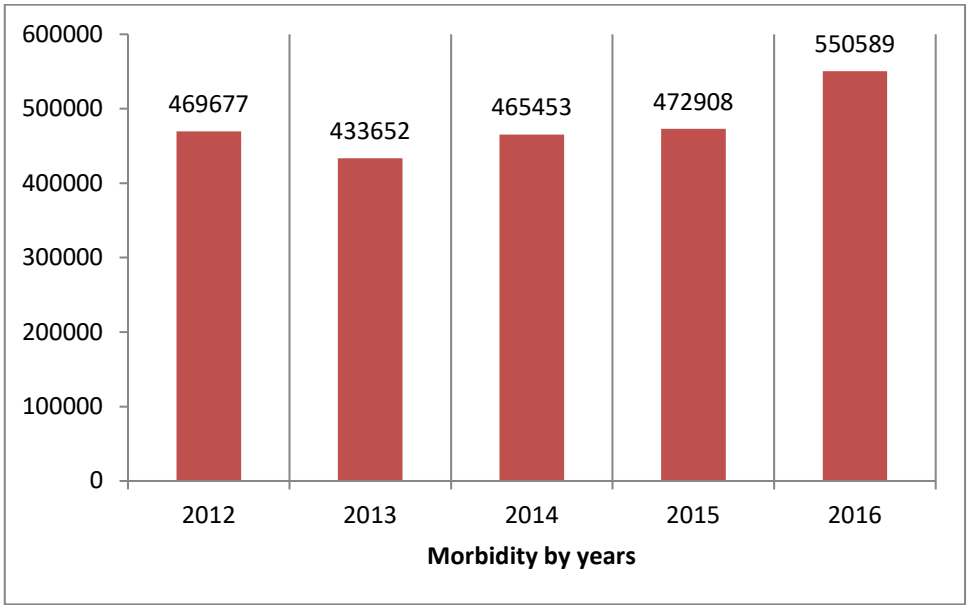

Figure 2 – Morbidity of the Almaty city population with respiratory diseases.

The problem of air quality is of vital importance in ensuring the health of the population in the terms of increasing technogenic and climatic changes. To date, the pathogenetic mechanisms of diseases such as asthma, cardiovascular, atherosclerosis have been determined. It has been shown that ultrafine solids (UFP) can not cause death in healthy people, but may increase the mortality rate among vulnerable groups, such as children, the elderly or people with weakened immune systems [12].

It is believed that ultrafine particles have the greatest impact on human health [13]. Increasing the level of their content increases the number of respiratory and cardiovascular disease [14]. Such particles have a large cumulative ability, the ability to penetrate the epithelium, as well as an increased proportion of organic material and metals in the composition, which leads to their high oxidative potential [15].

Epidemiological studies have found a positive correlation between the short-term exposure to elevated levels of airborne particles having an average diameter of less than 2.5 μm and the population mortality. The effect of PM2.5 is statistically significant in cardiovascular and respiratory infections, reducing life expectancy by about 8.6 months [16].

Conclusions. Solid particles are a heterogeneous structure and consist of combustion products of carbonaceous materials, biogenic compounds and metals. In all the investigated areas of Almaty, the MPC is exceeded for nitrites, phosphates, lead and cadmium.

With the decrease in the size of solid particles, the process of settling of heavy metals on their surface increases, which makes them most hazardous to health.

About half of the cases, according to official statistics, in the structure of morbidity of the population of the Republic of Kazakhstan belong to the diseases of the respiratory system. Almaty among other subjects of administrative units has a leading position on the morbidity of respiratory diseases.

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АЛМАТЫ ҚАЛАСЫ ХАЛҚЫНЫҢ ӨКПЕ АУРУЛАРЫМЕН АУРУШАҢДЫҚ ДЕҢГЕЙІН ЖӘНЕ АТМОСФЕРАЛЫҚ АУА МИКРОБӨЛШЕКТЕРІНІҢ САПАЛЫҚ ҚҰРАМЫН ЗЕРТТЕУ

Аннотация. Алматы қаласында қысқы кезеңде атмосфералық ауаның микробөлшектеріне сапалы баға берілді және халықтың тыныс алу ағзалары ауруларымен аурушаңдығының таралу деңгейі зерттелді. Аса аз қатты бөлшектерді зерттеудің физика-химиялық әдістері және халықтың аурушаңдығының ресми ақпаратын талдау қолданылды. Микробөлшектер гетерогенді құрылымды білдіреді және көміртекті материалдардың,

биогенді қосылыстар мен металдардың жану өнімдерінен тұрады. Қатты бөлшектер түскен кезде ағзаның биологиялық реакциялары олардың өлшемдерімен ғана емес, сонымен қатар ластану көзіне байланысты органикалық емес және органикалық құрам сияқты физикалық-химиялық сипаттамалармен байланысты болуы мүмкін. Қазақстан Республикасы халқының аурушаңдығы құрылымындағы жағдайлардың жартысына жуығы тыныс алу органдары ауруларына жатады. Алматы қаласы Қазақстан Республикасының әкімшілік бірліктерінің басқа субъектілерінің арасында халықтың тыныс алу ағзалары ауруларымен аурушаңдығы бойынша жетекші орынға ие.

Түйін сөздер: микробөлшектер, өте аз қатты бөлшектер, атмосфералық ауаның ластануы, көлік, ауру, тыныс алу органдарының аурулары.

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ИЗУЧЕНИЕ КАЧЕСТВЕННОГО СОСТАВА МИКРОЧАСТИЦ АТМОСФЕРНОГО ВОЗДУХА И УРОВНЯ ЗАБОЛЕВАЕМОСТИ ЛЕГОЧНЫМИ БОЛЕЗНЯМИ НАСЕЛЕНИЯ Г. АЛМАТЫ

Аннотация. Проведена качественная оценка микрочастиц атмосферного воздуха в зимний период в городе Алматы и изучен уровень распространения заболеваемости населения болезнями органов дыхания. Использованы физико-химические методы изучения сверхмалых твердых частиц и анализ официальной информации заболеваемости населения. Установлено, что микрочастицы представляют собой гетерогенную структуру и состоят из продуктов горения углеродистых материалов, биогенных соединений и металлов. Биологические реакции организма при поступлении твердых частиц могут быть связаны не только с их размерами, но и физико-химическими характеристиками, такими как неорганический и органический состав, который зависит от источника загрязнения. Около половины случаев в структуре заболеваемости населения республики Казахстан принадлежит заболеваниям органов дыхания. Город Алматы среди других субъектов административных единиц республики Казахстан занимает лидирующее положение по заболеваемости населения болезнями органов дыхания.

Ключевые слова: микрочастицы, сверхмалые твердые частицы, загрязнение атмосферного воздуха, транспорт, заболеваемость, болезни органов дыхания.

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PROBLEMS OF MUNICIPAL SOLID WASTES IN THE REPUBLIC OF KAZAKHSTAN

Abstract. It has been shown that the proposed method for processing municipal solid wastes by means of application of new technologies, using the process of pyrolysis, will minimize the release of toxic substances into the environment after their preliminary sorting, and with the correct organization of the waste management market.

Key words: ecology, municipal solid wastes, morphological composition, utilization, pyrolysis, processing.

Introduction. According to the statistical data, more than 20 billion tons of production and consumption wastes have accumulated in Kazakhstan. Annually, 5-6 million tons of municipal solid wastes (MSW) are generated in the country. For the eight months of the year 2018 about 3.2 million tons of wastes have been generated, whereof approximately 330 thousand tons, or ~ 10.5%, have been processed and utilized. Last year this indicator made up 9%, and in the year 2016 - 2.6%. For the reduction of wastes and their involvement in recycling, economic levers of incentive should be applied. The Government has approved the Plan for the Formation and Development of the "Metallurgy" Pilot Cluster. It provides for the measures to stimulate the processing and utilization of the production wastes of the metallurgical enterprises for increasing the integrity of processing the raw materials and complying with the ecological requirements for the environmental protection, including the introduction of changes into the existing legislation.

Therefore, the solution to this problem is an important, essential task of today, as a result of which the negative consequences of the activities of the urban infrastructure and society as a whole may be prevented.

In Kazakhstan the situation with the utilization and subsequent processing of municipal solid wastes still remains at the level of the 90s. Recovery of the recyclable materials from the mixed municipal solid wastes is planned for the implementation only in a few cities, and even then, without biodegradable wastes. All this fetid mass is explosive, it pollutes the ground and surface waters, and also affects the climate change; a waste landfill of the world class is so far available only in Astana. Despite the closure of a number of industrial enterprises for economic reasons, the concentration of hazardous substances in the city atmosphere still exceeds several times the permissible standards. Herewith, as it is noted by the experts, the most dangerous substances, i.e. fine solids, carcinogens, heavy metals, are neither measured nor controlled. Although, it is known that a short-term exposure to fine solids increases the morbidity and mortality of the population.

The work [3] pays special attention to the problem of studying the processes of waste formation, transportation, accumulation, management, and consumption, defining the existing shortcomings and developing measures for their elimination. In this connection, it seems to us appropriate to draw attention to one of the approaches to the problem of municipal solid wastes (MSW) - the Concept of Integrated Waste Management (IWM). This approach takes into account the following provisions, confirmed by the global experience:

- firstly, there is no single technology, capable of processing the entire waste stream without harm to humans and the environment;

- secondly, even a suite of technology may bring to the solution of the waste problem only when it is applied together with a set of economic and social instruments [3].

Kazakhstan has an opportunity to receive certain benefits from the development of this market, having in mind both the environmental and economic aspects of the issue. Due to the proper organization of the waste management market, through the application of new technologies, it is possible to minimize a harmful impact on the environment. Herewith, the companies engaged in this sphere, by means of using the advanced technologies, may improve the quality of their own work, which in turn will increase their competitiveness in this market.

"Since the year 2016, the country has introduced a ban on burial of mercury-containing lamps and appliances, scrap metal, spent oils and liquids, batteries, electronic wastes. From January 2019, a ban on burial of plastic, scrap paper, cardboard, paper and glass wastes comes into force. And from January 2021, a ban on burial of construction and food waste will come into force," - said the Minister of Energy of Kazakhstan, Mr. K. Bozumbayev. The high level of environmental pollution in Almaty was noted compared with the world leaders in pollution. The development of health care in order to improve the quality of life of the population indicated the need to support educational and research institutions in the medical field [3-5].

Problems of processing MSW:

- unsorted MSW;
- high humidity;
- low heating value;
- impossibility of compliance with an environmentally safe technology;
- storage on waste landfills;
- composting;
- waste incineration.

There are two main methods for processing MSW:

1. mechanical and biological methods - composting wastes, sorting wastes by recycling enterprises;
2. thermal methods: waste incineration, pyrolysis, waste gasification, combined thermal methods.

It should be noted that incineration is a widespread method for the destruction of MSW, which has been widely used since the end of the 19^{th} century. Unfortunately, the main drawback of this method is the emission of harmful substances into the atmosphere and destruction of valuable organic and other components, contained in MSW.

Upon MSW incineration 28–44% of ash and gaseous products (CO_2, vapors of H_2O, and various impurities) are obtained. Combustion takes place at t = 800 - 900ºC, so aldehydes, phenols, dioxins, furans, heavy metals are present in the gases. This mixture is more dangerous than such military gases as sulfur mustard and sarin.

The solution, which we propose for processing MSW, is pyrolysis.

Pyrolysis is a process, wherein the grinded waste material undergoes thermal decomposition in the absence of air [5-7].

As a result of pyrolysis three main products are formed:

• pyrogas (pyrolysis, pyrolytic gas or synthesis gas) is a mixture of gases, both combustible and non-combustible;

• pyrolysis (pyrolytic) oil and water. Pyrolysis oil has a different composition and can subsequently serve as heating oil or raw material for processing;

• picarbon (solid carbon-containing residue - coal).

Pyrolysis process flow sheet is shown in figure 1.

As is seen from figure 1, in the course of pyrolysis four processes, common to all its types, proceed. By the effect of different temperatures on the wastes, pyrolysis is divided into a low-temperature and high-temperature one. The first one proceeds at the temperature up to 900^0C, and the second one - at temperature above 900^0C.

The technology of waste treatment during the *low-temperature pyrolysis* consists in heating the raw materials in the mine up to 350-450 ^{0}C in the absence of air, i.e. in the absence of both oxygen and nitrogen.

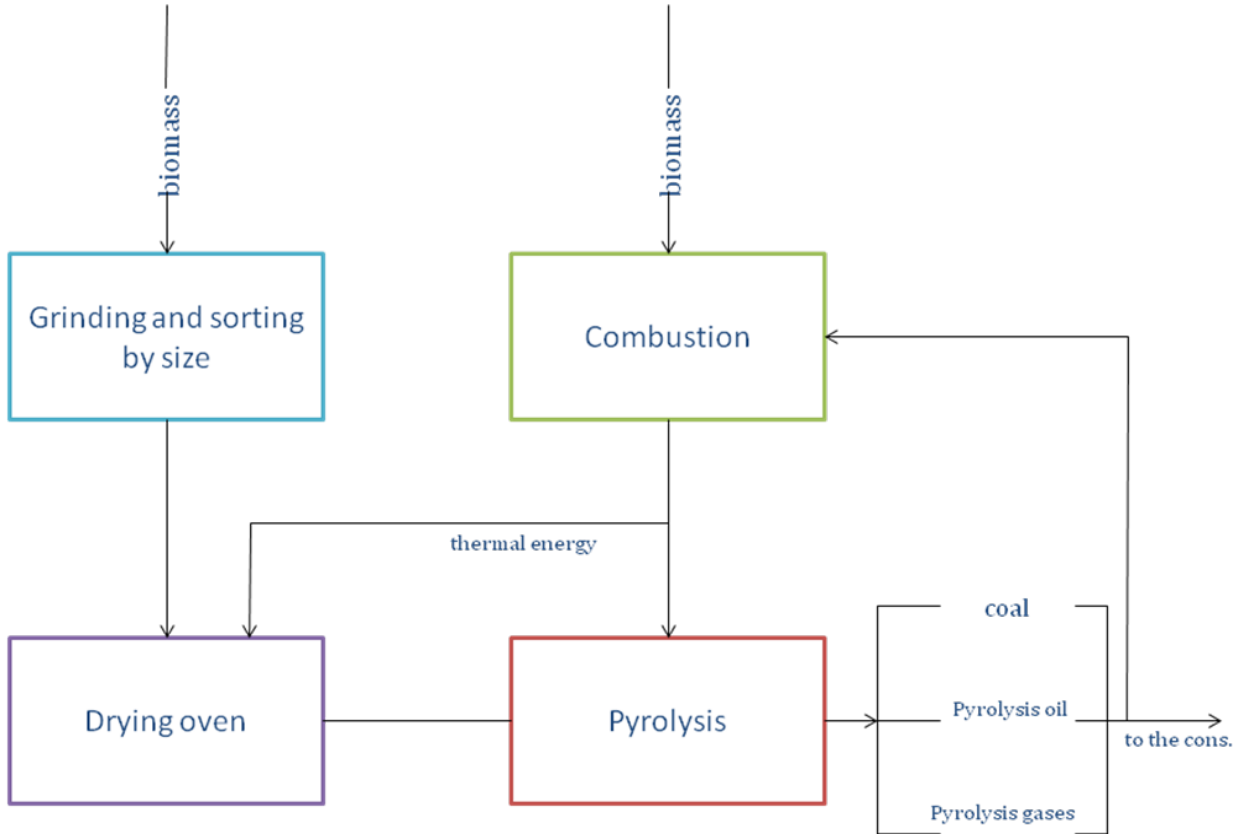

Figure 1 – Pyrolysis process [8]

The process chain of the *high-temperature pyrolysis*, presented in Fig. 3, includes:

1. waste sorting with the removal of large objects, non-ferrous and ferrous scrap metal;
2. grinding and drying of the selected waste;
3. decomposition of dried raw materials with the purpose to generate pyrolytic gas, pyrolytic oil, slags and by-products such as Cl_2, F_2, N_2;
4. elimination of pollutants and lowering of the temperature of the produced gas;
5. use of pyrolytic gas for generating steam, electric or thermal energy. Most often, this gas is used reversibly to initiate pyrolysis;
6. pyrolytic oil after storage is sent as a raw material to the petrochemical industry plants for the production of fuel and lubricants, heating oil substitutes and fuelwood

Of particular note are the positive aspects of the proposed pyrolysis methods:

1. The low-temperature pyrolysis:

- no urgent need to sort hydrocarbon residues (even the completely unsorted wastes provide a yield of pyrolysis gas twice as much as compared only with that of food wastes);
- a possibility of using MSW after their preliminary sorting as a source of raw materials for production;
- *an important feature is the absence of toxic sulfur and nitrogen oxides in the combustion products.*

2. The high-temperature pirolysis:

- a possibility to process the raw materials with a small quantity of combustible materials;
- the resulting gas rises upwards and passes through a layer of wastes, which is fed from above. In this case, the gas does not capture dust particles, which serves as a guarantee of its purity;
- pyrolysis gas is similar to natural gas, and it is expedient to use it to generate thermal energy and to generate electricity in small power plants;
- it is easier to clean pyrolysis gas from unnecessary impurities (if any) due to the low temperature;

- since the process proceeds in the absence of oxygen, pyrolysis gas does not contain hazardous dioxins, generated upon the combustion of hydrocarbons.

Out of various high-temperature methods of MSW treatment the following processes have been tested on a pilot and semi-industrial scale:

1) the process of "semi-carbonization - incineration" of SIEMENS Company, Germany;
2) the process of "pyrolysis-gasification" of NOELL Company, Germany;
3) the process of "pyrolysis-gasification" of "Thermoselect S.A", Italy;
4) the process of incineration at the temperature of 1350-1400°C in a slag melt layer [9-15].

Of the various technologies for waste biotreatment, the most progressive one at present is the technology of biothermal aerobic fermentation of BUHLER Company, Switzerland. The leading companies of the USA, Germany, Italy, and Japan have now switched to the Buhler technology, abandoning the technology of composting in bio-drums (used in all CIS plants) [16, 17].

The products obtained by these methods are in a good marketable state, and can be used not only as fertilizers (which is the practice in Italy, Spain and France), but also as the source raw materials for the production of ethyl alcohol, and as the processed fuel for combustion, etc. [16, 17].

Materials and study methods. For the conduction of the studies an experimental site for MSW deep sorting has been selected and special facilities for the workers' rest (two rooms with a shower and a toilet), a storage facility for the MSW, sorted by type, a storage facility for salvage work tools, equipment and first-aid kits in case of emergency have been built. An overhead crane for lifting and transferring containers with MSW, a press machine for packaging waste paper, 7 Euro bins with a capacity of 1.1m^3, a table for sorting wastes have been installed. A center for recycling glass and paper wastes is provided for.

Study results and discussion. In the modern period of development of young independent Kazakhstan, the topical issues include: ensuring environmental safety, environmental education of the population, accustoming the population to the habit for packaging standards, transportation, storage, and utilization of MSW, strict compliance with the Environmental Code of the Republic of Kazakhstan by the enterprises and population of Kazakhstan.

The main problems of MSW collection and utilization in the megacities include: ensuring the maintenance of sanitary conditions to prevent the emergence and spread of various epidemics, low culture of the population, both at production site and in everyday life, related to the elementary cleanliness, the lack of understanding the harmfulness of MSW accumulation for general health due to the pollution of soil, water and air.

Annually, on average 200-300 kg of MSW (about 1 m^3) are estimated for each city dweller. Besides, every year the wastes increase by 4-6%, which is three times as much as an increase in the birth rate in the country. Soon we will have just nowhere to dump wastes.

Nonetheless, recycling is a very profitable business, especially if approached wisely. For example, MSW are successfully used as recyclable materials. Unfortunately, the current MSW flow sheet does not provide for the use of municipal solid wastes as recyclable materials. Besides, a waste landfill, created in a deep ravine and located 30 km from the city, where the bulk of wastes is stored, 97% of which does not meet the requirements of the environmental and sanitary legislation of the Republic of Kazakhstan, causes great harm to the environment. Harmful substances are carried out by rain and flood waters to the rivers. In summer, the landfill spontaneously ignites and carries all harmful smoke to the city. Reclamation of a landfill is not carried out. Rotting residues of food waste spread stench and poison the air, attracting flies, rats and other animal vectors.

All this leads to the conclusion that the existing technologies for processing of municipal solid wastes cannot offer any decentralized methods of processing on site, and, therefore, the main directions for solving the problem can be reduced only to *the preliminary sorting of wastes with the purpose of their processing and re-using* [18].

Thus, we conclude that it is necessary to apply to strict actions, without hoping for vast spaces and waste incineration. Carrying out separate MSW collection and studying the morphological composition of the wastes have allowed the "Tabigat" Ecological Union to start introducing a new method for the separate MSW collection. A flow sheet of municipal solid wastes has been developed, wherein an intermediate stage is the creation of a waste sorting facility (figure 2).

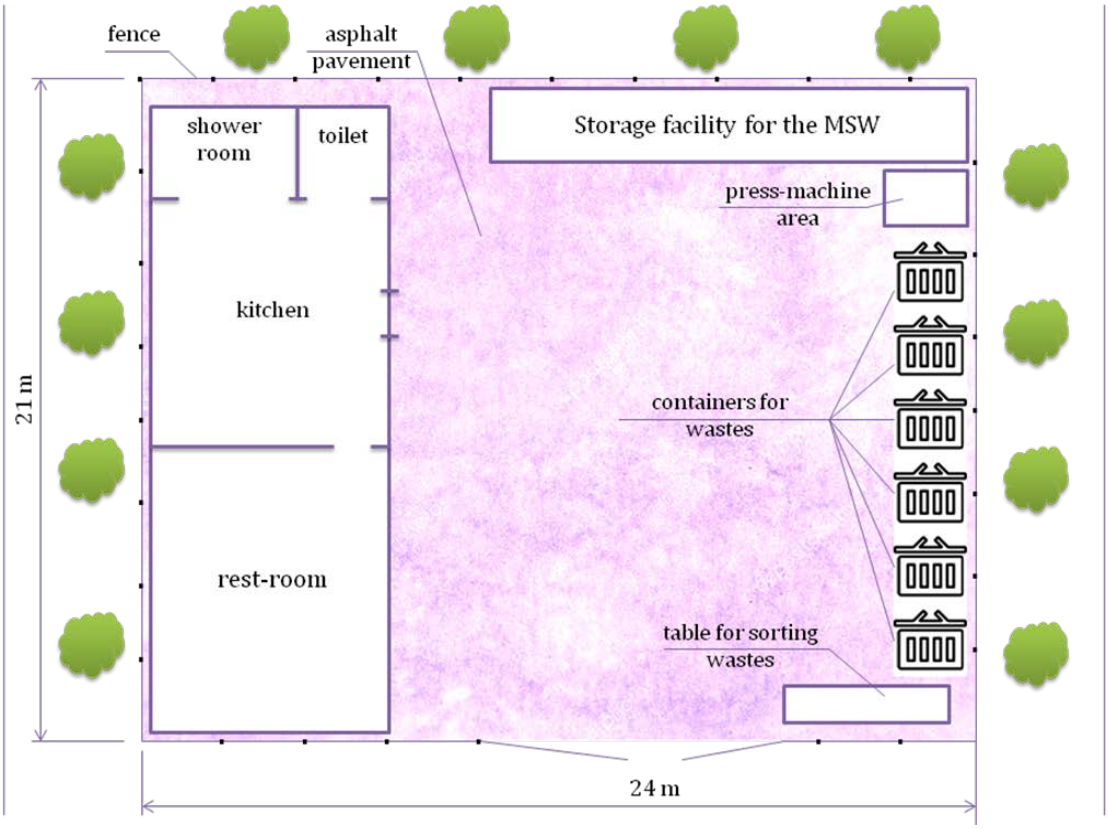

Figure 2 – A waste sorting facility

Due to the mixture of organic and inorganic wastes - paper, polymer wastes, etc., the recyclable materials lose their value, the cost of technologies for their cleaning and washing increases. That is why it is quite rational in the residential compounds to sort the wastes into organic and inorganic fractions. The waste sorting facility separates the inorganic wastes into paper, film, PETF bottles, etc.

Thus, the residents will not need to accumulate several packages for different types of wastes - there will be only two of them. The cost of cleaning the recyclable materials will decrease, and there will be more opportunities to sell it at a bargain price.

The experimental waste sorting facility has been located at the corner of the Satpayev and Rudnev streets. In the process of sorting municipal wastes, their approximate morphological composition has been established, which is shown in the table.

Morphological composition of the wastes

No.	Wastes	%	Specific input kg/cap/day	Specific admission kg/cap/year	Total population in mln. people	Input volume mln. kg/year
1	Paper	0.094	23	34.25	0.2	6.85
2	Food wastes	0.102	25	37.25	0.2	7.45
3	Polyethylene	0.009	2	3.3	0.2	0.66
4	Plastics	0.0099	3	3.6	0.2	0.72
5	Metals	0.0049	1	1.8	0.2	0.36
6	Textile	0.0099	3	3.6	0.2	0.72
7	Glass	0.051	14	18.63	0.2	3.67
8	Fine wastes	0.083	24	30.34	0.2	6.07
9	Plastic foam	0.0049	1	1.8	0.2	0.36
	Total:	**0.3785**	**100**	**138.17**	**0.2**	**27.58**

The data on the volume of wastes are provided on the basis of the performance indicators of the experimental site for 1 month.

The conducted experiment on the separate collection of municipal solid wastes and the study of their morphological composition for 8 years, have confirmed a possibility of collecting MSW in the city by the proposed method with the obtaining of a significant quantity of recyclable materials for their subsequent processing by our ***pyrolysis method***.

The creation of such integrated methods for sorting municipal solid wastes with their subsequent processing by the methods of low-temperature and high-temperature pyrolysis will solve the following existing problems:

- cleaning the city of MSW;
- improvement of the environment situation my means of using the methods of MSW incineration in the absence of air;
- development of industrial processing of the recyclable materials, saving the natural resources (gas, forest, chemicals);
- arrangement of the production of new types of industrial products, based on the use of innovative technologies;
- creation of import-substituting industries (various types of paper products).

Conclusion. Thus, an integrated approach to the utilization of municipal and industrial wastes has been proposed, which consists in using the developed method for preliminary sorting of municipal solid wastes with the subsequent application of the pyrolysis processes.

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ҚАЗАҚСТАН МЕМЛЕКЕТІНДЕГІ ҚАТТЫ ҚАЛДЫҚТАР МӘСЕЛЕСІ

Аннотация. Ұсынылатын әдіс тұрмыстық қатты қалдықтарды өңдеуде жаңа технология негізінде пиролиз үрдісін қолдану қалдықтарды жіктеуден кейінгі қатты заттардың қоршаған ортаға түсуін азайтуға, сонымен қатар тұрмыстық қатты қалдықтарды қайта өңдеуге мүмкіндік беретінін көрсетті.

Түйін сөздер: экология, қатты қалдықтар, морфологиялық құрамы, утилиздеу, пиролиз, қайта өңдеу.

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ПРОБЛЕМЫ ТВЕРДЫХ БЫТОВЫХ ОТХОДОВ В РЕСПУБЛИКЕ КАЗАХСТАН

Аннотация. Показано, что предлагаемый способ переработки твердых бытовых отходов за счет применения новых технологий с использованием процесса пиролиза позволит минимизировать выброс токсичных веществ в окружающую среду после предварительной их сортировки, а также при правильной организации рынка по утилизации твердых бытовых отходов.

Ключевые слова: экология, твердые бытовые отходы, морфологический состав, утилизация, пиролиз, переработка.

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MONITORING SOY DISEASES ON IRRIGATED LANDS OF KAZAKHSTAN

Abstract. The flock contains data on the monitoring of soybean crops carried out by the Almaty and Zhambyl regions on the spread and development of diseases.It was found that fusarium, peronosporosis, white and gray rot are widespread soy disease, as well as ascochitosis, septariosis, anthrocnosis and a burn of stems. It has been shown that fusariosis occurs in all soybean crops in the Almaty region. The causative agents are fungi of the genus Fusarium spp. From leaf forms of diseases peronosporosis is widespread. On the Eureka-357 variety, the development of the disease was 25.7%, and the prevalence of the disease reached 100%. Infection of soybean seeds with diseases was determined. On soybean seeds, the most common pathogen is a Fusarium infection. It is found in all analyzed seeds of the varieties of this culture. The results of the evaluation of soybean seed dressers are presented.

Among the treated dressers, the most effective were foundazole and Maxim, where, when using these dressers, the norm was 2-3 l / t, the intensity of the development of the disease during the harvest period decreased by 7.95 and 8.2%, respectively.

Key words: soy, disinfectant, distribution, degree of disease development, germination, fusarium, white and gray rot, peronosporosis, efficiency, seeds, yield.

In recent years, in the Republic of Kazakhstan, much attention has been paid to increasing soybean production, it is being taken to increase the yield of this valuable crop, expand sown areas, and reduce crop loss from diseases. It is well known that among legumes soybean has a high content of essential nutrients. Its seeds contain up to 50% of high quality raw protein. In addition, its protein has a higher digestibility coefficient, and it is richer in valuable essential amino acids (lysine, methionine, tryptophan, etc.). By biological value, soy is compared with the protein of meat, milk, eggs, the fat content of 25% and no worse than butter from cow's milk. Soy also contains minerals vitamins [1]. All this allows you to use it for food, technical and feed purposes [2].

Soybean is also of great importance in increasing soil fertility. Due to nodule bacteria, the arable layer is enriched with organic nitrogen. In addition, it is a good precursor for many [3,4] crops.

Being a culture of multifaceted use, soy is unparalleled in its universality of application. Already now it is used for the manufacture of more than 400 types of industrial products.

As you can see, the economic value of soybeans is multifaceted, therefore, a comprehensive increase in the size of sown areas in southeast Kazakhstan and its advancement to the east (East Kazakhstan region), west (Aktyubinsk, West Kazakhstan region) and north (Kostanay region) countries is an important step in the intensification of agricultural production. The introduction of this crop in the irrigated lands of the south, southeast, east, west and north of the republic that meets the biological and biological requirements of soy according to the soil and climatic conditions will make it possible to increase the productivity of each irrigated hectare, the payback of costs and the productivity of animal husbandry.

Currently, sown area under soybean reaches 150 thousand ha, which is not enough for Kazakhstan. The reserves for obtaining raw materials for the production of soy protein in the republic are essentially unlimited. Kazakhstan has every opportunity to bring clean soybean crops to 1.0 million ha.

In the republic, in leading equitable farms, subject to all the rules of agricultural technology, they get a high yield. So, in 2000 in the PC named after D.A. Kunaev, Talgar district, Almaty region, the soybean grain yield was 46.5c / ha, in the same year, the Aktyubinsk regional station received a crop of 27.09 / ha, and in 2015 on an experimental base of the Kazakh Research Institute of Agriculture and Plant Growing, the yield per hectare reached 67 , 5ts / ha. At the same time, in recent years, there has been a tendency to an increase in yield losses of this valuable crop due to the spread of various harmful organisms in its crops, which include infectious diseases that affect soybeans during different periods of vegetation.

Currently, according to scientists around the world, more than three hundred diseases have been discovered on soy. For example, in the USA, 25 pathogens are a constant threat to this culture, of which 19 are fungal, 3 are bacterial and 3 are viral. In China, out of the 8 most common diseases, fungal infections are 6. In Russia, only 32 soy pathogens are known, in Ukraine - 23. In the Russian Federation, among the 6-7 main soy pathogens, as a rule, 1-2 bacterial [5] are constantly called.

Soy diseases annually cause enormous damage to the crop of this valuable crop. So, in years with normal weather conditions in the Far East [6,7], due to damage to plants by various diseases, seed yields decrease by 20-30%, and in years with heavy rainfall by 50% or more.

We are in 2013-2017. Together with the staff of the leguminous crops department of the Kazakh Research Institute of Agriculture and Plant Growing, the phytosanitary condition of soybean crops was studied. The spread of diseases and the species composition of pathogens was studied by route surveys of soybean crops in Almaty and Zhambyl regions, and seed contamination was determined according to generally accepted methods [8, 9].

More than 20 diseases were registered on soybean plants in the republic: 15 fungal, 3 viral and 3 bacterial diseases. Among soy diseases in the republic, the most common and harmful are fusarium, peronosporosis, white and gray rot, and also in some regions of the country - phomopsis.

Fusarium is especially widespread in recent years. The causative agents are fungi of the genus Fusarium spp. The fungus infects seedlings and causes plants to wilt. So, the death of shoots from Fusarium infections in a cold and protracted spring can reach 30-50%. They were most affected by soybean in those farms where crops were thickened, clogged and crop rotation was not observed. So, in certain fields of the farm “Amangeldi” of the Koksu region, the damage to plants by the disease reached 50% [11]. In other farms on soybean crops, foci were found where 15-25% of plants were affected. In this regard, some fields had to be reseeded.

In wet years, white and gray rot spread strongly on soybeans (they were observed everywhere in 2013,2016 and 2017. Of the diseases affecting mainly plant leaves, downy mildew is widespread. The degree of damage in wet years reaches up to 100%, which leads to a decrease in the assimilation surface of the leaves, as a result of this pathogen can reduce the yield of this culture to 60-70%.

Surveys have shown that in a number of farms the development of epiphytoties of white, gray rot and peronosporosis or downy mildew was promoted not only by weather conditions, but also by violations of the technology of cultivation of the crop. Some farms do not comply with crop rotation and return soybeans to their former place in two to three years or even earlier. There is a farm culture cultivated in monoculture. This leads to massive accumulation of fungal infection in the soil.

Farm “Turgen” of Enbekshikazakhsky district soybean crops were heavily clogged with sow thistle and annual weeds, where 70% of the field was affected by plants affected by white and gray rot. Ayyr-Shir LLP of Talgar region, where soya is paid enough attention, is grown on a high agricultural background, there were no diseases on the crop during the growing season or they appeared to a weak degree before harvesting.

Zoned varieties of local and foreign selection, as well as varieties and varietal samples that are in a competitive test, are not resistant to diseases affecting soybeans (table 1).

Seeds serve as a source of infection of plants with dangerous infectious diseases. They can preserve the causative agents of many infectious diseases, be a source of renewal for the next year; with seeds, pathogens can be transferred to new areas where they did not exist before, i.e. are important in the migration of pathogenic microorganisms and the spread of infectious diseases of soy. Seed infection in soybeans is very harmful, its development on seedlings leads to the death of plants. Plants affected by Fusarium root rot lag behind in growth, do not form at all or form small beans that produce unobtrusive seeds. As a result of monitoring soybean crops, we selected 17 batches of soybean seeds for phyto-examination in 8 farms of the Almaty region. Its results are presented in table 2.

Table 1 – Infection of commercial soybean varieties with diseases during the growing season of Kazakh scientific research institute of protection and crop production 2013-2018

Class	Originofclass	Amazed, %		Growth, %
		fusarium	sclerotiniosis	peronaporosis
Kazakhstan 200	Kazakhstan	6,5	5,5	13,3
Almaty	Kazakhstan	3,5	0,0	9,5
Savage	France	1,0	0,0	3,0
Sting	Kazakhstan	12,5	4,5	13,5
Tazhin	Netherlands	2,5	0,0	21,1
Eureka-357	Moldova	7,5	4,0	25,7
Zen	China	9,5	0,0	17,0
SibNISH-1	Russia	27,0	10,0	13,5
Swallow	Kazakhstan	7,5	1,5	8,0
Zhansaya	Kazakhstan	11,5	6,5	23,0
Vita	Kazakhstan	8,5	7,0	17,8

Table 2 – Infection of soybean seeds with diseases in the conditions of Almaty region

Disease	Weighted average percentage of infection, %		
	2015	2016	2017
Fusarium	0,5	1,0	7,5
Peronosporosis	0,7	1,2	13,0
Septariosis	2,0	0,2	3,5
Burnstems	–	0,1	0,5
Ascochitosis	1,5	1,1	6,0
Alternariosis	0,1	0,5	5,5

We must not underestimate the danger of penetration into the republic of pathogens that are absent in our country with imported foreign seeds. A similar thing already happened when phomopsis entered Kazakhstan from abroad with infected seed material.

In addition, a number of diseases are described in different countries of the world that we have not yet discovered, however, judging by the biology of the causative agents of the diseases and given the similar climatic conditions, there is reason to believe that these diseases may eventually appear on our soy plantations.

By us during 2017-2018. At the experimental base of the Kazakh Scientific Research Institute of Agriculture and Plant Growing, as well as the laboratory of the Kazakh National Women's Pedagogical University, the influence of protectants on seed germination and disease emergence was studied.

To improve seed health from fusarium, scleretiniosis, ascochitosis, peronosporosis and other diseases, we studied the following drugs: foundationazole (3l / t), rovral (3kg / t), apron (6kg / t), derazole (3kg / t), tachigaren (6kg / t), maxim (2l / t), scarlet (2l / t), vitalon (3l / t). Control seeds were not etched. TMTD-4kg / t was used as a reference. Etching was carried out one to two days before sowing. Variety Zhalpak-Saz. The area of each plot was 25 sq.m., the repetition of 4-fold. When studying the effect of dressing agents on seed germination, the latter were sown in laboratory and field conditions, all preparations had a positive effect on seed germination (table 3), the highest results were noted in variants with foundationazole, tachigaren, maxim, scarlet and vitalon. Their laboratory germination rate was 85.9, respectively; 85.5; 85.0; 84.5; 83.0% and exceeded control by 8, respectively; 7.5; 7; 5.5 and 5%, the variant with ethanol is 4; 3.5; 3.0; 1.5 and 1.0%. The preparations acted favorably on the increase in field germination of seeds in comparison with the control by 1.3–13.8%.

Table 3 – Efficiency of soybean seed dressers (grade Zhalpak-Saz, 2017-2018)

Variant	Consumption rate, kg, l / t	Laboratory germination, %	Field germination, %	The defeat of Fusarium rot,%				Harvest, t / ha
				seedlingphase		beforecleaning		
				affected plants	disease-progression	affected plants	disease-progression	
Controlwithouttreatment	–	78,0	59,2	32,0	11,4	58,5	19,2	30,5
TMTD (standard)	4,0	82,0	63,7	22,1	5,04	42,0	15,2	33,2
Tachigaren	6,0	83,5	72,0	6,4	0,6	25,0	2,5	35,5
Apron	6,0	79,5	61,5	23,4	7,6	56,5	17,5	32,8
Fundazole	3,0	83,0	66,0	8,1	0,3	38,5	11,25	33,7
Scarlet	2,0	83,0	66,7	16,4	1,4	52,5	17,3	33,0
Derazole	3,0	82,0	63,7	20,3	5,3	40,0	17,8	33,0
Rovral	3,02,0	85,0	66,5	9,6	1,0	35,0	11,0	34,3
Maksim	2,0	82,5	65,5	9,1	0,5	35,5	11,0	34,0
Vitalon	2,0	84,5	67,0	10,0	0,7	39,0	12,0	33,9

On average, over two years in the variants with the use of foundationazole (3 l / t), maxim (2 l / t) and vitalon (3 l / t), the development of fusarium rot was 0.3; 0.5 and 0.7%, which is less than the control by 11.1; 10.9 and 10.7% and was lower than in versions with a standard (TMTD, 4kg / t) by 5.4; 4.9 and 4.7%. Positive results were obtained when treating soybean seeds with a scarlet (2 l / t) and tachigaren (6 kg / t). A similar pattern was observed during the harvest period. So, during the pre-sowing treatment of soybean seeds with rovral in the norm of 3 kg per 1 ton of seeds, the degree of damage to plants with fusarium rot decreased by 8.12%. In the fight against fusarium rot, a high effect was exerted by derosal and foundationazole at a rate of 3 l / t, the intensity of the development of the disease during the harvest period decreased by 2.4 and 7.97%, respectively.

The use of dressing agents has increased soybean productivity. So, the yield in variants with the use of foundationazole and Maxim, respectively, amounted to 33.7; and 34.0 t / ha, which is 3.2 and 0.8 t / ha more than in the control (30.5 t / ha) and 0.7 and 0.8 t / ha higher compared to seed treatment TMTD (4 kg / t).

Thus, among the studied protectants, the most effective were foundazole and Maxim. The use of these drugs helps to increase field germination by 6.3 and 6.8%, reduce the prevalence and development of fusarium rot in the seedling phase by 22.9-23.9% and 2.4-17.7%.

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КАЗАКСТАННЫҢ СУАРМАЛЫ ЕГІС АЛҚАПТАРЫНДАҒЫ ҚЫТАЙ БҰРШАҒЫНЫҢ АУРАЛАРЫНА МОНИТОРИНГ

Аннатация. Қазақстанның қытай бұршағы егілетін суармалы егіс алқаптарына жүргізілген мониторинг нәтижесінде осы дақылдың ауруларының таралуы мен дамуы анықталды. Кең тараған аурулардың түрлеріне мыналар жатада, фузариоз, ақ және сұр шіріктері және жапырақтарында көптеген дақ аурулары кездеседі. Алматы облысының егіс алқаптарында өте қауіпті және зиянды фузариоз ауруы кең тараған, ал жапырақтарында пероноспороз патогені кең көлемде кездеседі. Эврика-357 сортында аталған аурудың даму деңгейі 25,7% жеткен. Сонымен бірге қытай бұршағының тұқыммымен таралатын ауру қоздырғыштары анықталды. Қытай бұршағы тұқымымен берілетін ауру қоздырғыштарын препараттармен дәрілеудің тиімділігі келтірілген. Максим және фундазол препараттарының тққым ауруына тиімділігі жоғары екені көрсетілген.

Түйін сөздер: Қытай бұршағы, патоген, таралуы, дамуы, аурулар, өнгіштігі, фузариоз, ақ және сұр шіріктері, пероноспороз, тиімділік, тұққым, өнім.

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МОНИТОРИНГ БОЛЕЗНЕЙ СОИ НА ОРОШАЕМЫХ ЗЕМЛЯХ КАЗАХСТАНА

Аннотация. В стаье приводятся данные по мониторингу посевов сои, проведенного Алматинской и Жамбылской областях по распроастранению и развитию болезней, Установлено, что широко распространенной болезнью сои являются фузариоз, пероноспороз, белая и серая гнили, а также встречаются аскохитоз, септариоз, антрокноз и ожог стеблей. Показано,что на всех посевах сои в Алматинской области встречается фузариоз. Возбудители грибы родаFusariumspp. Из листовых форм болезней широко распространен пероноспороз. На сорте Эврика-357 развитие болезни составило 25,7%, а распространенность болезни достигало 100%. Определена зараженность семян сои болезнями. На семнах сои наиболее распрстраненным возбудителем являюется фузариозная инфекция. Она встречается во всех анализированных семенах сортов этой культуры. Представлены результаты оценки протравителей семян сои.

Среди изученных протравителей наиболее эффективными оказались фундазол и Максим, где при применении указанных протравителей в норме 2-3л/т, интенсивность развития болезни в период уборки уменьшилась соответственно на 7,95 и 8,2%.

Ключевые слова: соя, протравитель, распространение, степень развития болезни, всхожесть, фузариоз, белая и серая гнили, пероноспороз, эффективность, семена, урожай.

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