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STUDIES OF FUNCTIONAL PROPERTIES OF FRUITS OF WILD PLANTS OF KAZAKHSTAN

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The purpose of this work is to justify the choice of wild plants of Kazakhstan (rosehip, sea buckthorn, hawthorn) based on the study of their chemical composition and safety, in order to expand the raw material base and the possibility of using them in the technology of functional foods. As a result of the study of the chemical composition of hawthorn, rosehip and sea buckthorn fruits it was found that the content of vitamin C in hawthorn fruits is 27.8 mg, in rosehip fruits - 578.01 mg, in sea buckthorn fruits - 285.05 mg per 100 g of product. The content of vitamin E is 7.8; 1.8; 3.18mg, β-carotene - 9.27; 2.7 and 2.13 mg, dietary fiber - 7.2; 12.28; 2.24 g. The content of potassium in hawthorn fruit is 14.72 mg, in rosehip fruit - 26.18 mg, in sea buckthorn fruit - 197.18 mg per 100 g of the product. The iron content is 0.05; 1.7; 1.14 mg, Zn - 0.08; 0.23 and 0.004 mg, respectively. According to safety indicators, the studied plants meet the requirements of the regulatory documents. As a result of research on the nutritional value and safety of fruits of wild plants, the expediency of using them in the production of functional food products has been substantiated.

Keywords: wild plants, hawthorn, rosehip, sea buckthorn, quality, safety.

ИССЛЕДОВАНИЕ ФУНКЦИОНАЛЬНЫХ СВОЙСТВ ПЛОДОВ ДИКОРАСТУЩИХ РАСТЕНИЙ КАЗАХСТАНА

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Целью данной работы является обоснование выбора дикорастущих растений Казахстана (шиповник, облепиха, боярышник) на основе исследования их химического состава и безопасности, с целью расширения сырьевой базы и возможности применения их в технологии функциональных продуктов питания. В результате исследования химического состава плодов боярышника, шиповника и облепихи установлено, что содержание витамина С в плодах боярышника составляет 27,8 мг, в плодах шиповника – 578,01 мг, в плодах облепихи – 285,05 мг на 100 г продукта. Содержание витамина Е составляет, соответственно 7,8; 1,8; 3,18мг, β-каротина – 9,27; 2,7 и 2,13 мг, пищевых волокон – 7,2; 12,28; 2,24 г. Содержание калия в плодах боярышника составляет 14,72 мг, в плодах шиповника – 26,18 мг, в плодах облепихи – 197,18 мг на 100 г продукта. Содержание железа составляет, соответственно 0,05; 1,7; 1,14 мг, Zn – 0,08; 0,23 и 0,004 мг. По показателям безопасности исследуемые растения соответствуют требованиям нормативных документов. В результате исследований пищевой ценности и безопасности плодов дикорастущих растений обоснована целесообразность применения их при разработке продуктов питания функционального назначения.

Ключевые слова: дикорастущие растения, плоды боярышника, шиповника, облепихи, качество, безопасность.

ҚАЗАҚСТАННЫҢ ЖАБАЙЫ ӨСІМДІКТЕРІ МЕН ЖЕМІСТЕРІНІҢ ФУНКЦИОНАЛДЫҚ ҚАСИЕТТЕРІН ЗЕРТТЕУ

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Бұл жұмыстың мақсаты шикізат базасын кеңейту және оларды функционалдық азық-түлік технологиясында қолдану мүмкіндігі мақсатында олардың химиялық құрамы мен қауіпсіздігін зерттеу негізінде Қазақстанның жабайы өсетін өсімдіктерін (итмұрын, шырғанақ, долана) таңдауды негіздеу болып табылады. Долана, итмұрын және шырғанақ жемістерінің химиялық құрамын зерттеу нәтижесінде долана жемістеріндегі С витаминінің мөлшері 27,8 мг, итмұрын жемістерінде – 578,01 мг, шырғанақ жемістерінде – 100 г өнімге 285,05 мг екендігі анықталды. Е дәрумені мөлшері сәйкесінше 7,8; 1,8 құрайды; 3,18 мг, β-каротин – 9,27; 2,7 және 2,13 мг, диеталық талшық – 7,2; 12,28; 2,24 г.долана жемістеріндегі калий мөлшері 14,72 мг, итмұрын жемістерінде – 26,18 мг, шырғанақ жемістерінде-100 г өнімге 197,18 мг құрайды. Темірдің мөлшері тиісінше 0,05; 1,7; 1,14 мг, Zn – 0,08; 0,23 және 0,004 мг құрайды. Қауіпсіздік көрсеткіштері бойынша зерттелетін өсімдіктер НҚ талаптарына сәйкес келеді. Жабайы өсімдіктердің жемістерінің тағамдық құндылығы мен қауіпсіздігін зерттеу нәтижесінде оларды функционалды тамақ өнімдерін өндіруде қолданудың орындылығы негізделген.

Негізгі сөздер: жабайы өсімдіктер, долана жемістері, итмұрын, теңіз шырғаны, сапасы, қауіпсіздігі.

Introduction

In recent years, the number of diseases among the population has increased. The most common are neurological diseases, thyroid diseases, gastrointestinal diseases, cardiovascular and neoplastic diseases. The causes of all these diseases are related, inter alia, to insufficient intake of essential nutrients from food. In particular, they are associated with insufficient intake of minerals, vitamins, essential amino acids, dietary fiber, essential polyunsaturated fatty acids, and other biologically active compounds (BAC) in the human body [1, 2]. The use of synthetic additives in food production has resulted in a 12-18% increase in allergic diseases among the population. Consequently, there has been a growing interest in

the use of medicinal plants. Over the last decade, the global demand for this raw material has increased almost sixfold, and its production is increasing by 20-30% per year [3, 4].

Wild plants can be sources of biologically active nutrients necessary for the human body. Due to the ability of wild plants to accumulate and synthesize simultaneously hundreds, if not thousands of BAC, they can affect the human body. At the same time, being natural components, they are closer to the human body than synthetic drugs and, therefore, they are safer [3, 5, 6].

Our country is rich in many wild medicinal plants, which are found both as wild and cultivated species. About 18,000 species of wild plants grow in Kazakhstan. Wild plants contain bioactive compounds exceeding 15% of the daily physiological needs of the human body and can be used as functional ingredients in the production of functional foods, which today form the basis of therapeutic and preventive nutrition for the population. Medicinal herbs due to their antioxidant system and the presence of dietary fiber play an important role in protecting the body from various toxic substances [7-11].

Hawthorn is a genus of shrubs, less often low trees of the rosaceous family. There are 7 species in Kazakhstan, the most common are spiny hawthorn and redhaw hawthorn. Carbohydrates of hawthorn fruits are represented by sugars, starch, pectin substances and other compounds. Among the sugars there is a high content of inverted sugar and a low content of sucrose. Seeds contain from 27.5% to 39.2% fat. Hawthorn fruits contain citric acid, malic acid and a small amount of succinic acid, and in the fruits of prickly hawthorn also contain tartaric and crategus acids. Hawthorn flowers contain up to 1.5% of essential oils (aromatic substances), quercetin and trimethylamine [12-14].

Rosehips are beneficial for strengthening the immune system. They are rich in vitamin C, a powerful antioxidant that protects cells from free radical damage. Vitamin C also helps the body produce interferon, a protein that aids in fighting infections. Additionally, rose hips possess anti-inflammatory and antibacterial properties, making them an effective treatment for colds and flu. [15-17].

Sea buckthorn is a valuable berry with unique healing properties, rich in vitamins, minerals, and antioxidants essential for maintaining a healthy and youthful body. It contains a substantial amount of vitamin C, which plays a crucial role in collagen synthesis, enhances immune system function, and protects the body from infections. Additionally, sea buckthorn is a source of vitamin E, a powerful antioxidant that safeguards cells from free radical damage. Sea buckthorn is beneficial for the cardiovascular system due to its constituents that strengthen blood vessel walls and prevent blood clot formation. Furthermore, it helps reduce blood cholesterol levels, thereby aiding in the prevention of cardiovascular diseases. [18-20].

The vast array of medicinal plants with diverse technological properties enables the selection of functional ingredients to create competitive products with high physiological benefits and safety.

The purpose of this work is to substantiate the choice of wild plants in Kazakhstan (rose hips, sea buckthorn, and hawthorn) through a study of their chemical composition and safety. This research aims to expand the raw material base and explore the potential for incorporating these plants into functional food technologies.

Materials and research methods

We have carried out a selection of wild plants of Kazakhstan for experimental studies - rosehips (“*Rose Canina* L.”), sea buckthorn (“Altai” variety), hawthorn (*Crataegus laevigata*) (Figure 1).

		
Hawthorn berries (*Crataegus laevigata*)	Rosehip fruits (“*Rose Canina* L.”)	Sea buckthorn berries (“Altai” variety)

Figure 1. Photo of wild plant samples for experimental studies

The research was conducted in the laboratory facilities of the Department of "Technology of Bakery Products and Processing Industries," the accredited research laboratory "Food Safety," and the research laboratory of "Innovative Technologies of food and processing industries" at Almaty Technological University. Analyses on the quality and safety of wild-growing raw materials were carried out.

Determination of quality indicators of plant raw materials were carried out according to the following methods: protein content was determined by the Kjeldahl method, carbohydrate content - permanganometry method, fat fraction by Soxhlet, the amount of organic acids - according to GOST 32771-2014, dietary fiber - according to GOST R 54014-2010, ash fraction - according to GOST 25555. 4-91, the content of vitamin A - according to GOST R 54635-2011, vitamin B5 - according to GOST 32040-2012, vitamin C - according to GOST 24556-89, vitamin E - according to GOST R 54634-2011, β-carotene - according to GOST R 54058-2010, the content of minerals Mn, Cu, Si, Mo, K, Fe, Zn was determined according to GOST 56372-2015, Se - according to GOST 31707-2012.

The content of heavy metals (cadmium, lead, arsenic, mercury) was determined by colorimetric method according to GOST 26927-86.

The content of aflatoxin B1 was determined by GOST 33780-2016.

The content of pesticides (α, β and γ-HCH, DDT and its metabolites, heptachlor) was determined by gas-liquid chromatography according to GOST 32689.2-2014.

The number of mesophilic aerobic and facultatively anaerobic microorganisms was carried out by GOST 10444.15-94. Determination of the number of bacteria (coliform group) was carried out according to GOST 31747-2012.

Results and discussion

The chemical composition of the fruits of wild plants is determined by the following factors: soil structure, water composition, minerals contained in the soil, and climatic conditions. Therefore, chemical composition indicators are sources of preliminary information in the development of functional food products. Due to the high content of nutrients, plant fruits have a set of properties necessary to maintain human health [7, 21].

The chemical composition of the fruits of wild plants is presented in Table 1.

Table 1. Chemical composition of the fruits of wild plants

Nutrients	Content per 100 g of product		
	Hawthorn berries	Rosehip fruits	Sea buckthorn berries
Physicochemical indicators:			
Proteins, g	1,5	4,0	3,2
Fats, g	1,85	1,53	4,7
Carbohydrates, g	11,57	13,46	1,05
Organic acids, g	0,29	2,81	1,8
Dietary fibers, g	7,2	12,28	2,24
Ash, g	2,01	3,02	1,01
Vitamins, mg			
A	not detected	0,411	0,279
Pantothenic acid	not detected	0,91	0,14
Ascorbic acid	27,8	578,01	285,05
Tocopherol	7,8	1,8	3,18
Phylloquinone	not detected	0,023	not detected
β-carotene	9,27	2,7	2,13
Minerals, mg			
Manganese	not detected	0,97	0,47
Copper	not detected	0,127	0,31
Silicon	not detected	not detected	5,21
Molybdenum	not detected	not detected	0,009
Potassium	14,72	26,18	197,18
Iron	0,05	1,7	1,14
Zinc	0,08	0,23	0,004
Selenium	0,007	not detected	not detected

Vitamins C, E, β-carotene and dietary fiber can be considered as promising functional ingredients in the composition of new functional foods [7]. Vitamin C acts as an antioxidant in plasma and restores tocopherol radical. In the presence of iron or copper ions, ascorbate acquires the properties of a potent pro-oxidant. Vitamin C is key in the process of detoxification and removal of toxic substances from the body. They are also essential for the formation of vitamin D and help maintain the structure and functional activity of DNA and proteins. Carotenoids protect polyunsaturated fatty acids of membrane lipids, have an antisclerotic effect and increase the body's resistance to cancer. Tocopherols, also known as vitamin E, are antioxidants that support membrane health.

The table illustrates that the vitamin C content in hawthorn fruits is 27.8 mg, in rose hips – 578.01 mg, and in sea buckthorn fruits – 285.05 mg per 100 g of product. The vitamin E content is, respectively, 7.8; 1.8; 3.18 mg, β-carotene – 9.27; 2.7 and 2.13 mg, dietary fiber – 7.2; 12.28; 2.24 g.

Nutrient fibers, including cellulose, hemicellulose, gums, and pectin, play a vital role in our diet. Their capacity to retain water, up to 5-30 times their weight, facilitates digestion and peristalsis, aiding in the elimination of toxins from the body. The unique structure of dietary fiber makes them natural enterosorbents, while also participating in metabolism, reducing fat absorption, and maintaining optimal blood glucose levels.

Plants are a source of many minerals that are easily absorbed by the body. Elements such as cobalt, copper, iron, and manganese are known to help activate natural immunity. The combined presence of copper, cobalt, and chromium also ensures the activity of vitamin P. In addition, these elements contribute to the accumulation of flavonoids in fruits. Potassium plays an important role in maintaining water-electrolyte balance and osmotic pressure in cells [23].

Table 1 shows that the potassium content of hawthorn fruit is 14.72 mg, rosehip fruit - 26.18 mg, and sea buckthorn fruit - 197.18 mg per 100 g of product. The content of iron is 0.05; 1.7; 1.14 mg, Zn - 0.08; 0.23, and 0.004 mg, respectively.

Hawthorn, rosehip, sea buckthorn fruits and products of their processing will be used by us in the future in the production of snacks, breads, and slices, that is why the safety of wild fruits was investigated in the beginning. Table 2 shows the results of the study of safety parameters of hawthorn, rosehip and sea buckthorn fruits.

Table 2. Safety indicators for fruits of wild plants

Name of indicators, units of measurement	Hawthorn berries	Rosehip fruits	Sea buckthorn berries
Microbiological indicators:			
- QMAFAnM, CFU/g, not higher than	$7*10^1$	$4*10^1$	$2*10^1$
- Coliform bacteria in 1,0 g of product	not detected	not detected	not detected
Heavy metals, mg/kg:			
- lead	0,002±0,0004	0,003±0,0004	0,001±0,0003
- cadmium	0,002±0,0004	0,001±0,0003	0,002±0,0004
- mercury	not detected	not detected	not detected
- arsenic	not detected	not detected	not detected
Pesticides, mg/kg:			
Hexachlorocyclohexane ($\alpha-, \beta-, \gamma-$ isomers)	not detected	not detected	not detected
- Heptachlor	not detected	not detected	not detected
- DDT and its metabolites	not detected	not detected	not detected
Mycotoxins, mg/kg:			
- aflatoxin B_1	not detected	not detected	not detected

The results of the safety study of hawthorn, rosehip and sea buckthorn fruits showed their compliance with the requirements of the Technical Regulations of the Customs Union 021/2011 and confirmed their safety.

Conclusion

As a result of the study of the chemical composition of hawthorn, rosehip and sea buckthorn fruits it was found that the content of vitamin C in hawthorn fruits is 27.8 mg, in rosehip fruits - 578.01 mg, in sea buckthorn fruits - 285.05 mg per 100 g of the product. The content of vitamin E is 7.8; 1.8; 3.18mg, β-carotene - 9.27; 2.7 and 2.13 mg, dietary fiber - 7.2; 12.28; 2.24 g. The content of potassium in hawthorn fruit is 14.72 mg, in rosehip fruit - 26.18 mg, in sea

buckthorn fruit - 197.18 mg per 100 g of the product. The content of iron is respectively 0.05; 1.7; 1.14 mg, Zn - 0.08; 0.23, and 0.004 mg. As a result of studies of the nutritional value and safety of wild-growing plant fruits, the feasibility of their use in the development of functional food products was substantiated.

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Conflict of interest

All authors have read and are familiar with the content of the article and have no conflicts of interest.

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РАЗРАБОТКА ТЕХНОЛОГИИ ПРОИЗВОДСТВА БУЛОЧЕК ПОВЫШЕННОЙ БИОЛОГИЧЕСКОЙ ЦЕННОСТИ С ИСПОЛЬЗОВАНИЕМ ПОРОШКА ШЕЛКОВИЦЫ

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Разработка технологии производства булочек повышенной биологической ценности с использованием порошка шелковицы представляет собой исследование, направленное на создание инновационного продукта в пекарной индустрии. Порошок шелковицы, богатый белком, аминокислотами и полезными элементами, используется в качестве добавки к тесту для повышения пищевой ценности булочек. Этот процесс требует тщательного изучения влияния порошка шелковицы на текстуру, вкус и питательные свойства выпечки. Исследование также включает в себя оптимизацию процесса производства, чтобы обеспечить оптимальное сочетание биологической ценности и органолептических качеств булочек. Полученная технология может иметь большое значение для производства функциональных продуктов питания с повышенными полезными свойствами. На основании проделанной работы разработаны рецептуры и технологическая схема производства булочек с добавлением концентрата порошка шелковицы, которая предназначена для освоения передовых технологий в пищевой промышленности. Хлебобулочные изделия «Булочка» готовятся с использованием закваски или пресного теста.

Ключевые слова: порошок шелковицы, хлебобулочные изделия, пресное тесто, концентрат порошка шелковицы, мука.

ТҰТ ҰНТАҒЫН ПАЙДАЛАНА ОТЫРЫП БИОЛОГИЯЛЫҚ ҚҰНДЫЛЫҒЫ ЖОҒАРЫ НАН ТОҚАШ ӨНДІРУ ТЕХНОЛОГИЯСЫН ӘЗІРЛЕУ

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Тұт ұнтағын пайдаланып биологиялық құндылығы жоғары нан тоқаштарды өндіру технологиясын әзірлеу нан пісіру өнеркәсібінде инновациялық өнім жасауға бағытталған зерттеу болып табылады.