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WILD FRUITS OF AZERBAIJAN AS RAW MATERIALS FOR BIOADDITIVES

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Abstract. In Azerbaijan, the structure of nutrition is characterized by high caloric content, insufficient or unbalanced consumption of macro- and micronutrients, in particular, a deficiency of antioxidant nutrients is observed. One of the options for solving the problem of food quality is the development of a technology for processing domestic fruit raw materials into functional food bioadditives. The article provides an analysis of data on the biochemical composition (vitamin profile and polyphenolic substances) of some types of wild fruits, namely: eastern hawthorn (Crataegus orientalis L.) of the Rosaceae L. family; sea buckthorn (Hippophae L.) of the Elaeagnaceae family; wild rose (Rosa aciculus L.) of the Rosaceae family. The content of most vitamins that were determined in all water extracts is 1.1-1.2% less than the data specified in the handbook. However, the content of vitamin C is 4.5 times higher in hawthorn extract, and vitamin E is 4.88 times higher in wild rose extract. The choice of raw materials is determined by the stability and quantity of the harvest, the generally available price, as well as the availability of literary and own data of the authors that this source of raw materials contains in its composition a natural complex of physiologically active functional ingredients. For the quantitative extraction of the vitamin complex and polyphenolic substances of the wild fruits of sea buckthorn, hawthorn, and rosehip, the modes of hydroacoustic extraction using a rotary-pulsation apparatus were selected. The DPPH method was used to investigate the antioxidant activity of the obtained aqueous extracts, which varied in the series of sea buckthorn-hawthorn-wild rose. The study showed that wild fruits of Azerbaijan can be a source of biologically active substances for food production. The results of this research were implemented in production at the leading enterprise of Azerbaijan. The results confirm the potential of these types of fruits as wild plant raw materials rich in biologically active substances.

Key words: wild plant raw materials, biologically active substances, antioxidant activity, water extracts, hydroacoustic extraction.

Introduction. Formulation of the problem

The issue of nutrition in Azerbaijan is brought to the level of state policy (Law of the Republic of Azerbaijan "On Food Products" No. 759). This is explained by the fact that nutrition mainly affects the state of health of citizens of the state, their life expectancy and well-being [1]. The population of Azerbaijan strives for longevity, reducing the rate of aging, but the analysis of the actual diet showed that the structure of the diet does not correspond to the modern ideas of nutritiology (the science of nutrition [1]), the diet is characterized by increased caloric content, insufficient or unbalanced consumption of macro- and micronutrients, in particular, there is a deficit nutrients-antioxidants.

Wild food and medicinal plants can be a source of macro- and micronutrients, since it is known today that the fruits of wild plants are a complete source of various biologically active substances, in particular, antioxidant vitamins, polyphenolic substances, carotenoids, organic acids, sugars, dietary fibers, including pectin substances [2,3], and a number of others that are needed for the daily synthesis and construction of cells, as well as for the implementation of normal metabolic processes and other functions of the human body.

A recent study of the non-timber productivity of Azerbaijan's forests [4] showed the presence of a large number of wild fruits and berries (about 150 species [5]), including barberry (Berberis L. [6]), mountain ash (Sorbus (Rosaceae) [7], hawthorn (Crataegus orientalis L. [8]), wild rose (Rosaceae rosa L. [9], Rosaceae aciculus L.), sea buckthorn (Elaeagnaceae Juss (Hippophae rhamnoides L. [2]) and others. According to experts, the annual potential of harvesting fruits and berries can reach more than 10,000 tons [10,11]. In this regard, the search for waste-free technologies for processing the fruits of wild plant raw materials is a promising direction in the food and economic sectors of Azerbaijan.

Summing up, one of the options for solving the problem of the quality of nutrition of the population of Azerbaijan is the production of bio-additives, in particular antioxidant, for their further use in the development of new and improvement of existing types of healthy functional foods. For this, a necessary step is to determine the content of the main types of biologically active substances in the fruits of wild plant raw materials, in particular, the antioxidant orientation. At the same time, it should be taken into account that changes in the nutritional and biological value of wild raw materials, as well as the content of physiologically active substances in them, are very significant and depend both on the technology and processing of raw materials and their type, and to a large extent on the variety and region of growth. Therefore, indicators of the chemical composition of wild raw materials are not absolute, but can be a source of preliminary information for specialists working in the field of creating bio-additives for functional food products [13].

Analysis of recent research and publications

According to literary data, the fruits of wild plants are recognized by the scientific community as a promising source of raw materials for the production of a wide range of healthy food products with a multipurpose functional purpose [10,14,15]. As you know, biologically active substances contained in the fruits of wild plants have antioxidant activity; antihypoxant, anticarcinogenic, immunotropic and other positive effects on the human body [16,17]. Of the above effects, one of the greatest interests from the point of view of healthy nutrition and health in general is the antioxidant property.

Antioxidants of natural origin, in particular vitamins A, E, C, polyphenolic substances, carotenoids; have preventive properties and a therapeutic effect in diseases and pathological conditions caused by oxidative stress [18,19] – a condition in which there is a sharp activation of free radical processes against the background of depression or insufficient natural antioxidants [20]. The main task of antioxidants is the fight against free radicals [21].

The formation of free radicals is a process that inevitably occurs in biological systems [18]. Free radicals can cause various kinds of degenerative disorders in living organisms, such as: carcinogenesis, cardiovascular diseases, mutagenesis, and aging [21]. Antioxidants are able to react with free radicals, reducing their harmful effects on the living organism [21]. The inclusion in the daily diet of food products containing ingredients of wild plant raw materials is due to their positive effect on the functioning of the antioxidant system of the cells of the human body. Its activity requires the presence of a wide range of bioantioxidants, which are contained only in plant raw materials [15]. Therefore, the study of antioxidant properties of various plant materials, including wild plants, is an important and urgent task of scientists not only in Azerbaijan, but also in the whole world.

However, wild fruits and berries are perishable raw materials due to the content of a significant amount of free moisture. With improper technological processing, it is impossible to preserve biologically active substances in it. From this follows the need to find new and improve existing technological techniques for its processing, with the aim of maximally preserving natural biologically active substances in it and preventing the development of various degenerative processes in the process of processing.

At present, wild fruits and berries are mostly subjected to the drying process [22] with the further obtaining of powder products for use as food additives for the production of bakery and confectionery products [23], they are partially subjected to canning in the production of fruit and berry pastes, juices, food ingredients and functional drinks [24]. Moreover, the chemical composition of such fruit raw materials determines the possibility of forming and changing its taste, aroma and, especially, color as a result of technological operations in the manufacture of food products.

As a result of technological processing of raw materials, the integrity of cellular structures is violated, as a result of which intracellular enzymes are released, which are in an active state and cause biochemical changes in various tissues and chemical complexes, which contributes to the formation of properties in finished products that give them a specific taste, smell, aroma, color and other consumer indicators.

The task of the industry, in particular the food industry, is to use resource-saving, waste-free and economically profitable technologies, but with minimal loss of biologically active substances. Undoubtedly, drying is an integral part of the processing of wild fruit raw materials today, as it makes it possible to use such raw materials throughout the year without being tied to the ripening period. To determine the optimal parameters of drying, methods and equipment, research is conducted using various types of drying

(lyophilized, in an oven, steam oven, thermostat, using microwaves, etc.).

For example, a well-known study of the effect of different types of drying on biologically active substances, in particular polyphenolic substances, and antioxidant activity of hawthorn fruits, which showed sharply negative results when using drying methods in a microwave oven and an oven, and the highest concentration of polyphenols and the highest antioxidant activity was observed in samples after freeze-drying [22]. In addition, significant changes in the color of dried fruits were observed [22]. The authors [22] consider a combined method of drying to be economically feasible, that is, before lyophilized drying, drying using microwaves to reduce the duration of drying and its cost, while the content of polyphenols and antioxidant activity in dried fruits remain at a sufficiently high level.

In addition to drying, the use of cryogenic technologies in the process of processing fruit and vegetable raw materials with the formation of cryopowders and cryopastes is growing in popularity, because unlike the drying process, the level of antioxidant activity and the content of biologically active substances is much higher in raw materials processed in this way.

The complex chemical composition and multi-vector nature of positive physiological properties manifested by the plant components of raw materials in the human body with a reasonable and optimal combination of them allows for the development of a wide range of functional organic healthy food products. For this purpose, biologically active ingredients of wild plant raw materials are currently used in the form of powders, extracts, syrups, natural puree-like products, etc. [23].

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Justification of the choice of the method of extraction of biologically active substances from wild plant raw materials

Today, one of the effective methods of obtaining a complex of natural biologically active substances from wild raw materials with maximum preservation of its physiological activity is the extraction process [25]. The methods of obtaining extracts are based on the transfer of biologically active substances from raw materials to an aqueous medium using various methods of destroying the cell structure of the raw materials, among which the following have gained popularity: boiling or infusion (heat treatment with water), the use of alcohol solutions, fermentation.

The first two methods lead to the destruction of not only the cell membrane, but also the destruction of biologically active substances, which results in a low quality extract and a shorter shelf life.

The use of enzymes has an advantage over the methods described above, as it allows you to obtain a concentrate exclusively from biologically active substances, however, it always retains the remains of bacteria and their activity, which cannot be removed. And the cost of enzyme preparations is high.

Extracts can be obtained from freshly picked fruits of wild plant raw materials and dried (with their previous recovery). Most often in the literature you can find methods of extraction using water or alcohol extractants. For example, a study was conducted on the release of various biologically active substances from the fruits of the eastern hawthorn, which were collected from wild trees in Beyşehir (Turkey), using such solvents as: water, methanol and a mixture of 1:1 = methanol:water [26]. The highest overall antioxidant and phenolic activity among the presented samples was found in the methanol-water extract [26].

But science also knows a method of extracting biologically active substances from medicinal plants using deionized water (Patent of Ukraine for a useful model No. 83244 "Method of obtaining plant extract", publ. 27.08.2013, Byul. No. 16). Due to the occurrence of significant osmotic pressure at the cell boundary, deionized water causes a rupture of the cell walls, which, firstly, causes faster and more complete extraction of biologically active substances, and secondly, leads to the destruction of biological objects (viruses, bacteria, fungi), which are contained in plant raw materials, and thereby ensures sterilization of the obtained extract without heat treatment.

From the literature, it is known about the great potential of using plant extracts in the development of functional food products, enriched in particular with polyphenols of plant origin [27]. Such extracts, in addition to the food industry, are also used in the production of medicines against various diseases, including Covid-19 [27]. Plant extracts of natural origin have an advantage over artificially synthesized ones due to their effectiveness and safety for humans [27].

Justification of the choice of types of wild plant raw materials

Despite the large number of wild plant raw materials in Azerbaijan, to date there is a limited amount of data on its chemical composition and the content of biologically active substances in it, so research in this direction is relevant. Moreover, the food industries of the economy of Azerbaijan are currently interested in finding new types of functional ingredients among domestic wild plant raw materials [10], in particular for their further use for the production of bio-additives for the enrichment of functional food products.

For studies of the quantitative content of biologically active substances and antioxidant activity, the fruits of wild plants widely distributed in

Azerbaijan were chosen, such as: sea buckthorn Hippophae rhamnoides L. (the family of sedges Eleagnaceae Juss); Eastern hawthorn Crataegus orientalis L. (family Rosaceae L.); wild rose (Rosa aciculus L.).

Sea buckthorn Hippophae rhamnoides L. (family Eleagnaceae Juss) is a large shrub or small tree 4-5 m high [28]. Widely distributed on alluvial soils of mountain rivers from Western Europe to the Himalayas, Northwest China and Mongolia [28]. And the Great Caucasus is one of the main regions of its natural growth [28]. Sea buckthorn fruits have an oval-cylindrical shape, a pleasant sweet-sour taste and aroma. The color can vary from yellow to dark orange [28], which indicates a different and rather high content of coloring substances in it, in particular polyphenols, carotenoids, anthocyanins. Sea buckthorn contains natural antioxidants: vitamins A, E and the above-mentioned coloring substances. A modern study of the content of carotenoids (qualitative and quantitative composition) was conducted among fresh fruits of 28 forms of wild sea buckthorn collected in the Northern part of Azerbaijan [28]. The presence of such representatives of a number of carotenoids, such as: β-carotene, zeaxanthin, lycopene, cryptoxanthin, was found in all forms [28].

Eastern hawthorn Crataegus orientalis L. is one of the representatives of the genus Crataegus L. (rosaceae L. family) [29], it looks like a small tree with red fruits. This genus has a wide territorial distribution in Turkey, Iran, Azerbaijan and other countries. Flowers, leaves, and fruits of hawthorn are widely used in medicine in the treatment of cardiovascular diseases, such as: hypertension and atherosclerosis [29]. Hawthorn fruits have a high content of biologically active substances with antioxidant properties.

Rosa acicularis L. (Rosaceae family) is a shrub 1-3 meters tall, the arched stems are covered with thin straight or slightly bent spines and bristles, the fruits are red in color, and can be ovoid, inverted pear-shaped, and oblong in shape [30]. About 300 species of wild roses are known in scientific circles, of which 42 species can be seen in Azerbaijan, of which 26 are wild plants [30]. It is known from the literature that the pulp of rose hips contains a large amount of vitamins (C, B1, B2, K, rutin), as well as carotene, flavonol glycosides, kaempferol, quercitin, lycopene and rubixanthin, pectin substances [30]. Freshly picked fruits have an anthelmintic effect. In addition, wild rose is prescribed for diseases of the biliary system (cholecystitis, hepatitis, diseases of the gastrointestinal tract) due to its good choleretic properties [30].

To sum up the above, the relevance and importance of considering the fruits of wild plants of Azerbaijan as a promising source of a wide range of biologically active substances emerges. And the study of the content of the main biologically active substances and the antioxidant activity of the extracts of these fruits will allow to create functional food products, in particular with an antioxidant focus, with the prospect of further introduction into production. Biologically active substances of natural origin contained in fruits can provide 15-50% of a person's daily physiological need for essential ingredients, particularly antioxidants. The fruits of the above-mentioned wild plants contain antioxidants, polyphenolic substances, etc. in their composition, which is important for their further use in the development of a wide range of functional food ingredients and organic food products for healthy purposes with a given chemical composition and nutritional value, which have a directed physiological effect on certain functional systems of the human body [31], in particular, will have the ability to strengthen immunity and increase the antioxidant defense of the human body.

Considering all of the above, it is currently relevant to select modes for the effective maximum extraction of biologically active substances from wild plant raw materials, to study the chemical composition and level of biological activity of various types of wild fruits and berries growing on the territory of Azerbaijan, with the prospect of their further use in creation of healthy functional products.

The **purpose** of this research work was to investigate the content of the main types of biologically active substances in the fruits of wild plant raw materials of Azerbaijan.

To achieve the goal, the following **objectives** were defined:

- Selection of the optimal method of extracting the main biologically active substances of wild fruits of hawthorn, sea buckthorn and wild rose;
- To determine the content of the main biologically active substances in water extracts of wild fruits of hawthorn, sea buckthorn and wild rose;
- Determine the antioxidant activity of the extracts.

Research materials and methods

Research was conducted at the:

- Laboratory of the Department of Engineering and Applied Sciences of the Azerbaijan State University of Economics;
- Consulting laboratory of healthy nutrition of Odesa National University of Technology;
- Research laboratory of ZAO "AZNAR" (Geokchai, Azerbaijan);
- leading enterprise of Azerbaijan "AzGRANATA" LLC (Akhsu, Azerbaijan).

The objects of research were the fruits of wild plants of Azerbaijan, growing in different administrative regions of the republic:

- Eastern hawthorn (Crataegus orientalis L.) of the Rosaceae L. family;
- buckthorn buckthorn (Hippophae L.) of the Elaeagnaceae family;
- wild rose (Rosa acicularis L.) of the Rosaceae family.

Freshly picked fruits of the technical stage of maturity in September-November 2020, without mechanical damage and any signs of microbiological spoilage, were used for research.

The extraction process was carried out in hydroacoustic cavitation mode using a rotary-pulsation apparatus MT-1500 (Kinematica, Switzerland).

The total content of phenolic substances was determined by the spectrophotometric method with the Folin-Chocalteu reagent in terms of gallic acid [32], and to determine the total content of flavonoids (in terms of catechin) a method based on the interaction of an antioxidant with aluminum chloride and sodium nitrite was used [33].

Vitamin C was determined by the method of visual titration using the quantitative oxidation of ascorbic acid with a solution of sodium 2,6-dichlorophenolindophenolate [12], vitamins B_1 and B_2 – by the method of measuring fluorescence intensity [34], and vitamin B_6 – by the colorimetric method [34], vitamin E – by a modified method using column chromatography [34], β-carotene by a spectrophotometric method using thin-layer chromatography [34].

Antioxidant activity (AOA) was determined by the DPPH method using a spectrophotometer at a wavelength of 514 nm [16]. The method is based on the reduction of the stable synthetic radical DPPH (2,2-diphenyl-1-picrylhydrazyl) by a sample of a bioantioxidant contained in a plant extract [21].

Evaluation of the results of experimental studies was carried out using Microsoft Office Excel 2013 application programs and VinLab32 computer programs (Perkin Elmer).

Results of the research and their discussion

Method of preparation of raw materials and actual extraction (selection of parameters). Nowadays, plant extracts are widely used for the production of various groups of food products, in particular, biologically active food additives, as well as for confectionery and culinary products in the public catering system; and their use in the production of medicinal products is no less important [35]. One of the methods of extracting a complex of biologically active substances from natural plant raw materials is extraction, which involves extracting this complex from the plant mass with the help of solvents. Different types of extraction are known: infusion, remaceration, repercolation, circulation extraction, where, as a rule, water, water-alcohol solutions, ether solutions are used as a solvent-extractant [25].

In our case, deionized water was used as an extractant, which is characterized by a number of advantages, in particular:

- penetrates cell walls well;
- has pharmaceutical indifference;
- is a universal extractant;
- dissolves almost all biologically active low- and high-molecular substances [16].

The main physico-mechanical process of extraction is diffusion, which flows through the macropores of plant cells, due to the different content of soluble substances in the two-phase system. Diffusion consists in the transition of soluble substances from the solid phase to the liquid phase, and the rate of mass transfer largely depends on the contact surface of the phases.

When extracting plant raw materials in a rotary-pulsation apparatus in hydroacoustic cavitation mode, a combined process of fine grinding of raw materials, the process of diffusion of chemical components of raw materials from plant cells and their quantitative extraction into the aqueous medium is carried out. The effectiveness of the process of quantitative extraction of biologically active substances of raw materials depends on a number of technological parameters, in particular, the value of the hydromodule, the nature of the extractant, the type of raw materials, and the intensity of hydroacoustic cavitation.

In the process of extraction using a rotary-pulsation apparatus, the surface of the solid phase increases by 65–70 times, the rate of mass transfer increases by 10–12 times, and the time of the process of quantitative extraction of a complex of biologically active substances proceeds at ambient temperature and is reduced by 3–5 times, which allows to fully preserve the nativeness of the natural components of raw materials [13]. When extracting at high temperatures, the biologically active substances of the raw materials, in particular vitamin C and others, are partially or completely destroyed; the obtained extract is of low quality, which is not suitable for its further processing into food bio-additives.

According to [36], the raw material chosen for the study has the following content of biologically active substances (Table 1).

Table 1 – The content of biologically active substances in the fruits of wild plant raw materials [36].

The content of the main biologically active substances in fruits, mg/100g[36]	Raw materials		
	Hawthorn	Sea buckthorn	Wild rose
Vitamin C	31.5	200.0	650.0
Vitamin B_1	-	0.03	0.05
Vitamin B_2	-	0.05	0.13
Vitamin B_6	-	0.11	0.076
Vitamin E	6.0	5.0	1.7
β - carotene	7.1	1.5	2.6
Flavonoids:			
Anthocyanins	-	-	-
Catechins	-	-	-
Leukoanthocyanins	-	-	-
Flavanols	-	-	-

As can be seen from Table 1, there are no data on the quantitative content of polyphenolic substances in these fruits, as well as the content of group B vitamins in hawthorn fruits.

The technological process of preparing fruits for extraction included a number of technological operations to obtain a puree-like mass without pits and seeds, from which biologically active substances were further extracted. That is, the raw material is subject to inspection, washing, soft blanching (without changing the shape of the fruit), rubbing through a sieve with holes of 1.0–2.0 mm (to separate the pits and seeds).

The next stage was the actual extraction. The extraction process was carried out in the hydroacoustic cavitation mode using the MT-1500 rotary-pulsation apparatus (Kinematica, Switzerland) in the system vegetable raw materials: water = 1:2 at a temperature of 25–30^{0}C for 15–20 minutes. The clear layer of the extract was then separated by decantation on a filtering centrifuge at a separation factor of 4150 G for 15 minutes. The selection of parameters for the extraction of biologically active substances from those wild fruits that we are studying was carried out on the basis of the results obtained earlier [3,10].

Determination of the content of the main biologically active substances in the extracts. At the moment, the most well-known antioxidant micronutrients are vitamins C, E, D, A, K, as well as polyphenols and trace elements zinc, selenium, and others, which have a wide range of biological activity and great potential for use as preventive agents against many diseases [37].

The results of complex studies of the content of biologically active components in the obtained water extracts of wild rose, sea buckthorn and hawthorn fruits are presented in Table 2.

Table 2 – Content of biologically active substances (BAS) in extracts

Content of the main BAS in extracts, mg %	Raw materials		
	Hawthorn	Sea buckthorn	Wild rose
Vitamin C	140.0±3.10	190.0±3.10	615.0±3.10
Vitamin B_1	0.25±0.03	0.035±0.015	0.03±0.015
Vitamin B_2	0.45±0.03	0.06±0.15	0.04±0.15
Vitamin B_6	0.42±0.03	0.12±0.15	-
Vitamin E	5.05±0.50	6.50±0.50	8.30±0.50
β-carotene	6.10±0.50	3.30±0.30	3.10±0.30
Flavonoids:			
Anthocyanins	630.0±3.20	35.0±2.9	1300.0±3.20
Catechins	465.0±2.90	30.50±0.35	880.0±3.10
Leukoanthocyanins	520.0±3.01	310.0±2.90	21.0±2.90
Flavanols	165.0±3.10	240.0±3.10	78.0±2.90

Comparing the data in Tables 1 and 2, the content of vitamin C in the hawthorn extract is 4.5 times higher, and the content of most of the other vitamins presented in all water extracts differs from the literature data by 1.1–1.2%. The exception is the content of vitamin E in wild rose extract, which is 4.88 times higher than that reported in the literature.

As can be seen from the presented experimental data, water extracts of wild fruits of hawthorn, sea buckthorn and wild rose contain a multicomponent complex of biologically active substances and, thanks to their physiologically significant components, can be used in the creation of qualitatively new functional food products. In particular, polyphenolic compounds are the most well-known class of biologically active compounds with a wide spectrum of biological activity and great potential as an ingredient of prophylactic agents in the treatment of many diseases [37]. Anthocyanins are not only coloring substances, but also exhibit various types of biological activity, including anticancer, antimicrobial, and antioxidant [38]; β-carotene (provitamin A) and tocopherol (vitamin E) are also currently among the most well-known natural antioxidants, and although these vitamins in the obtained extracts are not enough for their daily intake, they make a certain contribution to the level of antioxidant activity in general. The ability to trap free radicals is the most important property of an antioxidant, since it is free radicals that have the most destructive effect on living cells, possessing high reactivity [38].

Determination of antioxidant activity of extracts. Analysis and measurement of the antioxidant activity of the obtained extracts was carried out by the DPPH method using a spectrophotometer at a wavelength of 514 nm. The reduction reaction of the stable synthetic radical DPPH (2,2-diphenyl-1-picrylhydrazyl) took place according to the scheme:

DPPH* + AH – DPPH-H + A*.

As a result of the reduction of DPPH by the antioxidant, the purple-blue color of DPPH in ethanol decreases, and the E_{c50} parameter is used to characterize the antioxidant activity - the concentration of the extract, at which 50% inhibition of the DPPH radical by the antioxidant of the extract occurs.

Inhibition of the oxidative decay reaction occurs faster and the antioxidant activity of the samples is higher, the lower the E_{c50} index. The results of the research are shown in Table 3.

Table 3 – Antioxidant activity of extracts by the DPPH method

Indicator $DPPH_{ec-50}$, mg/cm^3	Raw materials		
	Hawthorn	Sea buckthorn	Wild rose
	3.70	5.10	2.70

As can be seen from the data in Table 3: among the presented extracts, the highest antioxidant activity is observed in the extract from the wild rose, since in this extract the $DPPH_{ec-50}$ indicator has the lowest value among the presented samples (2.7 mg/cm^3).

The high antioxidant properties of the obtained water extracts are explained by the unique chemical composition of the studied wild fruits and the especially high content of such substances as: anthocyanins, tocopherols, carotenoids and flavonoids, which are responsible for the red-purple and red color of these fruits.

On the basis of the above, it can be stated that the structural chemical multicomponent systems of the fruits of wild plant raw materials are preserved in their water extracts obtained by hydroacoustic extraction, which, interacting, are incorporated into the antioxidant system of the cells of the human body, forming new compounds and promoting the activation of protective functions of cells and basic physiological body systems in general.

Approbation of research results

To date, the research results have been implemented at the leading enterprise of Azerbaijan, AzGRANATA LLC:

- preparation of an experimental batch of water extract from the fruits of wild hawthorn was carried out in November 2021, as evidenced by the act of industrial approval dated November 25, 2021;

- wild fruit extracts were put into production in November 2021, as evidenced by the act of industrial approval dated November 30, 2021.

Conclusion

1. Modes of extraction of the main biologically active substances of wild fruits of hawthorn, sea buckthorn and wild rose were selected using a rotary-cavitation apparatus.

2. The content of the main biologically active substances (vitamins C, B, E, A and polyphenols) in the obtained water extracts was determined. The highest content of vitamins C (615 mg%) and E (8.3 mg%), flavonoids (1300 mg%) and anthocyanins (880 mg%) is observed in the aqueous extract of wild rose. A high content of vitamins C (190 mg%) and E (6.5 mg), leucoanthocyanins (310 mg%) and the highest content of flavanols (240 mg%) is observed in the water extract from wild sea buckthorn. The water extract of wild hawthorn has the highest content among the presented samples of β-carotene (6.1 mg%) and leucoanthocyanins (520 mg%); high levels of vitamins C (140 mg%) and E (5.05 mg%), anthocyanins (630 mg%), catechins (465 mg%) and flavanols (165 mg%).

3. The DPPH method was used to determine the antioxidant activity of aqueous extracts of mature fruits of hawthorn, buckthorn, and wild rose. Among the presented samples, the highest biological activity was observed in the water extract from the wild rose, the second place was the extract of the wild hawthorn, and the third place was the wild sea buckthorn.

4. The results of the research were implemented at the leading enterprise of Azerbaijan "AzGRANATA" LLC, as evidenced by acts of industrial approbation.

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ДИКОРОСЛІ ПЛОДИ АЗЕРБАЙДЖАНУ ЯК СИРОВИНА ДЛЯ ВИРОБНИЦТВА БІОДОБАВОК

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Анотація. В Азербайджані структура харчування характеризується підвищеною калорійністю, недостатнім чи незбалансованим споживанням макро- та мікронутрієнтів, зокрема спостерігається дефіцит нутрієнтів-антиоксидантів. Одним із варіантів вирішення проблеми якості харчування є розробка технології переробки вітчизняної плодової сировини у харчові біодобавки функціональної направленості. У статті наводиться аналіз даних біохімічного складу (вітамінний профіль та поліфенольні речовини) деяких видів дикорослих плодів, а саме: глоду східного (Crataegus orientalis L.) сімейства розоцвітих Rosaceae L.; обліпихи крушиноподібної (Hippophae L.) сімейства Elaeagnaceae; шипшини голистої (Rosa aciculus L.) сімейства Rosaceae. Вміст більшості вітамінів, які визначали, у всіх водних екстрактах на 1.1–1.2% менше за дані, зазначені в довіднику. Однак вміст вітаміну С у 4.5 рази вище в екстракті з глоду, а вітаміну Е вище у 4.88 разів в екстракті з шипшини. Вибір сировини обумовлений стабільністю та кількістю врожаю, загальнодоступною ціною, а також наявністю літературних та власних даних авторів про те, що дане джерело сировини містить у своєму складі натуральний комплекс фізіологічно активних функціональних інгредієнтів. Для кількісного вилучення вітамінного комплексу та поліфенольних речовин дикорослих плодів обліпихи, глоду та шипшини було підібрано режими гідроакустичного екстрагування із застосуванням роторно-пульсаційного апарату. Методом DPPH була досліджена антиоксидантна активність отриманих водних екстрактів, яка змінювалася в ряді обліпиха-глід-шипшина. Дослідження показало, що дикорosла рослинна сировина Азербайджану може бути джерелом біологічно активних речовин для виробництва харчових. Результати даного дослідження були впроваджені у виробництво на провідному підприємстві Азербайджану. Результати підтверджують потенціал цих видів плодів як дикорослої рослинної сировини багатої на біологічно активні речовини.

Ключові слова: дикорosла рослинна сировина, біологічно активні речовини, антиоксидантна активність, водні екстракти, гідроакустичне екстрагування.