УДК 640

RHUS CORIARIA (SUMAC): FROM OF UNDERSTANDING THE BIOTECH POTENTIAL TO İTS INDUSTRIAL USES

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INTRODUCTION

Features of nutrition and health of modern man oblige to develop research to meet the needs of his food special composition, contribute to the expansion of the range of food products, cause the need to search for new types of biologically active raw materials.

From year to year, the production of new types of plant products, which not only do not contribute to the spread of alimentary, that is food and nutrition, diseases, but, on the contrary, are necessary for their prevention, becomes more and more urgent.

This forces many Azerbaijani companies to pursue a policy of development and use of local biologically active raw materials, which have not yet reached the hands of competitors, which are already few.

It is quite possible that the type of raw materials, which we are going to talk about further, is used only because of the lack of effective product and technological innovations that could bring profit and fame to the enterprises of the canning and other food industries, who mastered their processing first.

Sumac (Rhus coriaria L.) – this shrub is found in the mountain forests of the North Caucasus and Transcaucasia, as well as in the mountainous part of the Crimea. In the Republic of Azerbaijan it can be found in the mountain forests of Lenkaran, Geokchay, Sheki-Zakatala and Guba districts.

This plant is from the family Anacardiaceae – shrub height of 2–7 m. (see photos near the village of Gedik in the Guba districts of the Republic of Azerbaijan – Figure 1). Within Azerbaijan, sumac is distinguished polymorphism. Flowers are heterogeneous, small, greenish – white. The fetus (reaching 5–6 mm in diameter) is a small globular or kidney-shaped single-seeded drupe outside is red-brown, densely pubescent with glandular hairs.

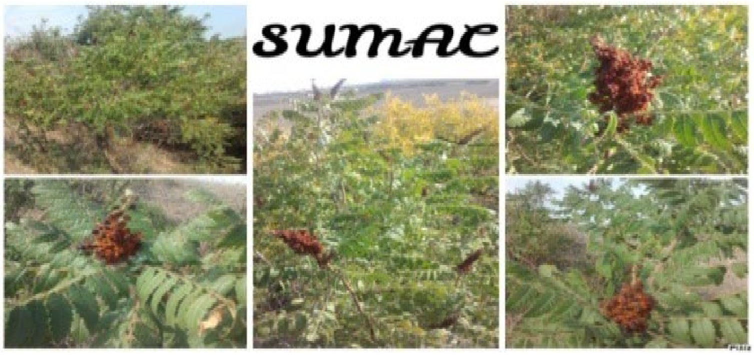

Figure **1**. View of Rhus coriaria L. (Guba districts, Azerbaijan)

The fruits of this plant ripen in September and October.

For the sour taste of fruits and leaves, sumac often called an "acetic tree". Sumac is widely used in Turkey, the Caucasus, as well as in North Africa, the Middle East and South Asia.

In the pharmaceutical industry, from the leaves and fruits of sumac receive not only tannin, but and medicament, such as Tanalbin and Tanzal.

Studied the physic – chemical indices of tannin sumac from the Konya region of Turkey and found that 92 % of them in their total mass were 4.25 to 5.0 mm in length, 88 % of the width from 3.50 to 4.50 mm, 90 % – with a thickness of 2.30 to 3.0 mm. The measurements showed that their diameter averaged 3.64 ± 0.023 mm, a volume of 19.49 ± 0.442 mm^3, a weight of 0.018 ± 0.001 grams. In the total mass of fruits 10.6 ± 1.1 % is water, 7.4 ± 1.6 % – fat, 63.8 ± 4.2 % – water-soluble extract. The mass fraction of crude protein was 2.6 ± 0.2 5 %, crude fiber – 14.6 ± 0.4 %, ash – 1.8 ± 0.4 %, organic acids – 4.6 ± 0.2 %. Among the mineral substances prevail potassium (7963.5 ± 47.85 mg / kg), calcium (3661, 57 ± 25, 71 mg / kg) and phosphorus (1238.74 ± 37.82 mg / kg). Behind them go other ash elements (mg/kg): magnesium (855,95 ± 17,63); iron (144,53 ± 3,76); aluminum (125,47 ± 11,04); sodium (114,06 ± 3, 65); boron (25,72 ± 1,86); zinc (10,93 ± 0,84); manganese (10,49 ± 1,32); vanadium (6, 43 ± 0,67); copper (3,73 ± 0,14); lithium (1,40 ± 0,13); nickel (1,07 ± 0,03); chrome (1,03 ± 0,07); barium (0,52 ± 0,12); lead (0,52 ± 0,03); selenium (0,47 ± 0,02) and cadmium (0,03 ± 0,01) [14].

According to dietary norms, the need for an adult in copper, iron and zinc is 3, 18 and 15 mg per day, respectively, and they appear to be present in rather large quantities in sumac fruit. Barium, bromine, cadmium, lead and lithium, which participate in biological processes are no less active, are present in the sumac in relatively small amounts, although the relatively low content of cadmium and lead is rather the value of sumac fruit than their disadvantage.

Of the leaves, flowers and fruits of the tan sum of tannins, myrycitrin ($C_{21} H_{20} O_{12}$ × 1.5 H2O) was isolated. The various organs of this plant can be used as a source of mirycetin ($C_{15} H_{10} O_8$), given its value as a hepatoprotector. Mirycetin in the experiment shows high protective activity in the formation of experimental dystrophies of the stomach on the model of reserpinization and immobilization of mice. In addition, mirycetin and quercetin inhibit lipid peroxidation processes catalyzed by cytochrome C [13].

İt was found that the phenolic complex of sumac fruits includes quercetin derivative, myricetin 3-rhamnoside, quercetin 3-glucoside, and its basis is Gallic acid and its derivatives (pentagalloyl-glucoside, hexagalloyl-glucoside, heptagalloyl-glucoside, octagalloyl-glucoside, nonagalloyl-glucoside, decagalloyl-glucoside) [17].

Rhus coriaria L. – the only kind used directly in food as a spice. A known method of obtaining beverages from the fruits of another member of the family Anacardiaceae – Rhus thiphina L. [7] widely in practice did not enter and remained in the past.

Almost never sold in Azerbaijan in the form of whole fruits-usually a ready-made coarse powder beautiful purple-red or purple-pink color (Figure 2). It tastes sour, tart, a little astringent. Its main exporters are Iran and Syria.

In our homeland, this powder is used as a seasoning for dishes such as lula – kebab (from the Persian كباب – kabâb – "fried meat"), kuku and kutab – cakes stuffed with fresh herbs, sometimes minced lamb or giblets (Figure 3).

Figure 2. Dried and crushed fruits of sumac

Figure 3. Azerbaijani dishes which are well combined with sumac: A -"kuku" and “kutab with fresh herbs”; B – "lyulya – kebab in pita bread"

From unripe fruits sumac get marinade, which used as an acute seasoning for meat and fish dishes and for obtaining medicinal extracts and infusions.

The fruits of sumac in dried form are used as one of the components of a mixture called "zatar" – an Arab snack and at the same time a mixture of fragrant and very useful spices, which in the East (Syria, Lebanon, Palestine) is used as a breakfast or a snack, and also for the preparation of many dishes. Syria is preparing the zatar with the following composition: thyme, sesame seeds, marjoram, dill, cumin, anise, coriander, sumac, hyssop, citric acid, salt. There are two types of zatar – red and green. The difference in the percentage of sumac (in red it is more) and in the degree of grinding.

There is growing interest in using this important seasoning in medicine and the food industry as a natural preservative [2]. Its aqueous extract exerts strong antibacterial effects (Aliakbarlu et al., 2013; Kossah et al., 2013) and antifungal action [15].

In addition, this plant is traditionally are used in the treatment of diabetes mellitus (Muhammad et al., [12]), stroke and cancer [19], gastrointestinal tract ailments [3], arterial hypertension [16]. It is recommended are used it at high temperatures [5]. Consumption of sumac can provide protection against atherosclerosis [18]. İndicate, that the antioxidant effect of sumac is 50 times stronger than that of vitamins C and E [6].

Even the naked eye can see that the fruits of sumac are rich in coloring substances – anthocyanins, which, incidentally, are characterized by high antioxidant and P-vitamin activity and are effective for preventing cancer of the esophagus and colon cancer.

Anthocyanins usually give different organs of plants a purple, blue, brown, red, orange color. This coloration often depends on the pH of the cell content, and therefore can change with increasing flowering and ripening. They are secondary metabolites. They are allowed to be used as food additives (E-163i) belonging to the group of water-soluble natural food colors.

The main disadvantage of anthocyanin dyes is a change in color with a change in the pH of the medium.

Other disadvantages of these dyes are the low content of dyes, low resistance to storage in their pure form, and in products in which it is used. At the same time, the raw material for anthocyanin dyes are most often berries or berry squeeze, that is seasonal, rapidly perishable raw materials, which makes the process of producing dyes multi-stage and complex in technical terms and expensive in financial terms.

All this prompted us to conduct a study aimed at obtaining a natural anthocyanin dye from sumac fruits, which has a high thermal and photo stability, the production of which can be carried out in any required amount, regardless of the time of year, seasonality and any other factors.

MATERIALS AND METHODS

We were not able to get into an environment of relevant information of scientific and inventive nature, which highly satisfies our plan about getting a liquid red dye from the fruit of the poison tree.

Therefore, the Foundation took the methodology followed in their work [11] during the tests, aimed at obtaining extracts from the fruit of the poison tree for therapeutic purposes.

The basis of this methodology is the testing of the boundaries of each experience different solvents and process parameters and selection of the best one the basis of the evaluation criteria, the main of which is the degree of extraction of phenols from dried and ground fruit of the sumac. It allows you to use the existing possibilities for the intensification of diffusion processes occurring at the interfacial contact components of the system "solid-liquid". Among the parameters studied, the most important influence on the degree of extraction was the concentration of ethyl alcohol in water and the duration of extraction. The work has been tested: absolute ethanol and its aqueous solutions of various concentrations; extraction time in the range of 1 – 9 hours; the temperature of extraction is in the range of 20– 60 °C; degree of grinding fruit sumac in the range of 0.5 – 2.5 mm; different ratio between the solvent and powdered sumac from 5:1 to 25:1.

They found that preferred is a variant in which solvent was used water ethanol solution of concentration 20 g/100 cm^3, dried sumac was milled to particles with an average size of 1 mm, the mass ratio between the solvent and the raw material was 15:1, temperature – 40 °C, the extraction time is 1 hour. The content of phenolic compounds in the extract obtained according to this variant was the highest and amounted to 159.32 mg/g for GAE.

One of the tested by these authors variants – extraction with aqueous ethanol concentration of 80 g/100 cm^3 – had nothing to do with the technologies we develop are and were considered by us as the method-analogue. The other – extraction with aqueous ethyl alcohol of concentration 20 g/100 cm^3 – was considered by us as the closest in nature to our idea of the prototype method.

We considered that the main drawback of the prototype method is associated with an unsuccessfully selected solvent. In this known method, they were forced to go from strong ethanol solutions down to weak ones in search of the optimal solvent. At the same time, the question of the possibility of complete rejection of ethanol in favor of water remained open.

Given this, we had to finalize the question of the optimal solvent, as well as to determine the direction of further processing of the separated extracts, which would ensure the receipt of the target product with a characteristic texture for the type of product chosen by us. To achieve this task had to be solved basic questions such as:

– Selection of the best solvent (both in terms of its safety and cheapness, and taking into account the achieved degree of extraction of phenolic compounds from this particular type of raw material);

– İdentification of the optimal parameters of the extraction process with the participation of the selected solvent;

– Evaluation of the quality of the target product based on the study of its coloring ability and other consumer characteristics.

The fruit of the sumac tree was collected in the mountainous part of the Guba district in the mountain forest near the village of Gedik in late September. In this time they until still contain water a bit more (13–15 wt. %), than it is required for the fruits, which are ground here to obtain the seasoning, which we have already mentioned. It is possible to collect sumac fruits almost dry in October, but by this time they fall under the rain several times.

The next day they were dried and ground into a fine powder and stored at a temperature of 5 °C before use.

Technological experiments and chemical analyses were carried out in the laboratory of Processing and storage technologies of the Ministry of agriculture of the Republic of Azerbaijan.

To dry mature sumac fruits, a laboratory drying Cabinet with forced ventilation and an inspection window of the SH-DO-149 FG series (South Korea) was used.

Grinding of dried sumac fruits was carried out using a laboratory mill Tube Mill control (Germany) with batch loading.

Extraction of the crushed product was conducted by percolation method.

Soluble extract was recovered two static methods: one-stage (maceration, percolation) and multistage (re-maceration) at different temperatures from room temperature to 80 °C.

Obtaining the extract by maceration was as follows.

Sumac fruits of a certain grinding were loaded into a macerator (glass container or enameled metal inside container), filled with a calculated amount of solvent and kept for the required amount of time. The resulting extract was then separated.

The process of re-maceration is characterized in that the solvent used not at once, but divided into several parts. The rest of the raw material after the first infusion is poured with the next portion of the solvent. Often used bi-maceration, that is, the solvent is divided into two parts.

The primary extracts were evaporation using a rotary evaporator Lab Protovar 2 l (China).

In the section "Formulation of the tasks" we have already touched upon the question of solvent selection and outlined the objectives of extraction. And we have already decided that we will use only weak solutions of ethyl alcohol and water as a solvent.

Therefore, the main attention was paid to the factors affecting the extraction process, such as the ratio of raw material / solvent, the duration of the process, the temperature, which varied at 3–5 levels.

As the output option was used the concentration of pigments in the extract (in units of optical density).

Sampling for chemical analyses was conducted in accordance with the GOST (State standard of the Russian Federation) 26313. The samples were prepared in accordance with the GOST 26671.

In dried and powdered fruits and products of their processing were determined:

– Dry substances – thermally-gravimetric method, which consists in drying the loosened sample of the product at high temperature and atmospheric pressure, according to GOST 28561–90;

– Monosaccharaides and sucrose – according to the Bertrand method, which is embedded in the basis of GOST 8756.134;

– Total acidity – titration with sodium hydroxide solution in the presence of phenolphthalein indicator, according to the Interstate (AM, BY, KZ, KG, MD, RU, UZ) standard ISO 750–2013;

– Vitamin C – iodine metric method, by the GOST 28556;

– The pH – potentiometric method according to the GOST 26188–84.

– The total amount of water-soluble phenols- – titration of their solutions 0.1 n. potassium permanganate solution by Leventhal. This method of their quantitative determination is based on the oxidation of phenols in an acidic medium with potassium permanganate. But this reagent is oxidized and some other substances. Therefore, all substances capable of reacting with $KMnO_4$ are first oxidized, then the phenols are separated, taking advantage of their property to be adsorbed by animal or charcoal, and oxidation is again carried out. According to the difference in the amount of potassium permanganate, which went to oxidation for the first and second time, the content of phenols is determined using 0.004157 as a conversion factor of 0.1 N milliliters of $KMnO_4$ solution per grams of phenols. This principle is embedded in the basis of the method for determining tannins in medicinal raw materials according to GOST 24027.2–80 and the corresponding article of the State Pharmacopoeia of the Russian Federation, which is also devoted to the definition of these substances in medicinal raw materials.

All analytical definitions are performed in 3-fold repetition. The data is statistically processed using Excel. The mean square error of the mean did not exceed 1.5–2.0 %.

Antioxidant activity of biologically active substances of extracts was determined by the indicator of total content of antioxidants (in terms of Gallic acid) by amperometric method on the device «ЦветЯуза 01-АА – TsvetYauza 01-AA, Russia» [19].

RESULTS AND DISCUSSION

The efficiency of the extraction process depends on the main technological factors: the temperature and time of extraction, the degree of grinding of raw materials, the type of solvent, hydromodule (the ratio between the raw material and the solvent), etc. for each type of plant raw materials are characterized by rational parameters, modes, conditions established experimentally.

Therefore, at the first stage of work it was necessary to optimize the process of extracting biologically active substances from sumac fruits; the method of bi-maceration was used. To select the optimal solvent, experiments were conducted, which showed that the best solvent for sumac fruits is an aqueous solution of citric acid concentration of 0.3 g/cm^3. Citric acid greatly intensifies the output of the coloring components of the raw material in the extract.

The selected solvent has another important property. It lies in the fact that an aqueous solution of citric acid absolutely does not extract fat – like substances (and there are a lot of them in sumac fruits-up to 17 % of their dry weight), because of which the transparency of primary extracts can be violated (which we saw, for example, in experiments using strong solutions of ethyl alcohol as a solvent).

The use as a solvent of an aqueous solution of citric acid with a concentration higher than 0.3 g/100 cm^3, almost does not affect the degree of extraction of tannins and dyes, leads to an unjustified increase in the consumption of citric acid and the rise in the cost of the method as a whole, and therefore it is impractical.

It was found that it is better to conduct extraction in two stages with the separation of the extract from the first stage and the addition of a new portion of the solvent before the second stage of extraction. The method of bismaceration was effective in the sense that it allows to significantly increase the degree of extraction of soluble components of raw materials, that is, to reduce their losses.

Based on a series of experiments, a graphical interpretation of the dependence of the mass fraction of solids (%) in extracts on two variables was obtained: temperature and extraction time was obtained (figures 4 and 5).

$$F(x,y) = -3.0495 + 3.0640x + 0.1576y - 0.3212x^2 - 0.00004xy - 0.0011y^2 \quad (1)$$

$$F(x,y) = -11.4332 + 2.6321x + 0.4752y - 0.2876x^2 + 0.0020xy - 0.0040y^2 \quad (2)$$

Mathematical models of extraction of sumac fruits are expressed in the form of polynomial equations of the second degree, where F (x, y) is a function of the content of soluble solids, %; x is the duration of extraction, hour; y is the temperature of the solvent, ºC. The absolute error for mathematical models ranged from 2.2 to 4.2 %.

According to the results of the experiments, the optimal modes of obtaining red food dye from sumac fruits were obtained: extraction time of 1 hour (30 minutes in each stage); temperature of 75–80º C; the degree of grinding of raw materials 3.0–4.0 mm; hydromodule (raw materials/solvent) in the first and second stages of bilaterali 1:8 and 1:4 respectively.

The specified ratio between the raw material and the solvent is chosen so that, on the one hand, it is possible to extract from the raw material as many components of a hydrophilic nature as possible, and on the other – there would be no strong dilution of the extracts, which after separation are evaporated under vacuum. This is also due to the need to create an environment with a pH of 3.2–3.5. In a less acidic or neutral environment, diffusion processes occur at a much lower rate.

Experiments have shown that the content of components that can be extracted with water in dried sumac fruits is at a level close to 38 wt. % and grinding and processing of this specific type of raw materials in the conditions selected by us provides 90–92 % degree of their extraction. At the same time, we have not identified any reasons that would not be in favor of our chosen parameters. While changing these modes led to undesirable consequences such as a strong dilution of extracts, reduction of the extraction coefficient, etc.

The technology provides for the drying of sumac fruits by convective method to a residual water content of 10–8 wt. %. For drying sumac fruits selected temperature 60–55 °C at which the raw material is quickly dehydrated. Experiments have shown that drying this raw material at higher temperatures activates the process of degradation of anthocyanins. Drying sumac fruits at a temperature below 55 °C is also undesirable, as it increases the drying time, and this is bad for the time of the overall production cycle.

Also, the efficiency of extraction largely depends on the degree of destruction of the cell structure of the object under study. For this purpose, grinding of the product was used.

The characteristic range of grinding of raw materials with residual moisture 10–8 wt. % the percentage with the help of disintegrator was also determined empirically and is 3–4 mm for sumac fruits. At the same time, when the particle sizes are more than 5 mm, the rate of diffusion processes is noticeably reduced.

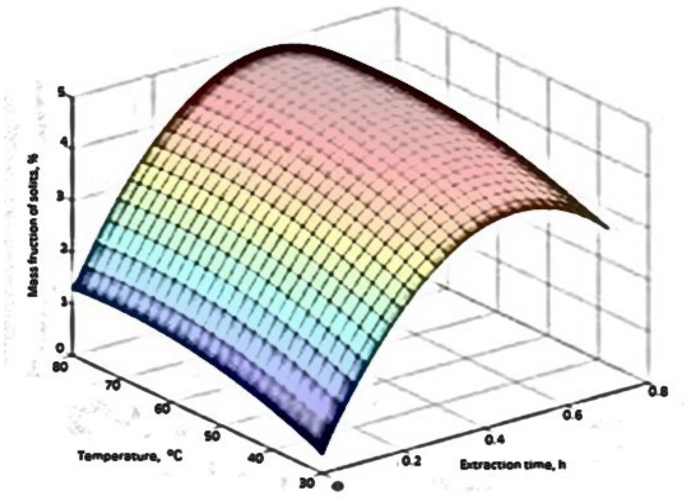

Figure 4. The dependence of the mass fraction of solids in the extract on two variables: temperature and extraction time (the first stage of extraction)

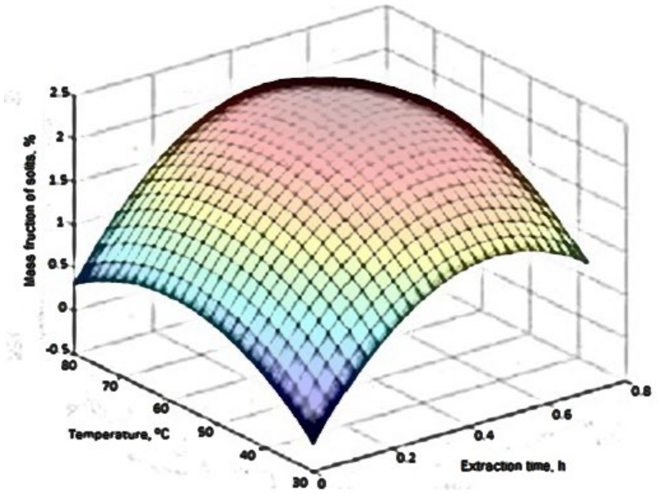

Figure 5. The dependence of the mass fraction of solids in the extract on two variables: temperature and extraction time (the second stage of extraction)

In extracts from the first and second stages of bi-maceration at the end of the time allotted for their conduct, the concentration of dry substances, depending on the used batch of raw materials, is set at 4±0.1 wt. % and 2±0.3 wt. %, respectively. After the extraction is completed, the extracts are separated, filtered, and then concentrated by evaporation. Experiments have shown that their evaporation to the desired consistency should be carried out under vacuum at a temperature of 50–60° C and a vacuum of 80–87 kPa (600–650 mm Hg). This gentle mode allows you to better preserve anthocyanins. The resulting liquid concentrate is pasteurized at a temperature of 65 °C for 5 minutes, followed by cooling to a temperature of 25 °C.

In factory conditions extraction can be carried out in usual devices of vertical type with heating and the filtering bottom to which the drain crane is attached. It is important that the separation of the formed extracts occurs quickly. To speed up filtration, vacuum filtration (suction with a water jet pump) can be used – a method of filtering liquids, in which the difference between the atmospheric pressure outside the filtrate receiver and artificially reduced pressure inside it is used to move the filtered liquid through the filter element.

Evaporation of primary extracts to a dry matter content of 30, 35, 40 or 60 wt. % and compare these four products based on characteristics such as color strength and viscosity, showed that the duration of this process depends on how the concentrate is fluid and how easy it will be to work with him in the future. The relatively long evaporation was bad for its fluidity. Beyond a certain point, it also began to provoke processes ending in the degradation of labile components of the extract, such as anthocyanins. Tests have shown that the loss of part of the anthocyanins are inevitable and prevent them completely is almost impossible. To reduce their losses, it is necessary to adjust the process time so that it ends relatively quickly, even before the moment when the mass fraction of dry substances in the concentrate begins to exceed the mark of 33 wt. %. Therefore, this gentle treatment mode was chosen, which allowed to obtain the target product with a dry matter content of 30 ± 1 wt. %.

Table. The chemical composition of the feedstock and the target products obtained in two ways

The dye	Chemical composition, g/100 g						Total antioxidant content, mg / dm^3
	Dry substan – ces	Mono – saccha raides	Saccharose	Total acidity (by citric acid)	Water-soluble phenolic compounds	Ascorbic acid (mg/100 g)	
Dried and shredded fruits sumac (Guba, Azerbaijan)	92.0±2,00	11.44±0.24	0.58±0.01	4.44±0.10	12.31±0.27	5.86±0.13	-
In the method-analogue	31.0±1.00	9.23±0.14	1.03±0.03	3.81±0.16	6.80±0.15	4.96±0,16	3013,2±80,7
Of the proposed method	31.0±1.00	7.84±0.23	0.05±0,001	4.78±0.15	8.19±0.26	4.20±0.14	4031,7±97,6
Data are means of three determinations ±SD. Means with different superscripts within the same row are significantly different (p<0.05)							

The target product is bottled in glass bottles. This is a necessary condition, since anthocyanins in glass containers are stored better, than in metal lacquered jars. This is due to the fact that during long-term storage of the concentrate in the lacquered coating, micro-cracks are formed, through which anthocyanins come into contact with the metal. This opens the way to the formation of chelate complexes of dark blue color.

Bottles with dye pasteurized to increase its biological resistance.

The table presents data on the chemical composition of dried and crushed sumac fruits and two food dyes, one of which is obtained by the method proposed by us (using as a solvent an aqueous solution of citric acid with a concentration of 0.3 g / 100 cm^3), and the other-by the method-analogue under exactly the same conditions, but using as a solvent an aqueous solution of ethyl alcohol with a concentration of 20 g / 100 cm^3. From it can be seen that in the dye obtained by the method-analogue, the content of tannins and dyes (water-soluble polyphenols) is 6.80±0.15 g/100 grams and this is much lower than that of the dye obtained by our method (8.1±0.26 g/100 g).

It is also seen that the dye obtained by the method–analogue contains a little more vitamin C than the dye obtained by our method. This is due to the fact that the alcohol from the extracts evaporates faster and with less harsh heat treatment than water, which led to a somewhat greater loss of vitamin C in our method, designed to work with an aqueous extract. But this insignificant difference can not affect the biological value of the dye, the main advantage of which, based on its purpose, is an extremely low content of antioxidants phenolic acid. This is evidenced by the large difference between these two dyes in the total content of antioxidants. As you can see, the dye obtained by the technology developed by us, with such a high percentage of antioxidants that it can be used as an additive to the substances of Botanical therapy.

Using the data table, you can see that a total dry mass of the dye obtained by the chosen solvent on phenolic compounds, many of which have high antioxidant activity, it is necessary 27.33 wt. %. Almost the same part falls on monosaccharides (26.13 wt. %). The proportion of organic acids in the dry matter of the dye is 15.93 wt. %.

The dye is a transparent thick liquid of dark red color, completely soluble in water and aqueous solutions of ethyl alcohol, with an odor peculiar to the smell of raw materials, sour taste. The dye is an extract isolated from anthocyanin-containing plant material with a total antioxidant content of 4031.7±107.6 mg / dm^3. It can be used for coloring in red-pink tones of different intensities of sweet-sour (pH = 6 – 4) and sweet – sour (pH 4 or below) drinks at a concentration of 700 – 1000 ppm (0.7–1 g / l).

According to the literature [1, 9], aqueous extracts of sumac fruit contain of delphinidin (delphinidin 3–glucosid) and some cyanidin glycosides (cyanidin 3-glucoside, cyanidin 3 (2´´ galloyl) galactoside, 7-methyl-cyanidin 3 galactoside and 7-methyl-cyanidin 3 (2´´ galloyl) galactoside), organic matter and mineral salts.

As you know, cyanidin glycosides in alkaline medium has a blue color, and acidic-red. Delphinidin has a bluish cyanidin and blue color, and red color is only in methylation. The combination of these anthocyanins in the developed dyes makes it possible to obtain a dye with a rich gamut of shades of red.

At the same time, the predominance of the most persistent forms of anthocyanins – cyanidin glycosides allows to obtain a dye with a number of physically valuable properties, namely, the claimed dye retains a red color at a pH of no more than 7, is heat-resistant and retains its properties for two years, while its relative optical density is maximum when exposed to light with a wavelength of 505–515 nm.

The developed dye is an extract of plant raw materials, contains biologically active compounds extracted from the raw material. The presence of such a large number of biologically active compounds increases the quality of the claimed dye. The highest concentration of biologically active substances allows its use in the technology of functional drinks.

The output of the dye with a dry matter content of 30 wt. % (specific gravity 1.3–1.14) is high and is 116 kg per 100 kg of dried sumac fruits. Speaking of this, it should also be noted that in Azerbaijan the market price of 1 kg of ground sumac is not higher than $ 7–8. For this money now you will not buy and 200 ml of natural dye. And in the proposed method, the yield of the dye from 1 kg of raw materials is more than 1 kg.

This relatively high yield of the target product will give the opportunity to maneuver its selling price and facilitate competition for a place in the market of food additives. This suggests that the proposed technology is very promising in terms of the available opportunities for its commercialization. It should also be borne in mind that the modern stage is characterized by an ever-increasing demand for natural products, which is associated with the deterioration of the environmental situation

CONCLUSION

Thus, as a result of our research, we have developed a technology for processing sumac fruits, including drying, grinding and extraction, followed by separation of the resulting extracts and their concentration to obtain anthocyanin dye.

SIGNIFICANCE STATEMENT

This is one of the rare works that aims to prepare the technological base for large-scale processing of sumac fruits-the most valuable biologically active raw materials, which, as we believe, should deserve more attention from product and technological innovation managers than is currently the case.

Today, the need for the fruits of this shrub is satisfied, mainly due to their natural reserves, since sumac is used very limited, only as a seasoning for meat dishes and as part of health mixtures for Breakfast. We have calculated that this is the relatively low demand for sumac fruits and is the main reason that in Azerbaijan and most other places of its habitat this plant is among the plants with unclear prospects for cultivation. The situation, frankly, is not the best for a plant with such a high biotechnological potential.

It is time to think about other ways to use them, given its high biotechnological potential.

Our proposed extraction technology is one of the rare examples of how sumac fruits can be obtained and other valuable products. Its development required the solution of inventive problems [8].

The extraction technology was not chosen by chance. A good reason for this choice was the fact that water-soluble phenolic compounds on the one hand and all other combined soluble components of the chemical composition on the other, are presented in dried sumac fruits in a rare ratio for vegetable raw materials equal to 0.75/1, which characterizes them as a natural storehouse of antioxidants of phenolic nature.

It is with this that the expected result of the developed and proposed extraction technology can be associated. It makes it possible to obtain from this rich raw material a red food dye, in the total mass of dry matter of which 26.43 % are phenolic compounds, including anthocyanins, which are natural antioxidants. This is so much that it allows the target product to be used as a red dye at a concentration of 700–1000 ppm (0.7–1 g / l) and in functional beverage technology.

The dye is not fat-soluble, and hydrophilic, which in the world now is not so much.

In favor of the considered innovation, the fact that now in the food industry, as a rule, synthetic dyes are used, which harms the health of consumers. Therefore, consumers prefer products colored with plant pigments, which is due to the deteriorating environmental situation.

The implementation of this new technology can increase the demand for this raw material, and this, in turn, will contribute to the withdrawal of the sumac plant from the list of plants with unclear prospects for cultivation, as is still happening, for example, in Azerbaijan.

ACKNOWLEDGEMENTS

The author acknowledges the efforts of the research teams and technical staff who read the manuscript and prepared the reagents in the course of this study.

CONFLICT OF INTEREST

None of the authors of this study have any financial interest or conflict with industries or parties.

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