Investigation of the Influence of the Parameters of the Process Extraction on the Content of the Phenolic Complex in the Extracts of the Dried Fruits of Blackcurrant

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ABSTRACT

The optimal parameters of the extraction process for the extraction of biologically active substances from the dried fruits of blackcurrant have been established and experimentally confirmed. The phenolic complex of the extracts obtained at different parameters of the extraction process was investigated - selection of the extractant; extraction temperature; extraction time and hydromodule. Studied are the extracts obtained at the optimals extraction parameters for total phenols 1,023 g gallic acid / 100 g CB, phenolcarboxylic acids 0, 12%, flavonoid phenolic compounds 53,4 mg%, sum anthocyanins 238 mg% and tannins 2,47 g catechin / 100g CB. On the basis of the experimental data, the technological regimes of the extraction process were selected. The use of 70% C2H5OH as an extractant is technologically warranted to produce extracts of dried fruits blackcurrants with maximum content of phenols, flavonoids, anthocyanins and tannins. Technologically justified extraction temperature is 65-80oC. By increasing the extraction temperature to 80°C, the quantity of anthocyanins in the extracts increases, which positively affects the organoleptic evaluation of the final products. The optimum extraction time is 3-4 hours. During this extraction period, a maximum content of the phenolic complex is obtained. The results obtained suggest that the most advantageous hydromodul for extraction is 1:30.

Keywords: *extraction parameters, extracts, biologically active substances, dried fruit blackcurrants.*

I. INTRODUCTION

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In today's context, the problem of rational nutrition is one of the main factors determining the state of human health, its working capacity and the sustainability of the influence of various adverse environmental factors. Reduced consumption of natural plant products has caused the development of functional disorders of the gastrointestinal tract and diseases related to metabolic disorders.
An analysis of the modern nutrition structure shows that further improvement and development of technologies for the production of biologically complete products with high content of biologically active substances is needed to improve nutritional status.
In this context, it is important to develop a technology for extracting biologically active substances from the fruits of wild raw materials, in particular from blackcurrants, and to include them in the development of new assortments of beverages.

In order to increase the nutritional value and antioxidant properties of the juice-containing beverages, extracts of wild raw materials having prophylactic and functional action can be introduced into production technologies.

The healing potential of wild shrub plants lies in their antioxidant, anti-allergic, anti-inflammatory and antiviral properties, which depend on polyphenolic complexes. Particular attention is given to the content of flavonoid phenolic compounds and anthocyanin pigments.

Beverages are an optimal form of food that can be used to enrich the nutritional portion with irreplaceable nutrients and biologically active substances that have a beneficial effect on metabolism and immune resistance of the body [1].

Studies conducted in different countries confirm that one of the main causes of pathological changes in the human body leading to premature aging and development of cardiovascular diseases, oncological diseases and diabetes is the excessive accumulation of free radicals and active forms of oxygen in the biological fluid of the organism . In order to increase the nutritional value and antioxidant properties of the juice-containing beverages, extracts of wild raw materials having prophylactic and functional action can be introduced into production technologies. The healing potential of wild shrub plants lies in their antioxidant, anti-allergic, anti-inflammatory and antiviral properties, which depend on polyphenolic complexes. Particular attention is given to the content of flavonoid phenolic compounds and anthocyanin pigments.

Blueberries and blackcurrant extracts serve as natural antioxidants. Berries contain powerful antioxidants and a proper balance of bioactive compounds. They are considered to be a good source of phenolic compounds, especially flavonoids and phenolic acids, which mostly contribute to their high antioxidant activity [2].

It fruits are a rich source of vitamin C and other health beneficial substances such as: routine, organic acids,pectins, micro-and macro nutrients and essential oils [3].

Blackcurrant fruits contain polyphenolic substances with antioxidant, antimicrobial, antiviral, and antibacterial properties [4, 5, 6, 7, 8]. In order to increase the nutritional value and antioxidant properties of juice-containing beverages, extracts of wild-growing raw materials having a prophylactic and functional effect can be introduced into the production technologies.

The purpose of this work is to determine, through research, the technologically sound parameters of the extraction process and to obtain extracts with a maximum BAV content.

The following tasks have been set to achieve this goal:

- establishment of the basic parameters of the process of extraction and development of technology for the extraction of BAV from the dried fruits of blackcurrant with the highest content of the phenolic complex.
- study of total phenolic compounds, phenolcarboxylic acids, flavonoid phenolic compounds, the sum of anthocyanins and tannins from the extracts obtained at different parameters of the extraction process.

II. Material and Methods

Object of study are the fruits of Ribesnigrum. In fruits contain a number of BAV that can affect the vital processes occurring in the human body.

The physicochemical and sensory analyzes were conducted using standardized methods approved by good manufacturing practice.

- General Phenol Compounds (AFS) spectrophotometric method with Folin-Denisa reagent,% as gallic acid [9].
- Phenol Carbonic Acid – Spectrophotometric [9].
- Flavonoid phenolic compounds – spectrophotometric [9].
- Anthocyanins - spectrophotometric such as cyanidine-3,5-diglucoside [9].
- Tanning substances - titrated with 0.02M potassium permanganate [9].

For the extraction of the vegetable raw material, various extractants are used: water and ethyl alcohol of various concentrations 30%, 50% and 70%. Concentration of the ethanol has a significant effect on the extraction of the various groups of compounds. To determine the optimum solvent, extractant is

added to a raw material. The feedstock / extractant ratio was 1:10 by weight of feedstock at 20°C for 24 hours. The change in concentration of the different groups of compounds in the extracts is due to their different solubility in ethanol and water and to the fact that they are extracted from dry plant material. Processes in plant raw materials are going on into the aquatic environment. Most of the compounds are found mainly in the vacuoles of the cells. To improve the extractability of substances contained in dry plant tissue, the raw material needs to absorb a certain amount of water. Water-alcohol solutions at a concentration close to absolute ethanol do not provide the necessary water to rehydrate the cells.
The effect of the hydromodule (1:10, 1:20 and 1:30), the temperature (35°C-80°C) and the duration of the extraction (1-4 hours) on the type and quantity of the extracted substances were investigated. Developed various variants of water and ethanol extracts from dried berries blackcurrant have been. The aqueous and ethanol extracts of the fruits are respectively athydromodul 1:10, 1:20 and 1:30 - fruit / extractant; at an extraction temperature of 35°, 50°, 65° and 80°C and extraction time 1, 2, 3 and 4 hours. The extracts are stored in tightly closed packages at 25°C in the dark. Each variant is developed in triple repeatability. The resulting extracts were subjected to physico-chemical analyzes. As a result of the research the process of extraction of phenolic compounds from dried fruit blackcurrant was optimized.

III. RESULTS AND DISCUSSION

The concentration of the total phenolic compounds is higher by extraction with ethyl alcohol compared to the water extraction. It grows with increasing the concentration of ethyl alcohol in the extracts, reaching its maximum in the extract with 70 % ethyl alcohol - Fig. 1.
When extracting to dried fruits blackcurrant with an increase in ethyl alcohol concentration from 30 % to 50 %, the amount of common phenolic compounds increased by 20 % and by extraction with 70 % ethyl alcohol the common phenolic compounds increased by 41% - Fig. 1.

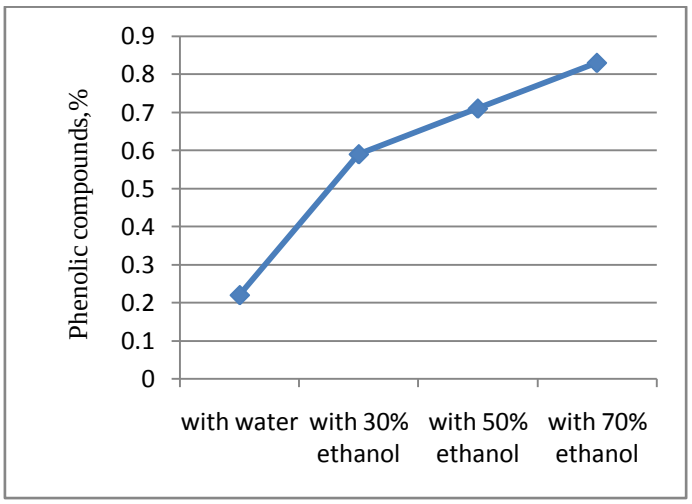

Fig. 1. Effect of the extractant concentration on the the total phenolic compounds content in extracts of dried fruits blackcurrant

The trend in the content of phenolic acids and flavonoid phenolic compounds is similar to that of the total phenolic compounds - Fig. 1, 2. Concentration of the phenolic acids by extraction with 30 %, 50 % and 70 % ethanol is higher, respectively, of 2.2; 3.6 and 3.9 times compared to their concentration in the aqueous extracts - Fig. 2.

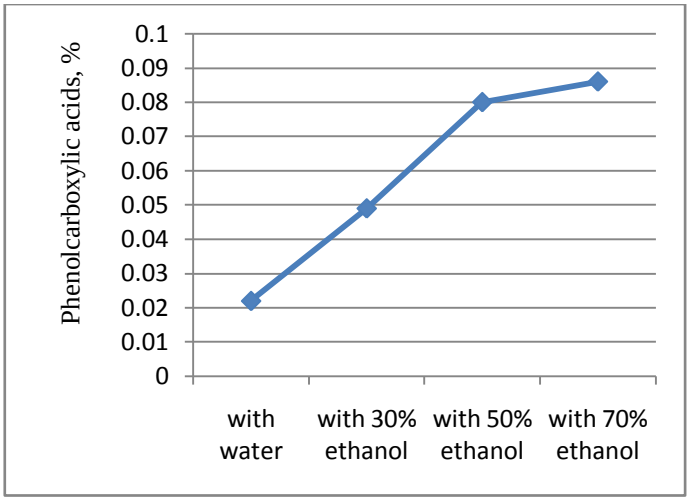

Fig. 2. Effect of extractant concentration on phenolcarboxylic acids content in extracts of dried fruits blackcurrant

For flavonoid phenolic compounds the increase in the concentration is 2,1; 3.3 and 3.5 times higher - Fig. 3.

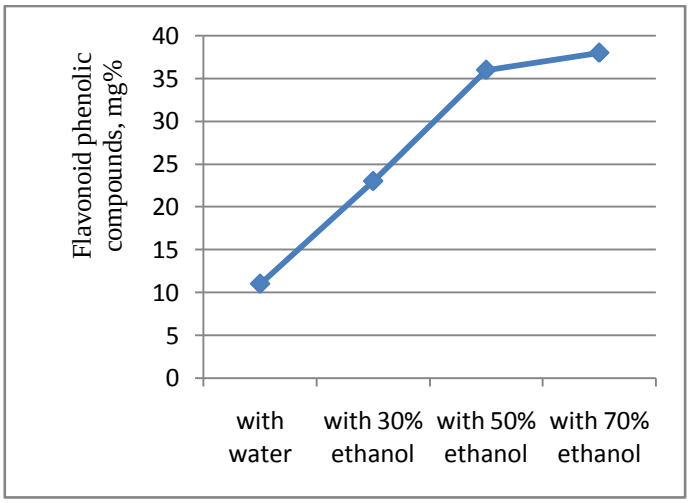

Fig. 3. Effect of extractant concentration on flavonoid phenolic compounds content in extracts of dried fruits blackcurrant

The amount of anthocyanins increases, with the highest being at 70% extractant and varying from 31 mg% when extracted with water to 189 mg% - Fig. 4.

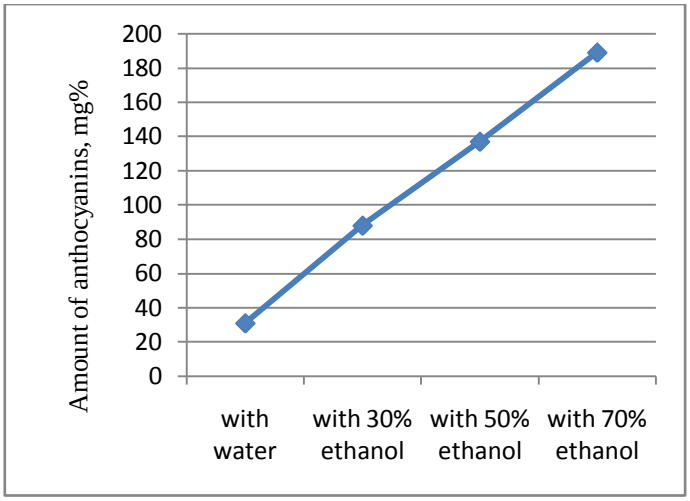

Fig. 4. Effect of extractant concentration on anthocyanins content in extracts of dried fruits blackcurrant

The change in the concentration of tanning substances follows the trend observed with other phenolic compound compounds. Tannins are most in the 70 % ethanol extract. The concentration of tannins in the extract is 19.2% higher than the extract with 30% ethanol - Fig. 5.

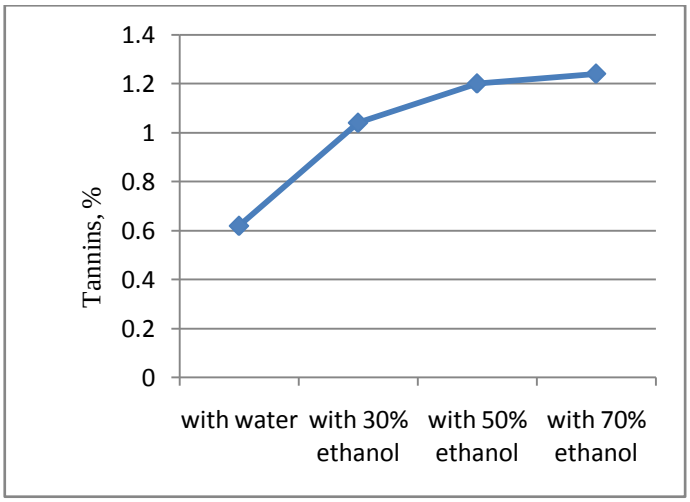

Fig. 5. Effect of extractant concentration on the content of tanning substances in extracts of dried fruits blackcurrant

In order to determine the optimal extraction temperature, four temperature variants were examined: 35 ° C, 50 ° C, 65 ° C and 80 ° C and 70 % C2 H5 OH as the solvent.

The results of studies on the effect of the extraction temperature on the chemical composition of blackcurrant extracts are given in Fig. 6-10.

The content of tanning substances extracted from dried currant berries ranges from 0.90 % to 1.33 % at an extraction temperature of 35°C, 50°C, 65°C and 80°C. The data show that with the increase of the temperature the quantity of tannins increases, their maximum value being at 80oC - Fig. 6.

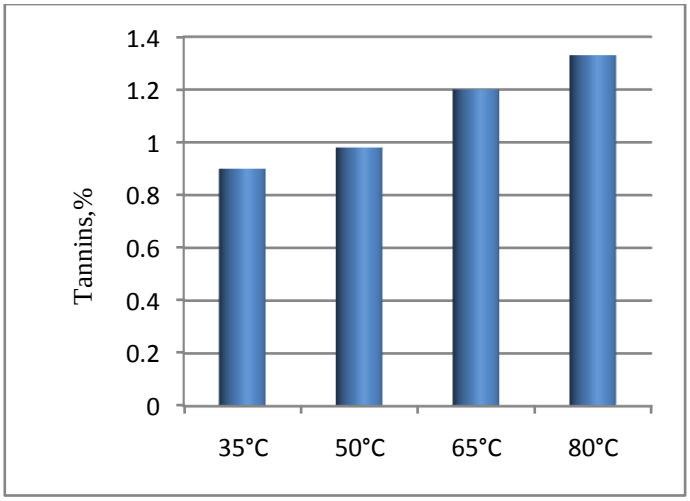

Fig. 6. Effect of extractant concentration on the content of tanning substances in extracts of dried fruits blackcurrant

The content of the total phenolic compounds in the extracts varies with different temperature regimes of 0.40 % at 50°C to 0.71 % at 65°C. The results obtained show that, by total phenol content of 0.71 g gallic acid / 100 g CB, the optimum extraction temperature for dried fruit blackcurrants is 65°C - Fig. 7.

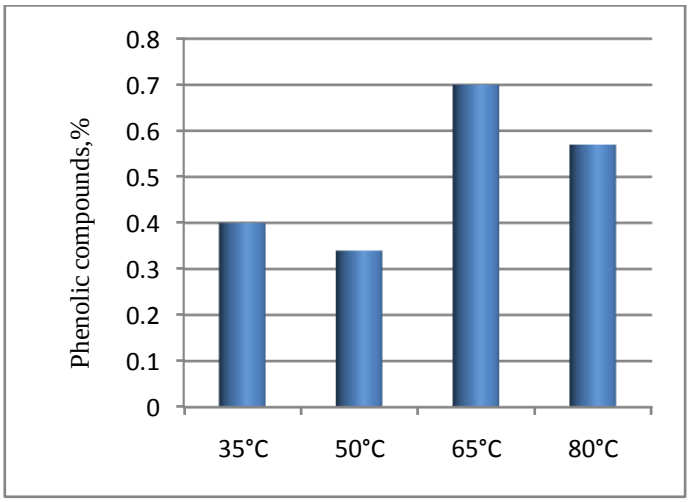

Fig. 7. Influence of the extraction temperature on the total phenolic compounds content in extracts of dried fruits blackcurrant

For the total content of flavonoid phenolic compounds, a favorable extraction temperature is 65°C - Fig. 8. Probably at higher temperatures some of them break down.

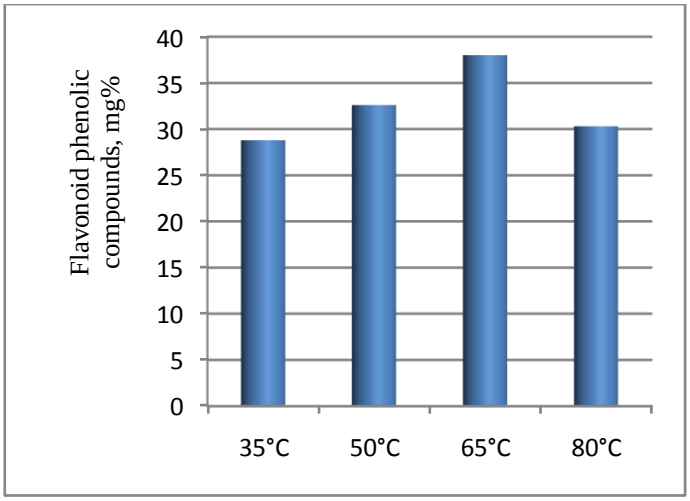

Fig. 8. Influence of the extraction temperature on flavonoid phenolic compounds content in extracts of dried fruits blackcurrant

By chemical structure and action, anthocyanin glycosides are close to flavonoids. By increasing the extraction temperature from 65°C to 80°C, the amount of anthocyanins in the dried fruit blackcurrant extract also increases. Therefore, for the sum of the anthocyanins, respectively 241 mg%, the optimum extraction temperature for the currant dried fruit is 80°C- Fig. 9.

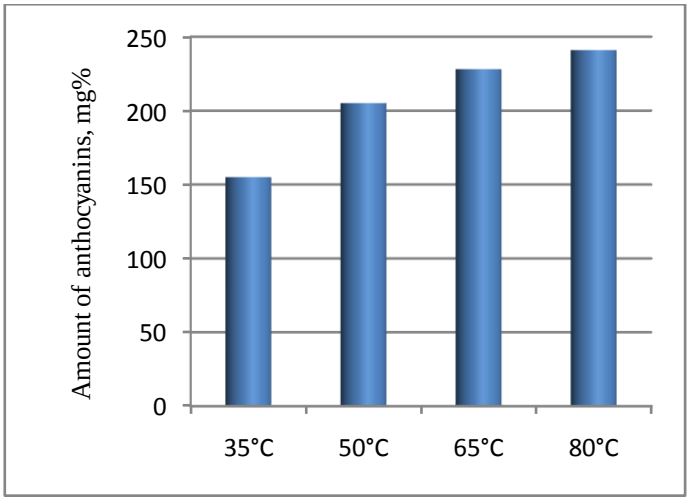

Fig. 9. Influence of the extraction temperature on anthocyanins content in extracts of dried fruits blackcurrant

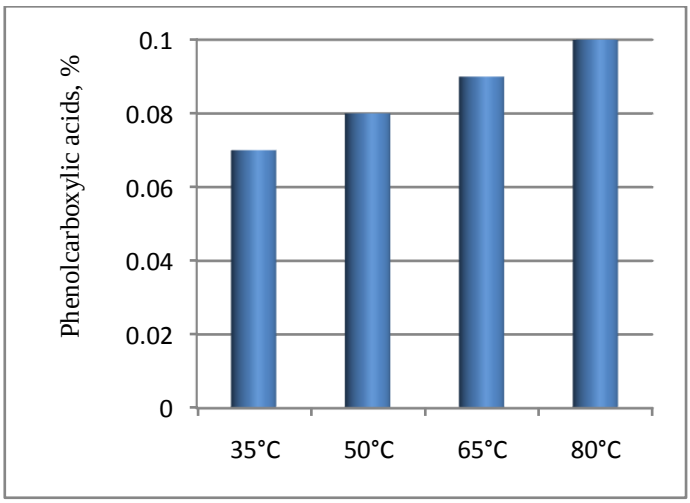

Fig. 10. Influence of the extraction temperature on phenolcarboxylic acids content in extracts of dried fruits blackcurrant

By total content of phenolic carbonic acids 0,1 % favorable temperature is 80°C - Fig. 10. Based on the results obtained, it can be concluded that the technologically justified extraction temperature is 65^{o} - 80^{o}C.

Based on the results obtained, it can be concluded that the technologically justified extraction temperature is 65o - 80oC. When high temperature is applied to the plant cells, their destruction occurs and the extraction of phenolic substances and flavonoids is facilitated. As a rule, phenolic substances are contained in natural sites not in the free but in the sugar-related state in the form of glucosides. In the heat treatment the bonds are destroyed and the phenolic substances are released from the cells.

The further increase in temperature does not help to increase full extraction and leads to the destruction of biologically active substances (polyphenols, vitamins). Therefore, raising the temperature in this case above 80 ° C is inappropriate.

In order to determine the process process life, extraction is carried out at optimal solvent values and an optimal extraction temperature for 1, 2, 3 and 4 hours. Results of studies on the influence of extraction duration on the physicochemical composition of the extracts are shown in Fig. 11-15. The concentration of the total phenolic compounds in extracts of dried fruit blackcurrant increased from 0.68 % in 1 hour to 0.95 % in 4 hours with 39.7 % - Fig. 11.

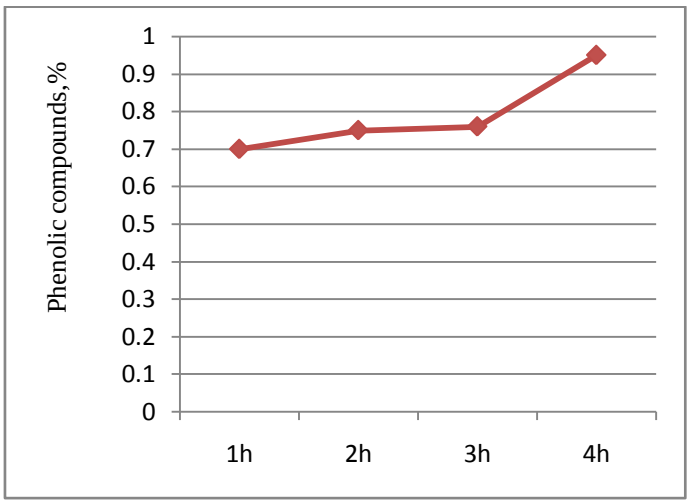

Fig. 11. Influence of the duration of extraction on the content of the total phenolic compounds in extracts of dried fruits blackcurrant

The amount of phenolcarboxylic acids extracted from the dried fruits of the blackcurrant by extraction with a different duration from 1 to 4 hours increases by 22% - Fig. 12.

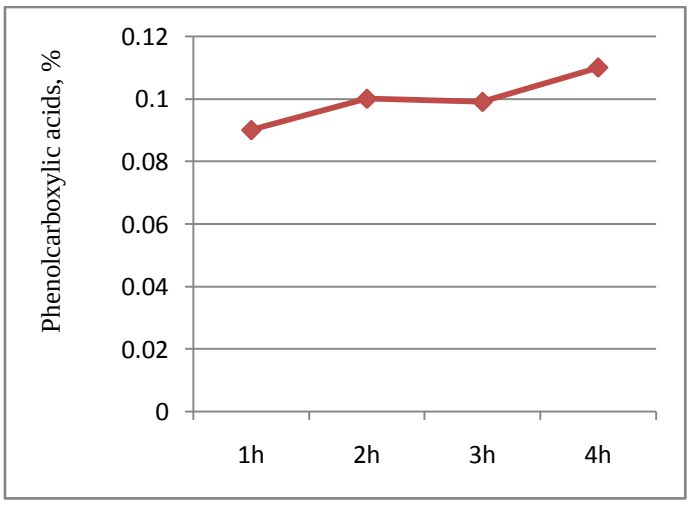

Fig. 12. Influence of duration of extraction on the phenolcarboxylic acids content in extracts of dried fruits blackcurrant

The content of the flavonoid phenolic compounds increased by 31.6 % with an extraction time of 1 to 4 hours - Fig. 13.

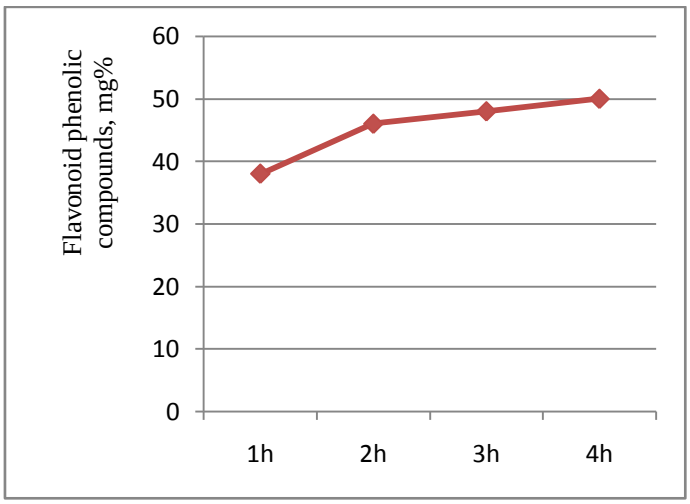

Fig. 13. Influence of the duration of extraction on the content of flavonoid phenolic compounds in extracts of dried fruits blackcurrant

Similar to flavonoid phenolic compounds, the amount of anthocyanins in blackcurrant extracts is also increasing. With different extraction times vary they range from 228 mg% to 243 mg%. The increase in the amount of anthocyanins in blackcurrant extracts with an increase in the duration of extraction is negligible by 6.6 % - Fig. 14.

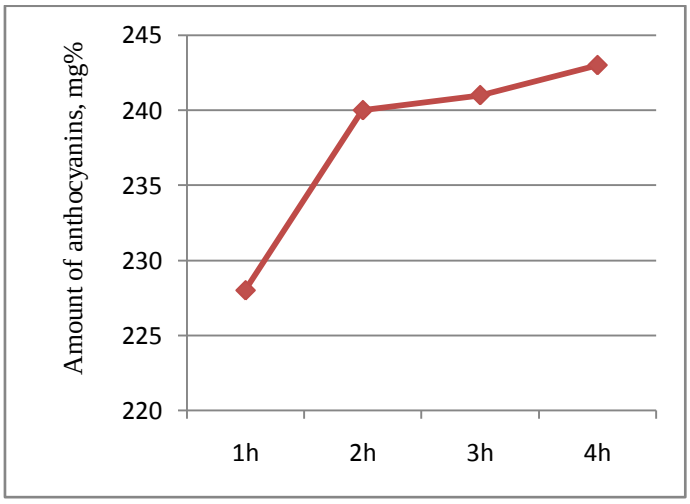

Fig. 14. Influence of the duration of extraction on the amount of anthocyanins in extracts of dried fruits blackcurrant

The content of tanning substances extracted from the blackcurrant at different extraction times ranges from 1.20 % to 1.41 %. The increase is 17.5 % respectively - Fig. 15.

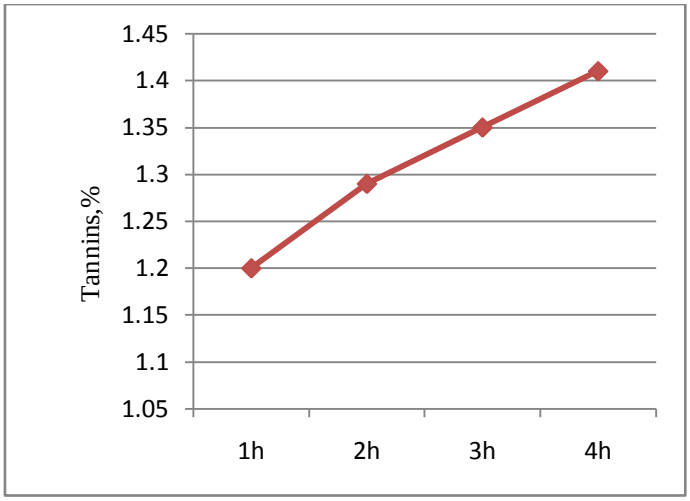

Fig. 15. Influence of the duration of extraction on the content of tanning substances in extracts of dried fruits blackcurrant

The results obtained from the studies allow us to conclude that about total phenolic complex content, the most advantageous extraction time is 3-4 hours.

The effect of the extraction hydromodule on the content of the phenolic complex in the extracts of the blackcurrant fruit is investigated.

The content of the total phenolic compounds in the blackcurrant fruit extracts varies with the different hydromodules, respectively, from 0.76 % at 1:10 to 1.02 % in the hydromodel 1:30. Technologically justified hydromolecule of extraction is 1:30 - Fig. 16.

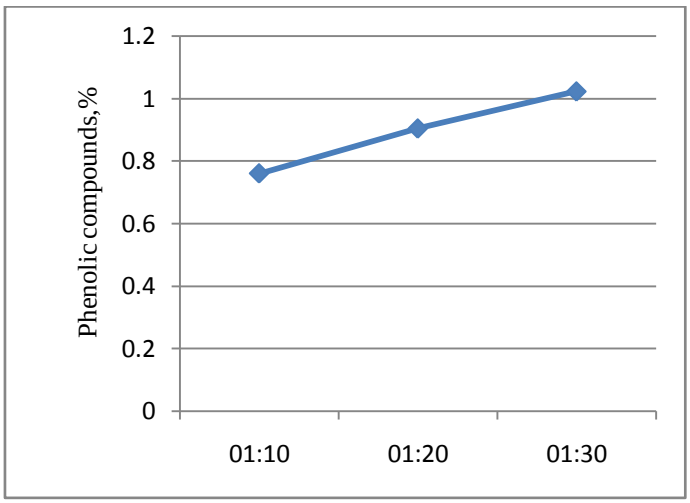

Fig. 16. Influence of the extraction hydromodul on the content of the total phenolic compounds in extracts of dried fruits blackcurrant

The amount of phenolcarboxylic acids extracted from the dried fruits of the blackcurrant by extraction with a different hydromodule increases and is highest at the hydromodule 1:30 - Fig. 17.

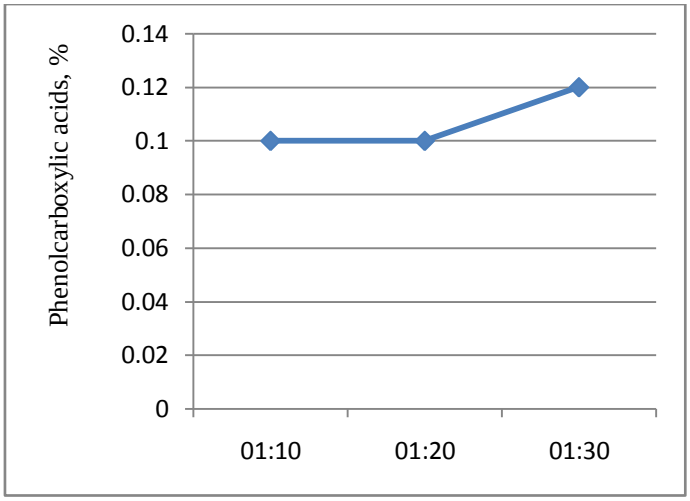

Fig. 17. Influence of the extraction hydromodul on the phenolcarboxylic acid content in extracts of dried fruits blackcurrant

The content of flavonoid phenolic compounds increased by 25.2 % at hydromodul 1:20. In hydromodul 1:30 the content of flavonoid phenolic compounds decreases by 11.2 % - Fig. 18.

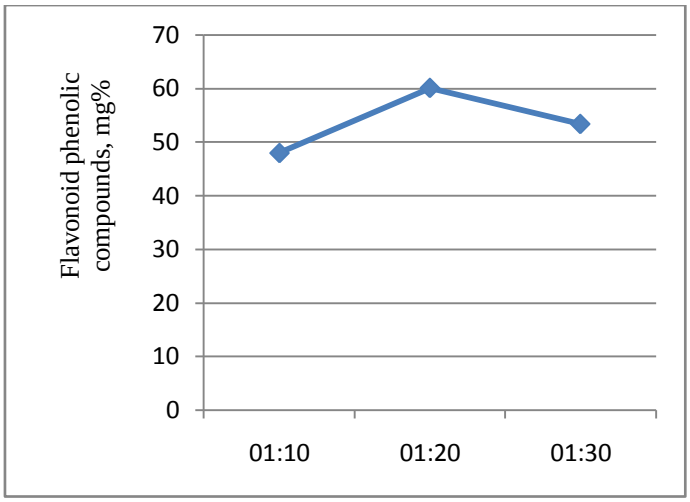

Fig. 18. Effect of extraction hydromodul on the content of flavonoid phenolic compounds in extracts of dried fruits blackcurrant

Studies of the amount of anthocyanins in the blackcurrant extract obtained in three different hydromodules show that the anthocyanin content ranges from 243 mg%, 233 mg% to 238 mg% - Fig. 19. The higher ratio of raw material to the extract ant does not significantly affect the amount of anthocyanins in blackcurrant extracts.

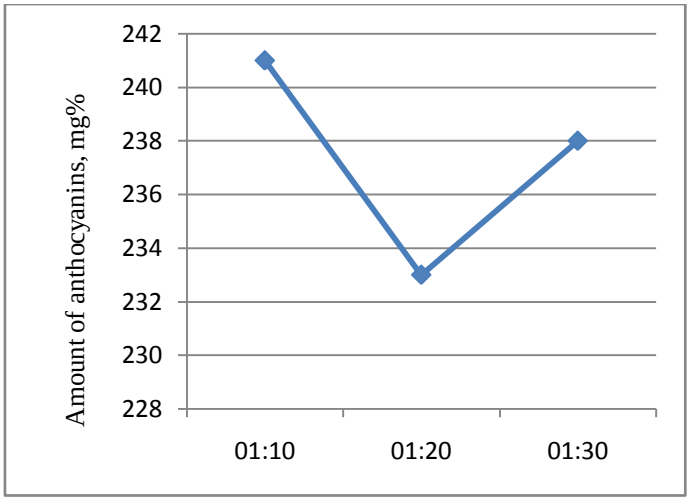

Fig. 19. Influence of the extraction hydromodul on the sum of anthocyanins in extracts of dried fruits blackcurrant

The content of tannins extracted from dried fruit blackcurrant ranges from 1.35 % to 2.47 % at the hydromodul 1:10 to 1:30. The data show that the hydromodule affects the amount of tannins, their maximum value being at a ratio between material and extractant 1:30 - Fig. 20.

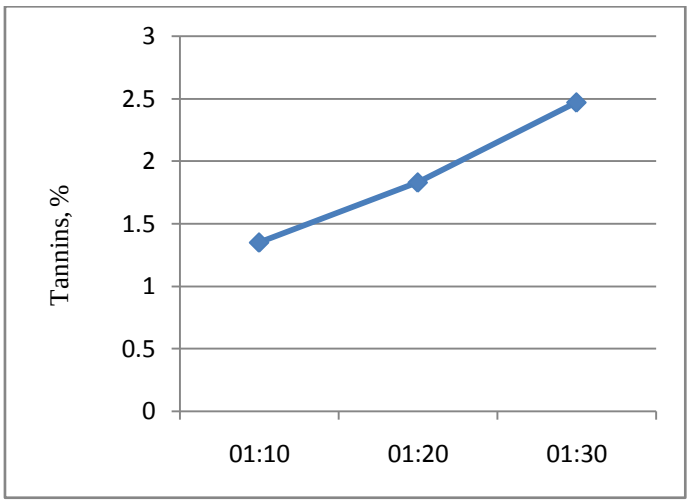

Fig. 20. Influence of the extraction hydromodul on the content of tanning substances in extracts of dried fruits blackcurrant

The results obtained suggest that the most advantageous hydromodul for extraction is 1:30 to obtain the extracts with the highest content of phenolic complex. To improve the extractability of substances contained in dry plant tissue, the raw material needs to absorb a certain amount of water, to provide the water needed to rehydrate the cells.

For the normal functioning of the body's complex antioxidant system, a wide range of biooxidants is required. Particularly effective is a systems in combination with the phenolic compounds contained in blackcurrant extracts, which themselves function as active antioxidants.

As a result of the research carried out, a technology was developed for the production of black currant extracts, the exemplary block diagram of which is shown in fig.21.On the basis of the experimental data, the technological regimes of the extraction process were selected.

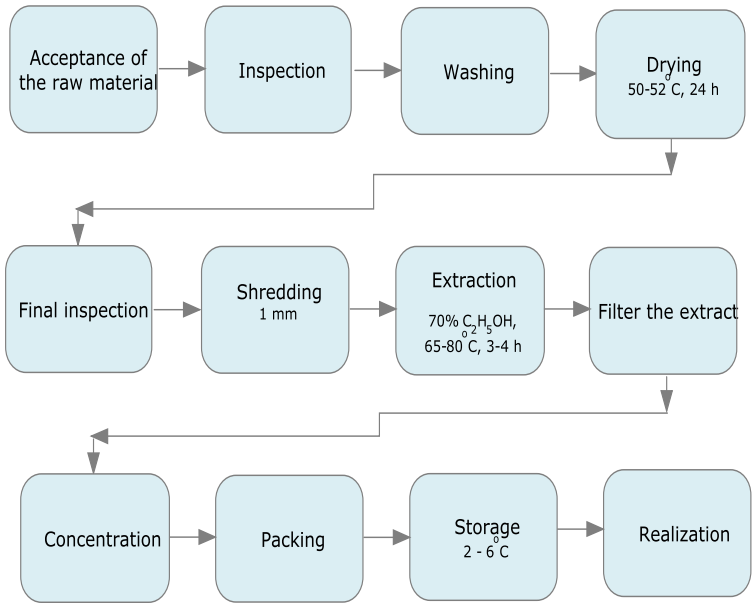

Fig. 21. Block scheme for obtaining extracts of dried fruits currants

A technology for the production of dried fruits currant extracts with a high content of biologically active substances used for the production of functional drinks is scientifically substantiated and developed.

IV. CONCLUSIONS

As a result of the research, the following conclusions can be drawn:

1. In the production of plant extracts, the choice of raw material is important for the physicochemical properties of the extract.
2. In the preparation of the extracts from the dried fruits of black currant, the technology of drying the raw material influences the physicochemical properties of the extract. Proper drying increases the shelf life and increases the phenolic complex content.
3. The use of 70% C_2H_5OH as an extractant is technologically warranted to produce extracts of dried fruits currants with maximum content of phenols, flavonoids, anthocyanins and tannins.
4. Technologically justified extraction temperature is 65°-80°C. Increasing the temperature above 80 °C does not lead to more complete extraction and destroys the biologically active substances. Therefore, raising the temperature in this case is inappropriate.
5. By increasing the extraction temperature to 80 °C, the quantity of anthocyanins in the extracts increases, which positively affects the organoleptic evaluation of the final products.
6. The optimum extraction time is 3-4 hours. During this extraction period, a maximum content of the phenolic complex is obtained.
7. On the basis of the experimental data, the technological regimes of the extraction process were selected.

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