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Physical and mechanical methods of intensification of the process of extraction of substances from plant raw materials

V A Pomezova¹, Y A Praskova², N A Frolova², N V Shkrabtak (Babii)² and L Yu Reznichenko¹

¹Kemerovo state University, 6 Red sq., Kemerovo, Russia

² Amur State University, 21 Ignatievskoye Highway, Blagoveshchensk, Russia

E-mail: ninelfr@mail.ru

Abstract. This paper presents data on the determination of parameters of extraction of plant materials and the assessment of the nutritional value of the obtained extracts. As the main object of research was selected *Schisandra chinensis*. The optimal extraction parameters were established: duration - 6 hours, temperature - 40-50°C. As a result of the work, organoleptic, physicochemical parameters and nutritional value of the obtained extracts were determined. The results obtained indicate that the developed extracts have a high nutritional value and can be used as sources of biologically active substances in the preparation of functional products.

1. Introduction

Vegetable raw materials of the Amur region are characterized by high biological value. Ingredients have a positive effect on metabolic processes. As an object of research in this work were selected berries of *Schisandra chinensis* - endemic to the Far Eastern region. Lemongrass, possessing a tonic effect, is considered as a promising raw material for use in the formulation of functional foods and determining the optimal biotechnological regimes and parameters for their production [3, 4].

Lemongrass can be used in the form of extracts, juices, fruit drinks, etc. As a result of the extraction, the biological components go into solution and become more accessible and digestible.

One of the most important factors in the choice of parameters and regimens for obtaining plant extract is the maximum preservation of the activity of biologically active substances.

Development of technology for the extraction of biologically active substances is carried out on the basis of the following principles:

- Availability of technology of the chosen method of extraction;
- Use available and permitted in the food industry substances and reagents;
- High taste and aromatic properties of the obtained extract.

Modern methods of processing and use of medicinal plant materials are based on the extraction of valuable components, their transition to a neutral carrier and dosing according to recipes in food products.

Extraction of soluble substances from various solids is the most common process in the production of concentrates, extracts, etc. [1-3].



Extraction is the extraction of one or several components from a solid using a solvent or extractant, which has the selective ability to dissolve only those target components that need to be isolated.

The following factors play an important role in the extraction process: the nature of the extractant, the degree of grinding of plant material, the temperature and duration of extraction, the difference in the concentrations of substances in the raw materials and extractant and hydrodynamic conditions, the anatomical structure of the growth material, the ratio of raw materials and extractant [2].

The extractant is chosen depending on the type of the obtained product and its purpose. Any extractant has a selective effect on the extractable raw materials. Depending on the properties of the extractant from one and the same plant material, you can get completely different extraction.

Plant and animal oils, liquefied carbon dioxide, liquid nitrogen, alcohol-water or water-alcohol solutions, ethers, etc. are used as extractants.

Physical and mechanical methods of intensifying the process of extracting substances from plant materials are based on the mechanical destruction of the plant cell walls. For effective extraction of aromatic and biologically active substances from medicinal plant materials, the following methods are used: pressing, cryo-grinding, decomposition (hydrolysis, autolysis), steam distillation, ultra sound, etc. [4-6].

Any extractant must be selective, chemically and pharmacologically (from a safety point of view) indifferent, be accessible and cheap [4]. In the food industry, only certain, non-toxic extractants can be used, which ensures the safety of the finished product. In order to select an extractant, the ability to extract biologically active substances from vegetable raw materials that are widely used in food and, in particular, non-alcoholic industrial extractants: water, 20% and 40% water-ethanol solutions was studied.

Under certain conditions, water treatment of vegetable raw materials allows the basic flavoring and aromatic compounds to be converted into solution, such as mono-, di-, and trisaccharides, pigments, tannins, cyclic alcohols, organic acids, a number of flavonoids and some mineral compounds [7-9].

Water-ethanol extraction extracts flavonoids, essential oils, resins, terpenoids, saponins, coumarins, glycosides, alkaloids, carbohydrates.

Biologically active substances in plant materials are either in the form of a solution inside the cells or on the walls of cells in the dried raw materials [10]. When extracting dried raw materials, the extraction process of biologically active consists of the following stages: penetration of the extractant into the raw materials; wetting of substances in the cell; the dissolution of biologically active substances in the cell and the flushing of substances from the destroyed cells and open pores; mass transfer of substances through porous partitions of the cell wall by molecular diffusion.

The purpose of the study is to analyze the process of extracting biologically active substances in the extraction of *Schisandra chinensis* and factors affecting it.

2. Research results and discussion

To obtain the extracts, both frozen and dried fruits of Chinese *Schizandra* were used. The content of biologically active substances in extracts was studied to compare the complexes of active substances in infusions and juice, as well as to assess the yield of biologically active substances from fruits. at the same time the problem was solved of the influence of the drying method on the extraction of vegetable raw materials

There are experimental data explained by the fact that the release of substances from the dried raw materials to extracts depends on the strength of the association of phenolic compounds with proteins, and this, in turn, depends on the method of drying [11].

The efficiency of the extraction is affected by the temperature, the duration of the process and the type of extractant. Since at high temperatures the biologically active substances of *Schizandra* can be inactivated, and also the processes of polymerization of phenolic compounds can be enhanced with the formation of sedentary forms, which leads to turbidity, the extraction temperature was chosen in the

range of 40-50° C. The traditional types of extractants are water and an aqueous solution of ethyl alcohol. Since the polyphenolic substances that make up the *Schisandra chinensis*, as well as vitamins and acids, are water-soluble compounds, water was used as a solvent [12].

The extracts were prepared, taking into account the coefficient of water absorption, which was determined experimentally. For the preparation of infusions was used crushed dry raw materials passing through a sieve with a hole diameter of 2 mm. The experiment was carried out on 6 samples subjected to one of the described types of drying: convective, infrared, natural. The duration of extraction was 6 hours. The duration of extraction for six hours is due not only to the yield of the maximum amount of biologically active components, but also to the "maturation" of the extract, which is expressed in the formation of fullness and harmony of taste.

The extracts determined the content of the same groups of substances as in the fruits and juice.

The obtained indicators of the content of biologically active substances for the three drying options were analyzed by the method of dispersion analysis. Since the analysis did not reveal significant differences, the data obtained were combined to calculate averages (tabl.1).

Table 1. The content of biologically active substances in the infusions of berries *Schisandra chinensis*.

Drying raw materials	Tanning substances %	Phenolic compounds %	Anthocyanin %	Organic acids %
Natural	0.021±0.002	0.008±0.004	0.0015±0.006	1.26±0.6
Convective	0.085±0.004	0.025±0.002	0.0072±0.002	2.18±0.2

The obtained data allowed us to compare the content of biologically active substances in the infusion and juice. Table 2 shows the average absolute content of biologically active substances in 100 cm³ of infusion and juice.

Table 2. The chemical composition of infusion and juice of lemongrass.

Name indicator	Tanning substances %	Phenolic compounds %	Anthocyanin %	Organic acids %
content in 100 cm ³ infusion	0.085±0.002	0.025±0.002	0.0073±0.006	2.2±0.8
content in 100 cm ³ of juice	0.020±0.006	0.0062±0.004	0.012±0.002	6.2±0.4

The choice of the method of drying does not have a significant effect on the content of the main biologically active substances in the dried fruits. Natural drying in the conditions of industrial preparations is practically not applicable: its duration is about 2.5 months. The obtained extracts were analyzed by organoleptic and physico-chemical parameters. Organoleptic indicators of quality extracts from *Schisandra chinensis* are shown in table 3.

Table 3. Organoleptic evaluation of extracts based on *Schisandra chinensis*.

Name Indicator	Weighting factor	Value, score
Color, transparency	0,3	1,5
Aroma	0,2	1,0
Taste	0,3	0,9
Overall impressions	0,3	1,5
Comprehensive indicator	1,0	4,9

On the basis of the conducted research, it can be concluded that when using extracts for the production of beverages directly in the enterprise, it is advisable to extract frozen raw materials or extract the juice.

If it is necessary to transport and store extracts, their production should be organized at a special enterprise from dried raw materials, followed by concentration to a mass fraction of dry substances of 50-55%.

The change in microbiological indicators during storage of the extracts is given in table 4.

Table 4. Changes in microbiological indicators during storage.

Name indicator	Norm	Value	
		In a day working out	After 6 months of storage
KMAFANM, CFU / cm ³ not more	5×10 ⁴	0	3
Yeast and mold (total) CFU / 10 cm ³ not more than	10	0	3
The volume of the extract which is not allowed cm ³			
BGP (coliform)	1,0	Not found	
Pathogens incl. salmonella	25	Not found	

As can be seen from table 4, the microbiological indicators of the extracts correspond to the hygienic requirements in accordance with the TP TC 021/2011.

The nutritional and energy value of the extracts obtained is given in table 5.

Table 5. Nutritional and energy value of extracts from *Schisandra chinensis* (100 g).

Name indicator	Value
Mass concentration of proteins. g	2,6
Mass concentration of carbohydrates. g	25,3
Mass concentration of organic acids. g	25,7
Energy value. kcal	170

3. Conclusion

Thus, the obtained extracts have a high nutritional value and can be used as sources of biologically active substances in the production of functional food.

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