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Book	Code	Faculty and Section
Razgrad Branch of the University of Ruse		
10.1	FRI- ONLINE-1-CT(R) SAT-ONLINE-P-2-CT(R)	Chemical Technologies
10.2	FRI- ONLINE-1-BFT(R) SAT-ONLINE-P-2-BFT(R)	Biotechnologies and Food Technologies
10.3	TUE-ONLINE-SSS-BFT(R)	Biotechnologies and Food Technologies
	TUE-ONLINE-SSS-CT(R)	Chemical Technologies

The papers have been reviewed.

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SAT-ONLINE-P-2-BFT(R)-03

REASONING OF THE SELECTION OF TECHNOLOGICAL PARAMETERS FOR THE EXTRACTION OF SUMAC

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Abstract: *In order to intensify the extraction process, the possibility of using a rotary-pulse apparatus was investigated. The use of rotary-pulse extractors makes it possible to intensify the process of eliciting extractive substances of plant raw materials in comparison with traditional methods, to improve the microbiological parameters of the obtained extracts due to the tightness of the circuit and to ensure the energy efficiency of the process.*

It was found that with increasing temperature, the mass fraction of extractives increased, while the duration of the process at the selected temperature was of great importance. The duration of the extraction at a temperature of 20 °C for 10 min, gave the same yield of extractives as heating the system "raw materials/solvents" to a temperature of 80 °C without endurance.

To compare the results of experimental data determined by different methods, the coefficient of variation was calculated. That is, the use of a rotary-impulse apparatus makes it possible to increase the yield of extractives by an average of 24.5% in comparison with classical maceration.

Keywords: *extraction, sumac, extractives, temperature.*

INTRODUCTION

The use of components of natural origin is promising due to the high content of biologically active and flavoring substances and the ability to retain their characteristics during storage.

Spices are a source of biologically active substances (essential oils, terpenoids, phenolic and polyphenolic substances, vitamins, micro- and macroelements, etc.). The food industry usually uses dried vegetable raw materials and in the form of an extract containing from 8% to 14% moisture. Carbohydrates are generally represented by fiber (17...48%), proteins in spices from 7.5% to 11% (Malashenko, & Borisova, 2014).

Preparation of spice extracts allows more complete extraction of biologically active substances from plant raw materials and use them in concentrated form (Kochubei-Lytvynenko, Marynin, Yushchenko, Kuzmyk, & Lazarenko, 2017). Liquid extracts are widely used due to the predicted ratio between the active substances, ease of measurement and obtaining (Ukrainets, Pasichniy, & Zheludenko, 2016).

The degree of extraction of biologically active substances depends on the type of solvent. The most commonly used types of extractants are alcohols, alkalis and organic acids, but they are not always desirable for use in the food industry, even subject to subsequently removed from the extract.

Therefore, milk whey is increasingly considered in terms of product and raw materials with functional properties, in addition, due to its composition and high acidity contributes to a more complete extraction of dry matters from raw materials. During extraction, water-soluble vitamins, tannins and dyes, macro-, microelements and other biologically active substances diffuse into it (Gavrilov, & Kravchenko, 2013; Abdulalim, Zayan, Campelo, & et. Al., 2018).

Various methods are used in the production to obtain extracts from plant raw materials: maceration, percolation, repercolation, as well as other methods, including grinding of raw materials in the extractant medium (Yushchenko, Grabova, Kuzmyk, & Pasichnyi, 2017).

Forming the taste properties of products, spices also increase the activity of food on the digestive system, promoting better absorption of nutrients. This is due not only to the more intense secretion of gastric juice, but also due to the content in spices of components that catalyze a number of processes and promote the activation of metabolism in general (Du, Cullen, & Buettner, 2012).

RESEARCH MATERIALS AND METHODS

The mass fraction of extractives in the extract was determined by refractometric method. The method is based on determining the mass fraction of dry matter by the refractive index of light. On the right scale find, in the percentage, mass of dry matter, which coincides with the boundary of the distribution of dark and light fields.

Determination of chromaticity in sumac extract was performed using an electrophotocolorimeter KFK-2MP at a wavelength of 560 nm. Chromaticity (Ch) in units of optical density was calculated by the formula:

$$Ch = (10 \cdot L560)/(DM \cdot d \cdot b) \qquad (1)$$

where L560 is the value of the optical density of the solution, which was measured by the device at wavelengths of 560 nm, units of optical density;

DM - mass fraction of dry matter in solution,%;

d - density of the solution, g/cm^3;

b - length of the cuvette, cm (Krivovoz, & Sidorenko, 2009).

To describe the experimental data for determining the dependence of the yield of extractives on the temperature and duration of the process selected multiple regression equations in General:

- for experimental data determined under the condition of extraction using maceration:

$$Y_1 = b_0 + b_1X_1 + b_2X_2 + \varepsilon \qquad (2)$$

- for experimental data obtained by extraction using a rotor-pulse apparatus:

$$Y_2 = b_0 + b_1X_1 + b_2X_2 + \varepsilon \qquad (3)$$

where, b_0 is a free term that determines the values of Y_1, Y_2, when all independent variables Xi are equal to 0; b_1, b_2 - show how much the resultant feature Y_1, Y2 will change, with changes per unit of measurement of each independent factor X_1 and X_2.

When determining the total mass fraction of extractives under different conditions: X_1 - temperature, °C; X_2 - process duration, min; Y_1 - mass fraction of extractives,%, determined with maceration; Y_2 - mass fraction of extractives,%, determined by means of a rotor-pulse apparatus; ε is a random variable that characterizes the deviation of factors X_1 and X_2 from the regression line (residual variable).

STUDY OF THE RESEARCH RESULTS

In order to determine the rational ratio between the crushed raw material and the extractant, the efficiency of the extraction process for changes in the hydromodule from 1:5 to 1:12 was investigated. The mass transfer process was carried out under the following constant conditions: temperature (85±5) °C; duration 15 minutes; stirrer speed 10 rpm. The research results are given in table 1.

Table 1. The efficiency of the extraction process in the system "sumac/whey" with a variable hydromodule

Indicator	The ratio of "raw material:extractant"							
	1:5	1:6	1:7	1:8	1:9	1:10	1:11	1:12
Weight, g: - sumac - milk whey	 8.4 41.6	 7.1 42.9	 6.3 43.7	 5.6 44.4	 5.0 45.5	 4.5 45.5	 4.2 45.8	 3.8 46.2
Extract mass, g	31.2	34.3	35.7	38.6	39.4	40.0	41.2	41.6
Mass fraction of dry matter in the extract,%	5.5	5.2	5.0	4.6	4.4	4.0	3.7	3.2
The degree of extraction of extractive sumac in solution,%	20.5	25.4	28.6	32.1	34.0	35.6	35.7	34.2

According to the results of the study, a rational ratio established between spice and solvent, which is 1:10. At this ratio, the amount of solvent is sufficient for efficient separation of the extract and maximum extraction of extractives.

At the next stage, the influence of independent factors (temperature and duration of extraction) on the efficiency of the mass transfer extraction process, implemented using maceration and rotor-pulse apparatus, was investigated.

The obtained data are presented in table 2, 3.

It was found that with increasing temperature, the mass fraction of extractives increased, also the duration of the process at the selected temperature was important. The duration of extraction at a temperature of 20 °C for 10 min, gave the same yield of extractives as heating the system "raw material/solvent" to a temperature of 80 °C without exposure. The largest mass fraction of extractives was observed at the following process parameters: temperature 80-85 °C, extraction duration - within 10 min.

Table 2. The yield of the mass fraction of extractives of sumac in the extraction process with maceration

Temperature, °C	Mass fraction of extractives, %					
	Extraction time, min					
	5	10	15	20	25	30
20	2,0±0,1	2,1±0,1	2,2±0,1	2,2±0,1	2,3±0,1	2,4±0,1
35	2,0±0,1	2,2±0,1	2,2±0,1	2,4±0,1	2,5±0,1	2,6±0,1
50	2,5±0,1	2,6±0,1	2,6±0,1	2,7±0,1	2,8±0,1	3,0±0,1
65	2,8±0,1	2,8±0,1	2,9±0,1	3,1±0,1	3,2±0,1	3,3±0,1
70	2,8±0,1	2,9±0,1	3,2±0,1	3,3±0,1	3,5±0,1	3,6±0,1
75	3,1±0,1	3,4±0,1	3,6±0,1	3,8±0,1	3,8±0,1	3,9±0,1
80	3,5±0,1	3,7±0,1	4,0±0,2	4,0±0,2	4,1±0,2	4,1±0,2
85	3,5±0,1	3,8±0,1	4,0±0,2	4,1±0,2	4,1±0,2	4,2±0,2
90	3,5±0,1	3,9±0,1	4,1±0,2	4,1±0,2	4,2±0,2	4,2±0,2
95	3,8±0,1	4,1±0,2	4,1±0,2	4,1±0,2	4,2±0,2	4,2±0,2

Table 3. The yield of the mass fraction of extractives of sumac in the extraction process using a rotary-pulse apparatus

Temperature, °C	Mass fraction of extractives,%					
	Extraction time, min					
	5	10	15	20	25	30
20	2.5±0.1	2.6±0.1	2.7±0.1	2.8±0.1	2.9±0.1	3.1±0.1
35	3.0±0.1	3.1±0.1	3.2±0.1	3.3±0.1	3.5±0.1	3.6±0.1
50	3.3±0.1	3.4±0.1	3.5±0.1	3.6±0.1	3.7±0.1	3.8±0.1
65	3.8±0.1	3.9±0.1	3.9±0.1	4.1±0.2	4.1±0.2	4.2±0.2
70	4.0±0.2	4.1±0.2	4.2±0.2	4.3±0.2	4.4±0.2	4.5±0.2
75	4.5±0.2	4.5±0.2	4.6±0.2	4.6±0.2	4.7±0.2	4.8±0.2
80	5.0±0.2	5.0±0.2	5.0±0.2	5.1±0.2	5.1±0.2	5.2±0.2
85	5.0±0.2	5.0±0.2	5.1±0.2	5.1±0.2	5.1±0.2	5.2±0.2
90	5.1±0.2	5.1±0.2	5.1±0.2	5.2±0.2	5.2±0.2	5.2±0.2
95	5.0±0.2	5.1±0.2	5.2±0.2	5.2±0.2	5.3±0.2	5.3±0.2

To compare the results of experimental data determined in different ways, the coefficient of variation is calculated.

$$V = \frac{\sigma}{\overline{Y}} \cdot 100\% , \qquad (4)$$

where, σ – rms deviation Y_1 (model data of the mass fraction of extractives, determined using maceration) from Y_2 - (model data of mass extractives, determined using a rotor-pulse apparatus); $\overline{Y}$ – the average value of control (data obtained using maceration).

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (Y_1 - Y_2)^2}{n}} , \qquad 5)$$

where, n is the amount of experimental data.

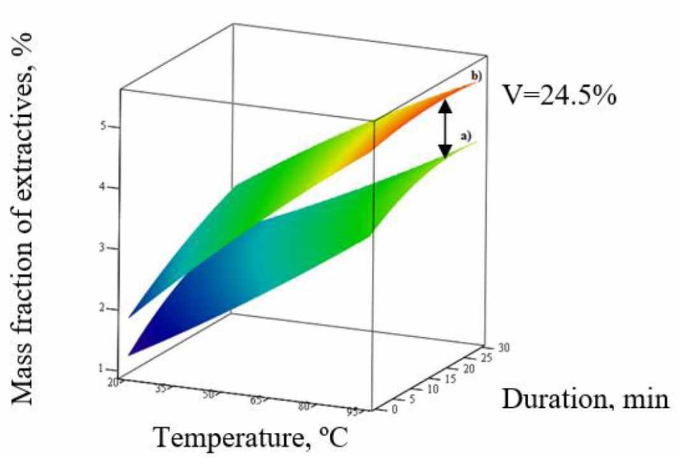

Fig. 1 The yield of extractives of sumac in different methods of extraction with changes in temperature 20…95 ° C and the duration of the process 0…30 min
(a - maceration; b - pulse action)

That is, the use of a rotary-pulse apparatus allows to increase the yield of extractives (V) by an average of 24.5% compared to classical maceration.

The color of the extract not only becomes more saturated with increasing extraction temperature, but also more stable with decreasing active acidity. This is relevant because the extract is intended to be used in sour milk paste technologies. The results of the study on the change in color of the extracts depending on the extraction temperature are presented in Fig. 2.

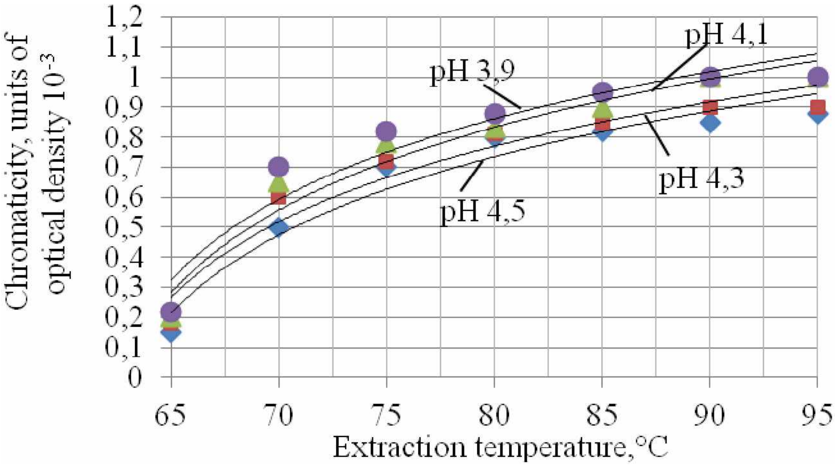

Fig. 2 Influence of sumac extraction temperature on chromaticity at different active acidity

CONCLUSION

Thus, it was decided to introduce the sumac into the sour milk pastes in the form of an extract at a temperature of (80 ± 2) °C with an extraction duration of 5 to 10 min, with a hydromodule of 1:10.

The rotary-pulse extractors use will strength the extraction process of extractive substances of vegetable raw materials, compared to traditional methods, will ensure energy efficiency of the process and minimal losses, including biologically active substances.\

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