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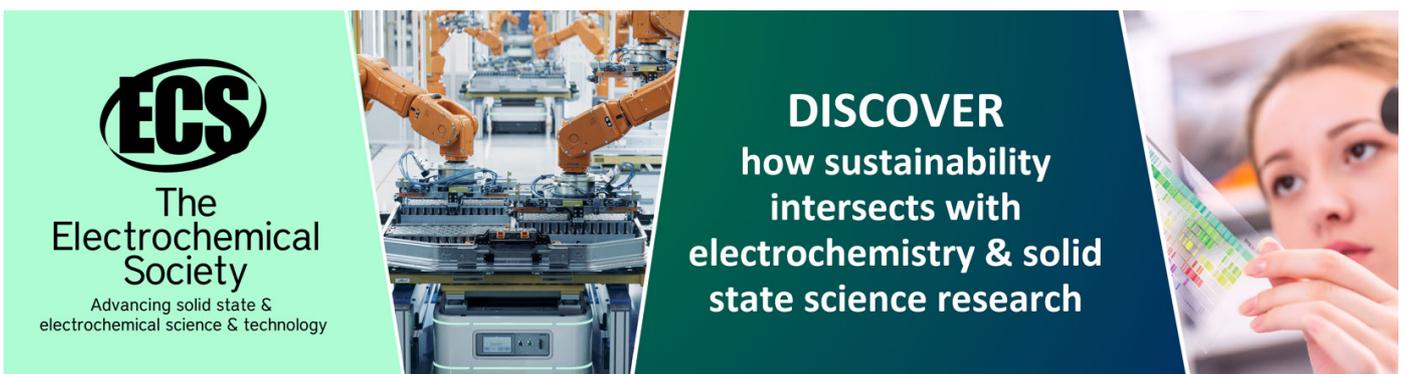
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Development of functional products by enriching plant raw materials with antioxidant

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Abstract. The deterioration of the ecological situation, the change in the structure of nutrition in the existing conditions determined fundamentally new trends formed in the social order for the development of entire groups of special-purpose food products. Creating and developing innovative technologies and increasing the nutritional value of products will allow replenishing the consumer market with domestic functional food products. The article presents the results of developing a recipe and production technology for lingering functional cookies using dry extracts of plants *Melissa officinalis* (*Melissa officinalis*), *Salvia officinalis* (*Salvia officinalis*), *Leonurus quinquelobatus* (motherwort), *Crataegus* species (hawthorn) and *Valeriana officinalis* (*Valeriana officinalis*), the introduction of which made it possible to enrich the products with antioxidants. Studies on the establishment of a method for applying dry extracts at various stages of the technological process for the production of long-lasting cookies are presented, and the expediency of replacing 7.0% flour with plant extracts is justified. It is proved that the developed cookies changed their quality indicators more slowly during storage. The results of determining the chemical composition of cookies "Energy of Nature" are reflected and the degree of satisfaction of the body's daily need for individual nutrients and energy during its use is calculated in comparison with the control sample. It is shown that the introduction of plant extracts allowed to reduce the energy value of products, increase the content of beta-carotene, ascorbic acid and flavonoids. When consuming 100 g of the developed cookies, the human body receives 58 mg of antioxidants. This corresponds to 16.6 % of the daily human need for antioxidants, which makes it possible to classify cookies "Energy of Nature" as functional products.

Providing consumers with high-quality food products of domestic production remains one of the priority tasks of the food industry and trade. Of particular importance is meeting the needs of a particular group of people for functional products. The availability of functional products in the sphere of consumption is not enough to meet the demand of the population, since food products based on them are produced in the Russian Federation in a small volume, and the import of such products does not meet the needs of certain groups of the population [1, 2]. Creating and developing innovative technologies and increasing the nutritional value of products will allow replenishing the consumer market with domestic functional food products.



Of particular relevance is the task of improving the consumer and preventive properties of flour confectionery products through the use of additives based on wild herbs that have therapeutic and preventive properties and are recommended by the Ministry of Health of the Russian Federation in everyday nutrition. Currently, the demand for dietary products is increasing due to the growth of various diseases, as well as consumer preferences to use low-calorie foods in the diet [3, 4].

The aim of the work was to develop a recipe and technology for the production of long-lasting functional cookies using dry extracts of plants *Melissa officinalis* (*Melissa officinalis*), *Salvia officinalis* (*sage officinalis*), *Leonurus quinquelobatus* (*motherwort*), *Crataegus species* (*hawthorn*) and *Valeriana officinalis* (*Valerian officinalis*), the introduction of which will enrich the products with antioxidants.

The choice of extracts is appropriate due to the wide prevalence of these types of medicinal plants in Russia, as well as their rich chemical composition with a high content of biologically active substances that exhibit strong antioxidant properties [5, 6, 7, 8].

The objects of the study were dry extracts of plants *Melissa officinalis*, *Salvia officinalis*, *Leonurus quinquelobatus*, *Crataegus species* and *Valeriana officinalis*; samples of dough and baked lingering cookies. During the test laboratory baking, long-lasting cookies "Maria", produced according to the traditional recipe and technology, were used as a control. The extracts were added to the experimental samples in the form of a finely dispersed powder consisting of a mixture of dry extracts taken in equal amounts, crushed to a particle size of 30-40 microns and sifted through a sieve No. 43 with a total dry matter content of 96-98 %.

At the initial stage of experimental studies, a method for introducing dry extracts of raw materials in the production of lingering cookies was determined. The possibility of introducing the analyzed additive in two ways was investigated: in the emulsion during its preparation and at the stage of kneading the dough in a mixture with flour.

The best way to apply extracts is to add them to the emulsion at the stage of emulsion preparation. It was noted that with this method of application, the color of finished products was more saturated, and the samples were characterized by clear and uniform layering. Samples in which extracts were mixed with flour at the dough kneading stage had dark single inclusions on the surface. When forming test pieces, they showed increased adhesion. The wetness of samples in which extracts were added at the stage of whipping the emulsion is 4% higher than the values of the same indicator of samples with extracts added to mixtures with flour at the dough mixing stage. Since an additional amount of dry substances in the extracts is added to the recipe, the gluten content in the total volume of the dough decreases. As a result, a less prolonged dough is formed: a decrease in the limit shear stress by 22.8% and 31.2% was noted compared to the control.

Table 1 shows experimental data obtained when baking cookie samples with the introduction of dry extracts as an additive and instead of a part of wheat flour.

It was experimentally established that adding up to 4% of dry extracts to the flour mass does not worsen the organoleptic parameters of cookie quality. These samples are characterized by an improvement in the layered structure and flavor of the products. When the dosage of extracts was increased to 6 % by weight of flour, single dark spots appeared on the surface of the products. The humidity of the test samples increases by 0.2-1.5% compared to the control, and the humidity of baked cookies increases by 0.1-1.1 %, which is due to the water-binding and moisture-retaining ability of the extract powder components. Samples with the addition of extracts as an additive are characterized by a decrease in the maximum shear stress of the dough by 22.8-30.8 % and cookie wetting by 7.5-55.9 %. Obtaining such results is due to the addition of an additional amount of dry substances in the extracts and the formation of a less prolonged dough, which is associated with their effect on the amount and quality of wheat flour gluten [9, 10].

Table 1. Quality indicators of cookie samples with plant extracts.

Quality indicators	Samples of cookies with the addition of dry extracts, % by weight of flour				Cookie samples with replacement of part of wheat flour with dry extracts, % by weight of flour				
	0	2	4	6	0	3	5	7	9
Dough:									
Mass fraction of dough moisture, %	25.4	25.6	26.6	26.9	28.3	28.5	28.5	28.6	28.6
Limit shear stress, Pa	1206.4	931.1	837.2	834.8	1510.77	1376.55	1232.51	1024.61	820.25
Cookies:									
Mass fraction of moisture, %	5.9	6.0	6.6	7.0	5.9	5.9	6.7	6.7	6.9
Maximum loading force, g	4581.1	3397.8	3739.2	4276.6	4567.8	4201.9	3958.4	2923.4	2633.2
Water resistance, %	211.9	204.4	179.0	157.0	188.8	217.3	214.5	208.4	222.9
Organoleptic rating, score	20	20	20	19	20	20	20	20	18

Based on the analysis of the results obtained on the study of the possibility of replacing up to 9% of wheat flour with plant extracts, it is concluded that it is advisable to replace 7% of flour with them, which helps to reduce the maximum loading force by 36.0 % and increase the wetting of cookies by 10.4 %. As a result of the dough preparation process, a dough is formed with optimal structural and mechanical characteristics, which further determine the best layered structure and looseness of baked products. Also, these samples are characterized by an improvement in such organoleptic parameters as color and aroma.

Based on the conducted research, a recipe and technology for the production of long-lasting cookies "Energy of Nature" was developed with the replacement of 7% flour with finely dispersed powder from extracts of melissa (*Melissa officinalis*), sage (*Salvia officinalis*), motherwort (*Leonurus quinquelobatus*), hawthorn (*Crataegus species*) and valeriana (*Valeriana officinalis*).

The effect of plant extracts on the shelf life of the developed cookies was determined in comparison with the control. Baked samples were stored in accordance with GOST 24901-2014 "Cookies. General technical conditions" at a temperature of (18±5) °C and relative humidity of no more than 75 % for 1 month in packaged form [11]. The degree of freshness preservation was judged by changes in humidity, weight, wetness, and structural and mechanical parameters of cookies (maximum loading force) (table 2).

During the entire shelf life, a gradual decrease in the weight and humidity of products was noted. Moisture loss and staling in the control sample occurred more intensively: the wetness of the control sample decreased to a greater extent (by 16.8 %) in comparison with the developed cookies (by 10.1 %). After 1 month of storage, the maximum loading force of the samples increases in comparison with the values obtained at the beginning of storage: for the control, this indicator is higher by 22.4 %, for the developed cookies – by 27.3 %. Thus, cookies "Energy of Nature" changed their quality indicators more slowly during storage.

Table 2. Cookie quality indicators during storage.

Name of the cookie	Storage duration, day	Humidity, %	Weight, g	Water resistance, %	Force limit voltage, yy
Monitoring	1	7.4	7.01	179.05	3567.8
	15	6.7	6.8	173.05	3996.7
	30	6	6.59	162.27	4365.6
Cookies "Energy of nature"	1	6.9	6.69	190.45	2227
	15	6.5	6.59	184.1	2622.1
	30	6.2	6.49	180.32	2835.2

The results of determining the chemical composition of cookies "Energy of Nature" and calculating the satisfaction of the body's daily need for nutrients and energy during its use in comparison with the control sample are shown in table 3.

Table 3. Satisfaction of the daily needs of the body in nutrients and energy.

Naming of indicators	Control (cookies "Maria")	Cookies "Energy of nature"
Satisfaction of daily protein requirements, %	8.6	8.0
Meeting the daily fat requirement, %	9.6	9.6
Meeting the daily carbohydrate requirement, %	19.2	18.6
Meeting the daily requirement for antioxidants, %	6.3	16.6
Meeting daily energy requirements, %	16.1	15.5

When using 100 g of Energy of Nature cookies, the daily requirement for protein, fat, and carbohydrates is 8.0%, 9.6%, and 18.6%, respectively. The introduction of plant extracts instead of 7.0% flour allowed to reduce the energy value of products by 3.4 %, increase the content of beta-carotene by 2.7 times, ascorbic acid by 2 times, flavonoids by 2.6 times. When consuming 100 g of the developed cookies, the human body receives 58 mg of antioxidants, which corresponds to 16.6 % of the daily requirement. Thus, cookies "Energy of nature" can be attributed to functional products [12]. These cookies can be recommended for use by all age groups of the population for preventive purposes, as well as to eliminate the lack of antioxidants in the diet.

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