Research of semi-finished sponge cakes made with the addition of willow-herb

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Abstract. Flour confectionery products, including semi-finished biscuit products, are of interest for conducting experiments aimed at obtaining new types of enriched products with various micronutrients. For the enrichment of the products, a powder from the grass of the willow-herb was used. Because it is known from the literature that willow-herb contains a large amount of micronutrients and is a medicinal plant. The collection of the herb willow-herb also has many medicinal properties and has a positive effect on the human body. In this paper, we consider the recipes for the production of semi-finished biscuit products with the replacement of flour in them with the powder of willow-herb in different percentage concentrations. The obtained samples of semi-finished biscuit products were examined in order to determine their quality indicators. An organoleptic evaluation was carried out, which allowed us to identify the best sample. Studies have been conducted to determine the amount of content of certain elements. The dependence of the content of these elements on the amount of the addition of willow-herb to the recipes of experimental samples of sponge semi-finished products is revealed. The quantitative indicators of the content of elements such as iron and phosphorus, important for the human body, in the samples were determined. Infrared spectra of experimental samples of biscuit products were obtained, and their analysis was carried out.

1. Introduction

One of the innovative directions in the processing of agricultural raw materials is the creation of functional food products. Recently, researchers in many countries have proposed using various compounds that include dietary fiber and biologically active substances to create such products [1].

Confectionery products are one of the most popular food products. They have a high energy value and good taste. Among flour confectionery products, biscuit products are becoming very popular. They consist of separate components: biscuit semi-finished product, filling and finishing semi-finished product, which in turn allows you to regulate the chemical composition and nutritional value of both the individual components and the product as a whole.

An urgent problem of the state of public health in modern conditions, it is considered that the diet of people lacks or contains insufficient amounts of vitamins, dietary fiber, macro - and microelements, minerals, and essential amino acids [2]. The main purpose of this work is to study the possibility of using the powder of the medicinal plant-willow-herb in the technology of biscuit semi-finished products. The use of natural vegetable raw materials will improve the quality, expand the range of flour
confectionery products. In this paper, the possibility of using willow-herb in the technology of sponge semi-finished products is investigated. The search for new types of raw materials for production that have a wide range of chemical compounds, the structural components of which will not only catalyze the biotechnological processes of the production of biscuit semi-finished products, but also save raw materials, improve the food, biological, and value of finished products is an urgent problem today [3].

In the authors’ studies, the mineral and amino acid composition of the aboveground part of the willow-herb was determined [4]. As a result of the analysis of the elemental composition of the vegetative part of the cypress, the presence of 24 elements was revealed, including four macronutrients and nine main trace elements [5]. The analysis also revealed 16 free amino acids. The total content of the amino acid fraction in the studied samples was about 10%. The presence of such a quantity and variety of amino acids should provide a wide range of pharmacological effects of the vegetative part of the plant and mainly have a positive effect on the cardiovascular system [4].

The research of other authors was aimed at developing recipes for a wide range of products, such as bakery products, sausages and soft drinks, using promising types of wild medicinal raw materials, one of the components of which was willow-herb [6]. It was also proposed to introduce willow-herb into kefir recipes at the fermentation stage as an enriching additive and its effect on the amino acid composition of the product was studied [7].

2. Materials and methods

Experimental samples of semi-finished biscuit products were obtained with the addition of various percentage concentrations of willow-herb grass powder, with the replacement of part of the flour in the formulations by 3%, 5% and 10%, respectively. The control was a semi-finished biscuit made according to the traditional recipe.

The obtained samples of biscuit products were examined by the organoleptic method of analysis. The following organoleptic parameters were studied: appearance, shape, surface, color, cross-sectional view, taste and smell.

To determine the concentration of mineral elements in biscuit semi-finished products, a spectrophotometric method for determining the concentration was used. A Genesys 10S UV-Vis spectrophotometer was used. In biscuits, such mineral elements as iron and phosphorus were determined. Before determining the mineral components, the samples were incinerated at the "Temos-express" rapid sample preparation unit. The method for determining iron is based on measuring the optical density of a solution of a complex compound of ferrous iron with red orthophenanthroline. The method for determining phosphorus is based on the use of a molybdenum-vanadium reagent.

The mass fraction of iron in products (X) in million-1 (mg / kg) is calculated by the formula

$$X = \frac{(m_1 \times V)}{(V_1 \times m)}$$

where $m_1$ is the mass of iron found according to the calibration graph, mcg; V is the total volume of the mineralized solution, cm$^3$; $V_1$ is the volume of the mineralized solution taken for determination, cm$^3$; m is the weight of the product sample taken for mineralization, g;

The mass fraction of phosphorus X, mg, per 100 g of the product is calculated by the formula

$$X = \frac{(m_1 \times V_0)}{(m \times V \times 10)}$$

where $m_1$ is the mass of phosphorus found according to the calibration graph, mcg; $V_0$ is the total volume of the mineralized sample, cm$^3$; V is the volume of the mineralized sample taken for testing, cm$^3$; 10 is the conversion factor per 100 g of the product; m is the weight of the sample sample, g. The product sample subjected to mineralization is 5 grams, the total volume of the mineralization solution is 50 ml, the volume of the mineralization solution in the cuvette taken to measure the optical density is 1.5 ml when measuring phosphorus and 2 ml when measuring iron. The method of infrared spectrometry was used for the study of semi-finished biscuit products. The measurements were performed on an Ik-Fourier spectrometer Nicolet is10 Thermo-Fisher Scientific.
3. Results and discussion

From the results of organoleptic studies, it turned out that the obtained sponge semi-finished products meet the standard organoleptic indicators, however, biscuits with large concentrations of willow-herb additives in their composition have worse organoleptic indicators of taste and aroma compared to samples of lower concentration. Optimal for these indicators were the samples with a 3% content of willow-herb with a weak pleasant herbal aroma and without surface defects. While the appearance and shape of the biscuits with a 5 and 10% willow-herb content was determined with small fine cracks, and the taste and smell of these biscuits was with a pronounced sweet taste, moderate herbal aroma and strong herbal aroma with a 10% willow-herb powder content.

Iron in combination with protein, vitamins, chlorophyll and silicic acid stimulates carbohydrate and protein metabolism, which is accompanied by an increase in the tone of the cardiovascular, respiratory and other systems of the body, contributes to an increase in the content of hemoglobin in the blood and the number of red blood cells. To determine the iron in the biscuit samples, a spectrophotometer was used, the calculation was carried out according to formula 1. Figure 1 shows the results of the determination of iron in biscuit samples.

![Figure 1. The concentration of iron in the samples of biscuits with willow-herb.](image1)

Phosphorus, as one of the important elements, ensures the normal growth of bone and dental tissues, provides a constant composition of nucleic acids, is part of enzymes, participates in fat metabolism, the synthesis and breakdown of glycogen and starch. Provides energy to all processes of vital activity in the composition of ATP. The phosphorus content was calculated according to the formula 2. Figure 2 shows the results of the determination of phosphorus in biscuit samples.

![Figure 2. The concentration of phosphorus in the samples of biscuits with willow-herb.](image2)
The results of calculating the concentrations of iron and phosphorus according to formulas 1 and 2 are shown in Table 1.

| Iron content in samples (mg / kg) | Phosphorus content in samples (mg/100g) |
|----------------------------------|----------------------------------------|
| control                          | 21.4                                   |
| willow herb 10%                  | 70.3                                   |
| willow herb 5%                   | 45.45                                  |
| willow herb 3%                   | 41.6                                   |
| control                          | 47.82                                  |
| willow herb 10%                  | 79.91                                  |
| willow herb 5%                   | 68.79                                  |
| willow herb 3%                   | 56.4                                   |

Based on the data obtained, it should be noted that the samples of semi-finished biscuit products containing a large amount of willow-herb powder in the formulations had a high concentration of iron.

Samples of semi-finished biscuit products were examined using Fourier-infrared spectroscopy. The obtained spectra of the analyzed samples, the control sample, and the spectrum of the willow-herb powder are shown in Figure 3.

**Figure 3.** Infrared spectra of sponge cake samples, control sample, and the spectrum of willow-herb powder.

The study of the spectra revealed peaks with common wavenumber ranges for willow-herb grass and for biscuits with the addition of willow-herb narrow-leaved grass powder — these are peaks of 1645 - 1643 cm\(^{-1}\); 1022-1038 cm\(^{-1}\). The peaks of 1645-1643 cm\(^{-1}\) indicate fluctuations in the groups –CO\(_2\) of amino acids and amino acid salts with the group –CO\(_2\)H; H\(_2\)N-(CH\(_2\))\(_n\)-CO\(_2\)-M\(^+\). The fluctuations of 1022-1038 cm\(^{-1}\) can be attributed to the essential compounds that are found in the cypress grass and provide a specific aroma [8]. From the presented figure, it can be seen that the peaks of willow-herb powder are also contained in biscuits with its addition, but these peaks are not present in the control sample. This shows that the chemicals included in the kiprei are present in the semi-finished sponge products enriched with it.

The peak mapping is shown in Figure 4.
From Figure 4, it can be seen that some spectra of willow-herb grass powder coincide with the spectra of experimental products, this indicates the presence of chemical components of willow-herb grass in experimental samples of biscuit semi-finished products.

4. Conclusions

The conducted studies show the effectiveness of the use of powders of the medicinal plant willow-herb in the technology of flour confectionery products, namely biscuit semi-finished products.

Based on organoleptic studies, the best samples for organoleptic indicators were selected — these are biscuits with the replacement of 3% flour with willow-herb grass powder, as products with the most harmonious taste.

Studies of the concentration of iron and phosphorus in the samples show an increase in these mineral elements in the samples of products with an increase in the percentage of adding a flour-replacing additive of willow-herb. It should be noted that the content of these elements is greater than in the control sample, even with the introduction of willow-herb powder with the replacement of flour in an amount of 3%.

Based on the observations and analyses carried out, and the preference of organoleptic parameters over other criteria, the best sample was determined — this is a sample with the introduction of willow-herb in 3% content with the replacement of flour in the recipe.

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