Development of a biscuit semi-finished diabetic purpose recipe

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Abstract. The current research deals with the possibility of using flour from the efficient variety of light grain rye in the recipe for a biscuit semi-finished product, which makes it possible to obtain products with good consumer properties, and replacing sugar with powder from sugar beet roots and the introduction of corn starch makes it possible to recommend it for diabetic nutrition. In prototypes, a mixture of light grain rye and corn starch flour in various ratios of 90:10 and 50:50. Flour from light grain rye has good foaming properties, reduces the sugar content of products to 38%, therefore, the calorie content increases the nutritional value of products.

1. Introduction
The problem of diabetes mellitus control is becoming more and more urgent for modern medicine, due to the general increase in the incidence throughout the world. Natural conditions and lifestyle of people in the XXI century associated with hypokinesia; eating foods high in carbohydrates, salt, fats, synthetic additives; frequent stressful situations. In this regard, the need to produce food with a therapeutic and prophylactic effect using functional ingredients is increasing in the modern food industry [1].

To expand the range of products for a healthy diet, it is necessary to rationally use regional raw materials. The breeders of the Federal State Budgetary Scientific Institution Research Institute of Agriculture of the South-East have developed a new variety of white rye “Pamyat Bambysheva”, which differs not only in color from the grain of the traditionally cultivated variety “Saratovskaya 6” (Figure 1).

The content of trypsin inhibitor (1.7 mg/g) in rye flour made from whole-grain grains of the Pamyat Bambysheva variety is lower in comparison with flour made from the grain variety Saratovskaya 6 standard (2.16 mg/g), which is an advantage when using light grain, as in baking purposes for dietetic bread; for the production of low-calorie bakery products with bran for certain groups of the population. This is confirmed by data on the digestibility of grain, which is higher by 0.26% [2].

Rye proteins have a higher nutritional value than wheat proteins due to the higher content of essential amino acids such as lysine, threonine, phenylalanine. The whiteness indicator for light-grain rye flour is high (37.4 units on the device), while peeled rye flour (18.6 units) is not good enough in color in comparison with the flour made from the light grain rye of the Pamyat Bambysheva variety, which allows it to be used in the technology of semi-finished biscuit [3-6].
2. Methods and Materials

The aim of the current research is to work out a recipe and technology for a semi-finished biscuit with a low carbohydrate content, increased nutritional value and diabetic properties based on promising regional raw materials.

The research was carried out in the educational laboratory for bakery and confectionery production of the Department of Food Technologies at Saratov State Vavilov Agrarian University and at the Testing laboratory of food products and food raw materials (Yuri Gagarin State Technical University of Saratov). The object of research is a unified recipe for a classic semi-finished biscuit.

The samples were as follows:

1. Control from light grain rye flour;
2. A prototype of a mixture of light grain rye flour and corn starch in a ratio of 90:10, instead of sugar, powder from beet roots;
3. A test sample from a mixture of light grain rye flour and corn starch in a 50:50 ratio, instead of sugar, beet root vegetable powder.

The technology for the production of semi-finished biscuits provides for whipping corn starch with melange, introducing rye flour, molding, baking.

In the research, the foaming capacity, foam resistance of the semi-finished product, specific volume, porosity, mass fraction of sugar, mass fraction of fat, ash content, and density of the product were determined according to standard methods.

3. Results

The replacement of wheat flour with flour from light grain rye is due to the good foaming properties of rye flour (Table 1). According to scientists from the Oryol State University (Russia), the foam obtained by whipping the water-flour mixture with rye flour turned out to be more stable than the foam mixed with wheat flour [7].

Table 1. Foaming capacity of the semi-finished product.

| Indicator                        | Control | Sample 1 | Sample 2 |
|----------------------------------|---------|----------|----------|
| Foaming ability, %               | 130     | 148      | 150      |
| Foam stability after 3 hours, %  | 97      | 100      | 99       |
| Foam density, g/cm³              | 1.06    | 1.12     | 1.08     |
Scientists from the Oryol State University (Russia) also propose, when using rye flour, to pre-mix it with water and hold it for 1 hour to increase the foaming ability, but the duration of the technological process increases [8]. The proposed technology excludes such a technological operation.

The data in Table 1 indicate that the mixture containing light grain rye flour is the most optimal in terms of foaming ability and stability of the obtained foam. In finished products, the specific volume of the product increases, the porosity does not differ from the control (Table 2).

According to organoleptic indicators, it could be seen that the best test sample from a mixture of light grain rye grain and corn starch in a ratio of 90:10, instead of sugar, powder from beet root crops (Figure 2)

![Figure 2](image)

**Figure 2** - Organoleptic indicators: 1 - control; 2 - Experimental sample from a mixture of light grain rye flour and corn starch in a ratio of 90:10, instead of sugar, powder from beet roots; 3 - A test sample from a mixture of light grain rye flour and corn starch in a 50:50 ratio, instead of sugar, beet root vegetable powder.

In prototypes, the crumb color of the product is lighter and acquires a pleasant cream shade. The taste of the prototype is harmonious, while the control has sugary sweetness. The smell of rye flour is not pronounced. The prototype has good consumer properties. (Figure 3)

![Figure 3](image)

**Figure 3.** Sectional view of a semi-finished biscuit

The use of flour made from light grain rye allows to increase the moisture content of products up to 42%, that is not typical for biscuits. Therefore, it is possible to exclude the technological operation - impregnation with syrup, which would also reduce the sugar content.

In experimental samples, the fat content is reduced by 4.8-7.3%, which would reduce the calorie content of the product.
Table 2. Physical and chemical parameters of semi-finished biscuit.

| Indicator            | Control | Sample 1 | Sample 2 |
|----------------------|---------|-----------|-----------|
| Moisture content, %  | 38.6    | 41.9      | 42.3      |
| Mass fraction of fat | 8.3     | 7.7       | 7.9       |
| Mass fraction of sugar| 7.11    | 4.41      | 6.12      |
| Ash content, %       | 1.2     | 1.11      | 1.12      |
| Porosity, %          | 66.0    | 66.5      | 66.2      |
| Specific volume, g/cm³| 0.52    | 0.57      | 0.55      |

It could be observed that in the test samples the sugar content also decreased by 38% when the ratio of light grain rye flour and corn starch is 90:10, by 14% when the ratio of these components is 50:50 with a higher content of flour from light grain rye in the recipe, the sugar capacity is significantly reduced. Based on the obtained data, a complete replacement of light-grain rye flour and corn starch 90:10 increases the amount of vitamins and minerals, reduces the energy value of a biscuit semi-finished product, thereby becoming a low-calorie product.

Table 3. Nutritional value of semi-finished biscuit with the application of technological additives.

| Indicator            | Control | Sample 1 | Sample 2 |
|----------------------|---------|-----------|-----------|
| Chemical composition | Content in 100g of product, g | Nutritional value, % | Content in 100g of product, g | Nutritional value, % | Content in 100g of product, g | Nutritional value, % |
| Ca                   | 21.1    | 2.11      | 18.59     | 1.9       | 15.09 | 1.5       |
| Na                   | 56.21   | 0.94      | 69.21     | 1.2       | 63.02 | 1.1       |
| K                    | 164.98  | 4.12      | 186.34    | 4.7       | 170.37 | 4.3       |
| P                    | 167.08  | 16.71     | 107.1     | 10.70     | 122.2 | 12.2      |
| Mg                   | 28.41   | 7.10      | 42.4      | 10.6      | 36.02 | 9         |
| Fe                   | 2.46    | 17.57     | 1.57      | 11.2      | 1.9   | 13.5      |
| Si                   | -       | -         | 19.8      | 66        | 19.8  | 66        |
| Vitamins             |         |           |           |           |       |           |
| B₁                   | 0.16    | 8.89      | 0.09      | 6.0       | 0.1   | 7.6       |
| B₂                   | 0.22    | 12.22     | 0.19      | 10.55     | 0.2   | 11.2      |
| B₃                   | -       | -         | 1.5       | 0.3       | 1.5   | 0.3       |
| B₉                   | -       | -         | 3.3       | 0.82      | 3.3   | 0.82      |
| C                    | -       | -         | 2.5       | 3.8       | 2.5   | 3.8       |
| PP                   | 0.69    | 3.43      | 0.5       | 2.5       | 0.57  | 2.8       |
| Energy value, kcal   | 449.30  | 17.97     | 431.97    | 17.3      | 430.8 | 17.2      |

4. Conclusions
As a result of the research, the following conclusions could be formulated:
- the use of flour from light grain rye gives the opportunity to reduce sugar content and calorie content to increase the nutritional value of products;
- the use of flour from light grain rye makes it possible to cook the semi-finished biscuit as a diabetic product.

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