Choux gingerbread production technology based on light rye flour

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Abstract. The paper proposes a practical solution to improve the gingerbread technology based on flour from light rye flour and vegetable products. The breeders of the Research Institute of South-East cultivated the varieties of light rye In The Memory of Bambyshev and Solnyshko. The versions of the experiment varied according to the grade of flour in the formula of choux gingerbreads: the first version – from high-grade bakery wheat flour; the second version – from light rye flour of Solnyshko variety; the third version – from light rye flour of In The Memory of Bambyshev variety. The possibility of using grain flour of these varieties in the technology of gingerbread products was studied. It is proposed to use the carrot jam as filling. The use of the carrot jam allows reducing sugar content in the formula, which will give the product dietary properties and save production raw materials. Despite the reduction of sugar in the formula, in the sample based on light rye flour of Solnyshko variety the mass fraction of sugar is 3% higher compared to the control and three samples, which allows reducing the sugar content in the finished product by 50%. The proposed resource-saving technology will allow producing competitive products, expanding the range of products of therapeutic and preventive action.

1. Introduction
Healthy and balanced nutrition is the basis for high quality of life of the population. The introduction of natural food enriching agents into the formula of flour confectionary products makes it possible to effectively solve the problem of prevention and treatment of various diseases connected with the deficiency of minerals and vitamins [1-7].

The breeders of the Research Institute of South-East cultivated the varieties of light rye In The Memory of Bambyshev and Solnyshko. According to the scientists of the Research Institute of South-East, the main advantage of light rye varieties is that the content of trypsin inhibitor (1.7 mg/g) is lower compared to the flour from green rye variety – Saratovsky 6 (2.16 mg/g), which is an advantage when using light grain for dietary bakery purposes; for the production of low-calorie bakery products with bran for certain population groups, and for the production of mixed fodders for livestock breeding. This is confirmed by data on grain digestion, which is higher by 0.26% [8].

In the Research Institute of South-East, winter rye grains are formed with lower protein content but balanced in amino acid composition. The biological value of proteins of Saratovsky selection rye variety is higher by 9.7-13.7% in comparison with light wheat flour and medium rye flour [9].
The introduction of light rye flour and vegetable products into the formulation of choux gingerbreads will give them therapeutic and preventive properties and will significantly affect the diet of a person. The minerals and dietary fibers contained in these components improve the digestion process and intestinal microflora, which is useful for overweight and elderly people. Therefore, the development of choux gingerbread technology based on light rye flour with the addition of vegetable products is relevant and bears theoretical and practical importance.

2. Purpose of the study
To develop the formula and technology of choux gingerbreads based on light rye flour with the application of vegetable products.

To achieve this purpose, the following tasks are solved:
- production of jam from carrot roots;
- determination of parameters for dough preparation of choux gingerbread based on light rye flour with addition of vegetable products;
- study of organoleptic, physical-chemical and microbiological indices of choux gingerbread quality;
- economic justification of the feasibility of making choux gingerbreads on the basis of light rye flour of Solnyshko variety with the use of vegetable products;
- calculation of food and energy value of finished products;
- development of draft technical documentation for a new type of choux gingerbreads.

3. Materials and methods
The study was carried out in the training laboratory on bakery, confectionery and pasta production in Saratov SAU named after N.I. Vavilov; in the testing laboratory of food products and food raw materials of ETI (branch) of Yuri Gagarin State Technical University of Saratov; at the Research Institute of South-East.

The carrots are selected according to taste properties to prepare jam. There should be no bitterness in the roots. It is recommended to use small root vegetables because they are sweeter and juicier. Figure 1 shows the process diagram of carrot jam production.

Figure 1. Process diagram of carrot jam production
White sugar content was reduced by 50% in carrot jam, which will give the product dietary properties and save raw materials.

Cooked gingerbreads on the basis of light rye flour with addition of vegetable products were analyzed according to the following physical and chemical parameters: moisture content according to GOST 5900-2014 [10], sugar content according to GOST 5903-89 [11], fat content according to GOST 5899-85 [12], ash content according to GOST 5901-2014 [13]. A comprehensive quality assessment of products was carried out on a five-point scale taking into account the weight factors of the indicators.

The versions of the experiment varied according to the grade of flour in the formula of choux gingerbreads: the first version – from high-grade bakery wheat flour; the second version – from light rye flour of Solnyshko variety; the third version – from light rye flour of In The Memory of Bambyshev variety.

4. Results

The quality score of finished products is shown in Figure 2.

![Figure 2. Comprehensive quality assessment of finished products](image)

The view in the fracture is attractive for consumers, the filling is inside the product, does not flow out on the surface of the product. The taste and aroma are pronounced, sweet, with carrot taste.

The structure of gingerbreads in all cases is soft, bound, does not fall to pieces when broken. The diagram shows that according to the results of the complex assessment of the quality of finished products, the version based on light rye flour of Solnyshko variety with the carrot jam is the most prominent, which was confirmed by the tasters (Figure 3).

![Figure 3. Gingerbread products: top row – light rye flour of Solnyshko variety, bottom row – light rye flour of In The Memory of Bambyshev](image)
Table 1 shows physical and chemical quality parameters.

**Table 1.** Physical and chemical indicators of finished product quality

| Indicator          | Test results | Method error |
|--------------------|--------------|--------------|
|                    | Control sample | Light rye flour of Solnyshko variety | Light rye flour of The Memory of Bambyshhev variety |
| Moisture content, % | 12.5          | 12.0         | 12.0         |
| Sugar content, %    | 44.0          | 47.1         | 44.1         |
| Fat content, %      | 11.1          | 9.8          | 8.5          |
| Ash content, %      | 0.33          | 0.55         | 0.70         |

According to the table, the experimental samples meet the requirements of regulatory documentation in terms of all quality indicators.

The mass fraction of sugar in the largest amount is contained in the sample made on the basis of light rye flour of Solnyshko variety, which allows reducing the sugar content in the finished product by 50%.

Knowing the amount of raw material ingredients added to 100 g of choux gingerbreads, the chemical composition of each raw material added to 100 g of products is calculated.

The nutritional value of the product is determined by comparing the chemical composition of the product with the formula of balanced nutrition and is expressed in % of daily human consumption in basic substances and energy [6]. The obtained results are shown in Figure 4.

**Figure 4.** Vitamin and mineral content of choux gingerbreads: 1. Standard recipe 2. Light rye flour of Solnyshko variety; 3. Light rye flour of Solnyshko variety with reduction of white sugar content by 50%

The calculations show that choux gingerbreads based on light rye flour of Solnyshko variety with the use of vegetable products have the highest nutritional value, unlike the control sample, due to the increase in the content of minerals, food fibers and vitamins. The energy value is reduced by 2%, and when white sugar is reduced in the formula – by 16.53%. Thus, choux gingerbreads with the addition of vegetable products acquire biologically active substances such as vitamins, carotenoids, macro- and microelements, and dietary fibers.
Microbiological analyses of finished products were carried out according to the number of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM), the presence of yeast and moulds. The choux gingerbreads were stored packaged for 30 and 45 days at 30±1 °C and relative humidity of 70-75%. This type of analysis was carried out on the 30th and 45th day of storage (Table 2) [8].

Table 2. Microbiological indicators of shortbread cookies

| Indicator                        | Values for studied sample of shortbread cookies | Norm according to TR CU 21/2011 |
|----------------------------------|-----------------------------------------------|---------------------------------|
|                                  | Standard recipe                                | Light rye flour of Solnyshko variety | Light rye flour of In The Memory of Bambyshev variety |
| On 30th day of storage           | QMAFAnM, CFU/G                                 | 0.8x10^2                         | 1.1x10^4                              | 9x10^2                         | 5x10^3                         |
| Moulds, CFU/G                    | N/A                                           | 1.1x10^4                         | Not more than 50                      |
| Yeast, CFU/G                     | N/A                                           | 9x10^2                           | Not more than 50                      |
| On 45th day of storage           | QMAFAnM, CFU/G                                | 1x10^2                           | 1.4x10^4                              | 1x10^3                         | 5x10^3                         |
| Moulds, CFU/G                    | N/A                                           | 1.4x10^4                         | Not more than 50                      |
| Yeast, CFU/G                     | N/A                                           | 1x10^3                           | Not more than 50                      |
The results of the study showed that QMAFAnM in the tested samples of choux gingerbreads stored for 30 and 45 days remained within the permissible norm in accordance with the requirements of TR CU 21/2011, yeast and moulds were not present.

The calculation of the economic efficiency of choux gingerbreads production based on light rye flour with the use of vegetable products confirms the profitability and success of this project (Table 3).

Table 3. Project economic indicators

| Indicator | Costs, rub. |
|-----------|-------------|
| Standard recipe | Light rye flour of Solnyshko variety | Light rye flour of Solnyshko variety and with reduction of sugar content by 50% |
| Total cost per 1000 kg of product, including: | 16562.929 | 18234.5215 | 18322.1145 |
| Raw and primary materials, C_p | 10313.69 | 10922.065 | 11001.695 |
| Auxiliary materials, C_a | 1031.369 | 1092.2065 | 1100.1695 |
| Energy consumption, C_e | 412.93 | 412.93 | 412.93 |
| Salary, P_s | 4386.3 | 4386.3 | 4386.3 |
| Amortization, P_a | 28.88 | 30.02 | 30.02 |
| Additional capital investments | 1350 | 1350 | 1350 |
| Level of profitability, \( Y_p \) | 13.0 | 13.0 | 13.0 |

The economic analysis shows that when high-grade wheat flour is replaced with light rye flour, the profitability of production does not change, despite the fact that the cost of production increases.

Thus, the production of choux gingerbreads on the basis of light rye flour of Solnyshko variety with the addition of vegetable products will allow producing competitive products, since the use of such raw materials reduces the costs of raw materials and expands the range of therapeutic and preventive products.

5. Conclusions

The expediency of using light rye flour of Solnyshko variety and vegetable products in the technology of choux gingerbreads was justified theoretically and experimentally.

The study revealed the positive effect of the reduction of white sugar dosage on quality indicators of choux gingerbreads with the addition of vegetable products, which strengthens the product dietary properties.

In order to expand the range of products of increased nutritive value, it is recommended to introduce choux gingerbreads based on light rye flour of Solnyshko variety with the use of vegetable products.

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