Application efficiency of new raw materials in the production of flour confectionery products with increased nutritional value

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Abstract. The article deals with the issues of efficiency in the production of flour confectionery products with increased nutritional value due to the introduction of developed technologies for the production of high-protein flour from wheat grain. A comparison for the norms of quality indicators for three-grade grinding flour and the high-protein fractions isolated from them is made. It was found that the isolation of a high-protein fraction at optimal technological parameters had virtually no effect on the main quality indicators of the main product. Calculations for the production efficiency of flour confectionery products (gingerbread) showed that the profit from the sale of 1 ton of finished developed products is higher than in the production of traditional gingerbread, the profitability of new products was 22.3%. Adding high-protein flour to the gingerbread recipe increases the nutritional value of the finished product, increases the amount of proteins and B vitamins.

1. Introduction

In the last decade, the Krasnoyarsk region has been actively modernizing existing mill enterprises and introducing new production capacities. In place of non-grade and two-grade mills, modern mill complexes were put into operation, which significantly reduced labor and energy costs, and significantly improved the working conditions of employees. However, increasing the grade of wheat flour production leads to a further decrease in its protein content by removing the protein-rich germ and aleurone layer to by-products. Therefore, the degree of satisfaction of human needs for essential amino acids due to the consumption of food products from wheat flour is constantly decreasing [1].

The nutritional value of wheat grain processing products is also affected by the fact that flour mills receive batches of grain that are not uniform in quality, since wheat grains of different varieties and growing areas differ significantly in physical, biochemical, milling and baking properties [2].

In addition, the existing goods-money relations in the Russian Federation make the flour producer constantly look for ways to reduce the cost of its production, primarily due to raw materials, the share of which in the cost of wheat flour is 80%. “Modern industrial enterprise of agro industrial complex is a complex multi-functional system, the successful functioning of which is determined by a variety of factors” [3].
With the current trend of reducing the biological value of food products from wheat flour, primarily due to the reduction in their protein content, it is important to introduce low-cost technological solutions for obtaining high-protein flour in existing flour mills and its use in the production of traditional confectionery products of the flour group.

2. Research methods
Most of the research on the creation of flour products with increased nutritional value is aimed at the introduction of additional components, while new technologies for processing grain are poorly considered, which confirms the relevance of the issue under consideration.

Modern equipment of enterprises allows to organize the selection of high-protein flour in the technological process of milling production. “One of the most important factors affecting the technical and economic indicators of agricultural activity is time” [4]. For this purpose, the following temporary structural changes are proposed to be made at the mill during the period when serial production is stopped for maintenance. To the cyclone-discharger of the control sieving of the highest and second class, attach an additional cyclone-discharger to the battery of cyclones for final air purification. In the lower part of the cyclone, a fitting with a flexible tube attached to a regulated pressure compressor should be installed.

The intermediate product of grain grinding crushed in 7 grinding and 3 washing systems enters the air pipeline in a centrifugal cyclone-discharger, where the volume weight of the product is deposited. 98-99% of flour is deposited and sent through the sluice gates to the control sieves. Its particles up to 17 – 22 microns in size, which did not settle in the main centrifugal cyclone, together with the air are moved through the upper opening to an additional cyclone-discharger, in which high-protein flour is deposited from the air mixture.

Particles that are not released in the additional cyclone-discharger enter the battery cyclones, where they are finally separated from the air and removed through the sluice gates.

For the experiment three wheat grinding batches of class 3 weighing 10 tons each with the following main indicators were compiled: the 1st batch (volume weight 760 gram / liter, the amount of dry gluten 23%), the 2nd batch (volume weight 760 g/l, dry gluten 25%), the 3rd batch (volume weight 760 g/l, dry gluten 27%).

It was found that wheat flour of the first and especially the highest grade contains particles up to 40 microns in size with a protein content of 20-25% or more. These particles are characterized by greater adhesion and cohesion than the particles of mass deposited in the main cyclones-discharger. The developed mode of adjusting the amount of air intake allows to achieve the selection of up to 1.35% of high-protein flour from the total output of flour. The described method of selecting high protein flour is economically feasible and is applicable to any pneumatic mills of varietal wheat grinding.

High-protein flour can be used to form a mixture with regular flour, as well as a flour improver with a low content of raw gluten. The qualitative diversity of individual flour streams during wheat milling, as well as the available ability to move protein from one flour stream to another during pneumatic transportation and pneumatic separation create the necessary prerequisites for expanding the product range at variety mills [5].

“The efficiency in the production of flour confectionery products is evaluated by a number of technical and economic indicators including: the output volume of finished products, reducing waste and losses, improving the quality of flour products, while a large role belongs to the quality of raw materials” [6]. A new technology for obtaining high-protein flour, developed in the course of scientific research, allows to get raw materials for the production of flour products with increased nutritional value, increase the economic efficiency of grain processing plants [7,8].

In this paper, the economic efficiency of technologies for preparing flour confectionery products (gingerbread) using grain processing products with increased nutritional value is considered. The nutritional value of the product was determined by comparing the chemical composition of 100 g of control and optimal samples of confectionery products with the formula of balanced nutrition.
3. Results
The development of the confectionery industry is carried out under the influence of market mechanisms. “The state of the modern market environment is characterized by a significant degree of instability: the state code of laws is changing, the standard of the population living is changing, new players are constantly emerging, the competitive environment is increasing, and every year some other business trends appear and disappear” [9]. In the post-Soviet period, the main criteria are profit and the competitiveness of the product produced at the enterprise. The volume of output is formed on the basis of studying the demand for it. Therefore, when developing new types of confectionery products, it is necessary to solve a number of tasks set for the manufacturer. To increase the demand for the offered products, it is necessary to reduce the amount of costs for its production to a minimum, while obtaining the maximum profit [10, 11, 12]. At the same time, the offered products must be of high quality and have a high nutritional value, which also affects demand. “This market offers products that meet the physiological need for nutrition” [13]. If these conditions are not met, none of the companies will take up the introduction of this type of confectionery.

"Much attention is paid to the baking properties of high-protein flour, which depend on both the total protein content and its quality. High-protein flour produced using domestic technology is characterized by the following indicators” (table 1) [14].

Table 1. Quality indicators of three-grade flour and high-protein fractions extracted from it.

| Flour grade | Ash content, % | Protein, % | Crude gluten, % | Whiteness according to CM-3, units |
|-------------|---------------|------------|----------------|----------------------------------|
| high-grade  |               |            |                |                                  |
| original    | 0.41          | 13.45      | 29.10          | 7                                |
| high protein| 1.07          | 24.32      | 55.80          | 16                               |
| first-grade |               |            |                |                                  |
| original    | 0.65          | 15.56      | 33.80          | 31                               |
| high protein| 1.16          | 24.83      | 57.40          | 19                               |
| second-grade|               |            |                |                                  |
| original    | 1.17          | 15.82      | 35.80          | 71                               |
| high protein| 1.16          | 24.72      | 57.00          | 16                               |

The high-protein fraction extracted from high-grade flour has a higher ash content and a darker color than the original one. The color of the high-protein fraction of the first-grade and the second-grade flour, on the contrary, is lighter than that of the corresponding source products. The separation of high-protein fraction at optimal technological parameters had virtually no effect on the main quality indicators of the main product, which, of course, is very important for evaluating the economic efficiency of the process of producing high-protein flour [15]. In terms of gluten quality and gas forming ability high protein flour did not differ from the norm.

The method of direct pneumatic separation can be applied to any mill equipped with pneumatic transport, without installing additional complex technological equipment, vehicles, dust cleaning devices that occupy a significant production area [16].

The higher the nutritional value, the more the product meets the physiological needs of the organism in these substances and ensures its normal functioning. A comparative assessment of the nutritional value of traditional gingerbread and gingerbread with the addition of high protein flour is presented in the table 2.

Table 2. Nutritional value of gingerbread.

| Indicators | Gingerbread (control sample) | Gingerbread with the addition of high-protein flour |
|------------|------------------------------|-----------------------------------------------|
|            | Content in 100 g of product  | Degree of satisfaction of daily needs, %       |
| Proteins, g| 6.43                         | 5.4                                           |
|            | Content in 100 g of product  | Degree of satisfaction of daily requirement, % |
|            | 10.5                         | 8.93                                          |
Fat, g
Carbohydrates, g
Non-digestible carbohydrates, g
Mineral substance:
Na, mg
K, mg
Ca, mg
Mg, mg
P, mg
Fe, mg
Vitamins:
B1, mg
B2, mg
PP, mg
Energy value, kcal

Table 2 shows that adding high-protein flour to the gingerbread recipe increases the nutritional value of the finished product. The amount of proteins and B vitamins increases.

Table 3 shows a comparative calculation of finished products using traditional flour (control sample) and flour obtained using developed technologies.

Table 3. Comparative calculation of gingerbread.

| Indicator name                      | Consumption rate for 1 t of gingerbread (control sample), kg | Consumption rate for 1 t of gingerbread with gluten, kg | Cost of 1 kg of raw materials, rub. | Production costs of 1 t of gingerbread, rub. |
|-------------------------------------|-------------------------------------------------------------|--------------------------------------------------------|--------------------------------------|---------------------------------------------|
| 1. Main raw material                |                                                             |                                                        |                                      |                                             |
| The second-grade flour              |                                                             |                                                        |                                      |                                             |
| Granulated sugar                    | 566.61                                                      | 566.61                                                 | 18.0                                 | 10198.98                                    |
| Vegetable oil                       | 351.3                                                       | 351.3                                                  | 62.0                                 | 21780.6                                     |
| Essence                              | 14.17                                                       | 14.17                                                  | 936.0                                | 772.265                                     |
| Ammonium                             | 2.26                                                        | 2.26                                                   | 80.0                                 | 408.0                                       |
| High-protein flour                   | 5.1                                                         | 5.1                                                    | 45.0                                 | -                                           |
| Total:                              | -                                                           | -                                                      | -                                    | 35275.20                                    |
| 3. Production costs                 | -                                                           | -                                                      | -                                    | 36472.21                                    |
| 4. The production cost              | -                                                           | -                                                      | -                                    | 72658.72                                    |
| 5. Business expenses                | -                                                           | -                                                      | -                                    | 8137.78                                     |
| 6. Full cost price                  | -                                                           | -                                                      | -                                    | 109859.98                                   |

Having considered the comparative calculation of finished products using traditional flour (control sample) and flour obtained using developed technologies, we note that the total cost of 1 ton of products using high-protein flour will increase by 8.5%, due to the use of additional raw materials [17,18].
Table 4. Indicators of economic efficiency in the production of product.

| Name of indicators                                      | gingerbreads control sample | With high-protein flour |
|---------------------------------------------------------|-----------------------------|-------------------------|
| Cost of 1 ton of commercial products, RUB.              | 128769.6                    | 145838.8                |
| Profit from the sale of 1 ton of finished products, rub.| 26647.0                     | 45233.2                 |
| Product profitability, %                                 | 17.2                        | 22.3                    |

Analyzing the data in table 4, we note that the profit from the sale of 1 ton of finished products is higher than in the production of traditional gingerbread, the profitability of products was 22.3 %. This is due to the fact that in the production of products using the developed technology, high-protein flour was used, obtained when implementing a new method of grinding flour, which allows reducing waste during grinding and increasing the percentage of output, as well as by improving the quality of finished products and their nutritional value, the sales price of manufactured products increases. “The high quality of our products allows successfully competing with other manufacturers that produce similar products” [19].

4. Conclusion
The raw material for obtaining high-protein flour is wheat grain grown in the Krasnoyarsk region, its use in new technologies solves the production problem of value-added products, and high technological indicators contribute to improving the quality of finished products. The profit of the developed products increases, the profitability is 22.3 %, so it is advisable and profitable to use high-protein flour as a raw material for the production of flour confectionery products.

The resulting products have an increased nutritional value, their use in nutrition will provide a high degree of satisfaction of human physiological needs for basic nutrients and energy.

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