Comprehensive assessment of bakery products with malt additives and optimal consumer properties

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Abstract. The article presents the data on the development of the products with specified consumer properties based on the methods of descriptive analysis. The development of the specific products including the bakery products with intense taste and aroma properties and high nutritional value for people, who prefer natural products, becomes rather relevant. The aim of the research is to develop the products with the specified consumer properties based on wheat flour and malt additives and to carry out a comprehensive assessment of their quality. Tritikaly, Tagansky and Stepnoy kinds of bread (control), Taganskaya, Moskvoretskaya and Kuntsevskaya (control) buns made from high-quality wheat flour using grains and legumes in the formulations are taken for the research. During the process of the development of the bakery products technology and the comprehensive assessment of their quality organoleptic, physical and chemical, statistical methods of the research and the methods of sensor analysis are used. Such organoleptic parameters of the quality as attractive appearance, taste and aroma, nutritional value and safety are considered to be essential. As a result, using an innovative approach to the development of the products with the specified consumer properties using a generalized quality indicator, it is possible to make the products that are in demand by certain groups of the population. The economic performance of the bread and buns developed is extremely high. The bakery project with cereals and legumes is resistant to the market fluctuations and is competitive.

1. Introduction

The bakery market (bakery products) is now growing mainly due to the expansion of the range and the increase in the consumption of dietary and national products of this group of food products. In some large cities the consumption of these products even exceeds the consumption of the products from the traditional raw materials such as wheat flour and yeast. Specialized natural products are very popular among the population, despite the fact that sometimes they are even more expensive than traditional kinds of bread and buns [1].

The experts cite the reason for the shift in the priorities in the bakery market which is an increase in incomes and the desire for a healthy lifestyle with increasing time constraints.

In general, the experts note an increase in demand for the specific bakery products in Russia, and in this regard, the market of natural products with strong taste and aromatic indicators and high nutritional value is considered to be rather promising.
The quality and convenience of consumption become essential. Therefore, the hits of sales are the products that do not require additional processing: bread, buns, puffs, croissants, doughnuts and cheesecakes, as the Russians are working more and more every year and they begin to appreciate their time.

Despite the fact that today supermarkets and stores offer a wide range of baked goods, the statistics still shows the lack of saturation of this segment. Demand still exceeds supply, a small but steady increase in sales is marked and it will grow, making the specialized bakery products with cereals and legumes promising in the Russian market.

The enrichment of the bakery market is also possible with the expansion of raw materials used in the production, for example due to new varieties of cereals and legumes, the use of various ways to advance in the process in order to improve the quality of the finished product, and the creation of the functional products.

Nowadays, the way to intensify the proteolysis of flour proteins and the acceleration of the fermentation of the dough associated with the use of enzyme drugs are considered to be the most promising. Therefore, enzyme preparations of plant and microbial origin, as well as combined functional-technological additives are used. The use of enzymes in fermentation of the dough is rational when due to certain biochemical features of this type of raw material (the main of which is low activity of proteolytic enzymes) to get a qualitative product is impossible.

The purpose of the research is to develop the products with the specified consumer characteristics based on wheat flour and malt products and a comprehensive assessment of their quality.

2. Materials and methods

Tritikalev, Tagansky and Stepnoy kinds of bread (control), Taganskaya, Moskvoretskaya and Kuntsevskaya (control) buns made from high-quality flour with the use of grain and legume in the recipes are studied.

During the development of the baking technology and the comprehensive quality assessment organoleptic, physical-chemical, statistical methods of the research and the methods of sensor analysis are used [2].

3. The main results and their discussion

The analysis of the literary data shows that enzyme additives of plant origin, used in baking, significantly improve the consistency of crumb and contribute to the formation of the taste and aroma of the ripe product. Malt additives of grains and legumes allow one to get bread and buns with new taste characteristics: spicy-flavored, legume sour and sour with spicy aroma, spicy with bitterness, with natural taste and attractive light-yellow developed texture.

The marketing studies have shown that consumers prefer buns and bread with different malts because of their so-called "bread bouquet", i.e. the specific taste and aroma formed during the fermentation of the dough. On the other hand, along with the general satisfaction with organoleptic indicators of bread products, the expectations of consumers when buying it at the end of its shelf life are often not justified due to a narrow range and irregular production.

Combining two types of the enzymes (malt and yeast) in one product will allow you to get a product that meets the preferences of consumers.

An innovative solution in the development of the bakery products was a systematic approach of modeling product compositions, taking into account consumer preferences, functional properties of raw materials and organoleptic characteristics of the finished product. In designing, the nutritional value, safety and organoleptic benefits of the product that determine consumer demand are considered to be the prior parameters.

A comprehensive quantitative assessment of quality is based on the fact that the product quality characteristics are quantified and then are summarized. When quantifying the quality, it is necessary to develop a system of co-measurement, to choose the properties of the product, which decisively affect the formation of its quality.
In order to translate consumer preferences into quantitatively measured indicators, a comprehensive quantitative assessment of the quality of the bakery products was carried out, such assessment included identifying the basic consumer requirements, the most important mandatory and recommended regulatory requirements, setting weight ratios, quantified indicators, determining the dependencies of consumer preferences and the defined indicators.

The study showed that the level of conformity of the actual consumption with the accepted standards that characterize consumption quantitative parameters, as well as the correspondence to a number of the subjective parameters, such as the qualitative level of food consumption should determine the degree of satisfaction of personal needs with the food products.

Since the quality of an object is manifested primarily through its properties, i.e. through the objective features of the object, it is considered that to assess the quality it is necessary, first of all, to determine the list of those properties, the complexity of which ultimately characterizes the quality; secondly, to measure the properties, i.e. determine their numerical values; third, analytically to compare the data with similar characteristics of another object taken as a sample or quality benchmark. The result will characterize the quality of the studied object with a reasonable degree of certainty [5].

To quantify the quality of the new innovative product, the following areas included in the experiment model have been developed and substantiated:

- determination and relevance of the indicators that shape the quality, nutritional, biological value, digestion and digestibility of the product;
- combining the reasoned indicators into blocks, development of the ball score scale and determination of the weight of each product;
- conversion of disparate product properties to a single dimension or expression in immeasurable units of measurement;
- identification and systematization of the basic values of the parameters that determine the properties and quality in general, and formation of the control sample (prototype or benchmark);
- comparison of the actual value of the indicator with the benchmark (prototype or benchmark).

To analyze the obtained data, the following formulas used in qualifiers when comparing disparate indicators can be applied:

\[ K_j = \frac{P_{jn}}{P_{js}} \]  

where \( K_j \) – non-dimensional value of j-property;
\( P_{jn} \) – indicator of j-property of the studied sample;
\( P_{js} \) - standard value of j-property.

All the properties that are taken into account are classified into three groups:

The I\(^{st}\) group combines the hedonic properties of the products associated with sensory pleasure, characterizing the organoleptic quality of the bakery products (shape, taste, aroma, surface condition, color), and texture (smoothness and specific density).

The II\(^{nd}\) group characterizes the utilitarian properties necessary to maintain the creation of optimal conditions that meet the physiological personal needs, characterizing the nutritional and biological value, the ratio of essential food substances, energy and safety.

The III\(^{rd}\) group regulates the social properties, the social group and class affiliation (products reflecting the status of the consumer and its functional orientation, the type of professional activity and price factor).

The maximum score of the tasting scale (5 scores) is adopted as a reference value, characterizing the optimal organoleptic indicators of the bakery products.

According to the proposed model, quality is considered as a set of the properties that determine purchasing power. The generalizing quality indicator is a sum of the single and complex quality indicators. The comprehensive assessment is determined by multiplying the values of the estimates of the relative single indicators and the related weight ratios.
Thus, the quantitative calculation of the comprehensive quality indicator was carried out according to the following formula (2):

\[
K = B_n B_i \left( M_o \sum m_o K_{oj} + M_f \sum m_f K_{ij} \right)
\] (2)

where \( K \) is a generalized measure of quality; \( B_n \) - the factor that characterizes the safety of the product by safety indicators (if all safety indicators meet the requirements, then \( B_n \) equals 1, if at least one safety indicator is unsatisfactory, the quality of the product, despite the equality of all other things, is zero, i.e. the product cannot be used as intended); \( M_o, M_f \) - weight ratios for the property groups, characterizing respectively consumer properties (weight ratios are determined on the basis of the importance of the given indicator and on the basis of expert assessments); \( m_o, m_f \) - intragroup weight ratios of the individual properties, set with the significance for each group of the properties; \( B_i \) – a factor characterizing the identification characteristics of the product (provided the actual values of identification quality indicators meet the requirements of the regulatory and technical documentation, the quality of the products is zero, as in this case the consumer rights are violated) \( K_{oj} \), - the value of the individual quality indicators characterizing the consumer properties of the product [7].

The comprehensive quantitative model of the quality assessment of the bakery products considers both the well-known elements of the formula of competitiveness of the innovative food products with the specified properties and the traditional ones, made by classical technology. In the case of the bakery products, the quality identification indicators (according to GOST 31805-2018, GOST 24557-89), safety and nutritional value (SanPin 2.3.2.1078-01), cost (raw materials costs, fixed assets, production costs), functional properties, which are characterized by the composition of raw materials, are taken into account.

The combination of the organoleptic (taste, aroma, color, shape, condition of the surface) parameters and the indicators characterizing texture (baking, plastic and elastic deformation, porosity, density) is assessed by a comprehensive indicator of the quality of the bakery products. Tagansky and Tritikaly bread and Taganskaya and Moskvoretskaya buns met the requirements of the regulations (Table 1) [4].

| Table 1. Bakery quality indicators with different malts |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Indicator                       | Control (Stepnoy bread) | Control (Kuntsevska ya bun) | Tagansky | Tritikaly | Taganskaya bun, 100g | Moskvoretskaya bun, 100g |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Organoleptic, average score     | 4.2±0.3         | 4.5±0.2         | 4.4±0.3         | 4.3±0.3         | 4.5±0.2         | 4.4±0.3         |
| Mass share of moisture, %       | 38.4±0.3        | 36.12±0.3       | 57.29±0.1       | 43.13±0.4       | 3.6±0.2         | 29.1±0.3        |
| Mass protein share, %           | 4.74±0.3        | 7.9±0.2         | 9.34±0.0        | 4.72±0.1        | 7.5±0.3         | 8.5±0.2         |
| Mass fat share, %               | 0.6±0.2         | 9.4±0.2         | 1.76±0.2        | 0.63±0.4        | 4.8±0.4         | 8.1±0.3         |
| Mass percentage of carbohydrates, % | 28.98±0.2        | 55.5±0.3        | 45.26±0.1       | 36.97±0.1       | 54.2±0.2        | 53.3±0.2        |
| Ashes, %                        | 0.9±0.02        | 0.68±0.02       | 0.93±0.02       | 0.81±0.02       | 0.98±0.01       | 1.28±0.01       |
| Humidity, %                     | 43              | 35              | 44              | 34              | 34              | 38              |
| Acidity of the crumb, hail.     | 2.9             | 3               | 3               | 2.5             | 2.5             | 3               |
| Porosity of crumb, %            | 73.8            | 70              | 74              | 73.9            | 70              | 70              |

The studies of the safety indicators provided by SanPin 2.3.2.1078-01 have shown that these products meet the requirements for the bakery products (Table 2).

For a comprehensive assessment of the consumer properties of the new types of bread and buns made of wheat flour with different types of malts, their chemical composition, energy value, as well as the degree of satisfaction of the average daily physiological human body need in nutrients when consuming 100 grams of the product are calculated.
Table 2. Acceptable standards of toxic elements, mycotoxins, pesticides in bakery products

| Indicators        | Tagansky and Triticaly bread | "Taganskaya" and "Moskvoretskaya" buns |
|-------------------|------------------------------|---------------------------------------|
| **Toxic elements:** |                              |                                       |
| Lead              | 0.35                         | 0.3                                   |
| Cadmium           | 0.15                         | 0.05                                  |
| Arsenic           | 0.07                         | 0.1                                   |
| Mercury           | 0.015                        | 0.01                                  |
| Copper            | -                            | 5                                     |
| Zinc              | -                            | 25                                    |
| **Mycotoxicity:** |                              |                                       |
| Aflotoxin B₁      | 0.005                        | 0.005                                 |
| Deoxynivalenone   | 0.7                          | 0.5                                   |
| Seealenon         | 0.2                          | 1                                     |
| **Pesticides:**   |                              |                                       |
| Methyl bromide    | -                            | 0.5                                   |
| Dichloroethane    | -                            | 0.1                                   |
| Methathion        | -                            | 0.1                                   |
| Emulsion          | -                            | 0.006                                 |
| Four-chlorine carbon | Not allowed                | 0.05                                  |
| **Pesticide residue** | Not allowed                  | Not allowed                           |

In the comprehensive quality assessment, the cost is important. To estimate the cost of the products, the data on the different types of costs involved in the process of the bakery production are calculated and analyzed. In this regard, the cost of the developed products and the cost of raw materials for the production of 100 kg of bread from wheat flour, made with the introduction of malt additives in the recommended ratios, are calculated. Thus, the planned working time fund, the number and payroll of workers, the need for raw materials and basic materials, the need and cost of packaging and packaging materials, the need and cost of electricity and heat are defined. The results of calculating the cost of raw materials for the production of semi-finished products and the cost of making the bakery products are presented in Tables 3–6 [5].

Table 3. Costing of the production costs for 100pc of wheat bread from high quality flour weighing 750g each

| Name of Raw materials | Price, rub. | The cost of raw materials for Tagansky bread | The cost of raw materials for Triticaly bread |
|-----------------------|-------------|---------------------------------------------|---------------------------------------------|
|                       |             | Weight, (kg) | Amount, rub. | Weight, (kg) | Amount, rub |
| Wheat flour           | 17.5        | 50           | 875          | 40.36        | 706.3       |
| Pressed yeast         | 190         | 0.25         | 47.5         | 0.2          | 38          |
| Wheat malt            | 100         | 0.75         | 75           | -            | -           |
| Triticale malt        | 100         | -            | -            | 1.48         | 148         |
| Salt                  | 8           | 0.375        | 3            | 0.12         | 0.84        |
| Water                 | 3.5         | 31           | 108.5        | 28.12        | 98.42       |
| **Total:**            | 1109        |              |              | 991.56       |

The cost of the basic materials and raw materials is determined by the standards of consumption of all materials per a unit of the finished product, which are calculated on the basis of the product recipe and the corresponding prices. The transportation costs include the cost of delivery of materials and raw materials, their value is 15-20% of the raw materials cost. The cost of auxiliary materials includes the cost of containers, lubricants, packaging materials, equipment, detergents, etc., and they are calculated at a rate of 4% of the cost of the basic materials and raw materials.
Table 4. Costing of the production costs for 100 pc of buns weighing 100 g each

| Name of Raw materials | Price, rub. | The cost of raw materials for Taganskaya buns | The cost of raw materials for Moskvoretskaya buns |
|-----------------------|------------|-----------------------------------------------|-----------------------------------------------|
|                       | Weight, (kg) | Amount, (rub.) | Weight, (kg) | Amount, (rub.) |
| Wheat flour           | 17.5        | 6.353            | 111.18      | 3.69            | 64.57            |
| Pressed Yeast         | 190         | 0.085            | 16.15       | 0.17            | 32.3             |
| Wheat malt            | 100         | 0.255            | 25.5        | -               | -                |
| Barley malt           | 100         | -                | 100         | 50              |
| Sugar-sand            | 35          | 0.32             | 11.2        | 1.84            | 64.4             |
| Salt                  | 8           | 0.13             | 1.04        | 0.13            | 1.04             |
| Butter                | 400         | 1.27             | 508         | -               | -                |
| Margarine             | 40          | -                | 0.1         | 4               |
| Melange               | 150         | 0.19             | 28.5        | -               | -                |
| Egg                   | 125         | -                | 0.2         | 25              |
| Water                 | 3.5         | 2.85             | 9.98        | 1.7             | 5.95             |
| Total:                |             | 711.55           |             | 247.3           |

The cost of the workshop is determined, according to Table 4, having previously determined the cost of the main production equipment, which will be depreciated (Figure 1) [6].

Figure 1. Cost and lifespan of basic production equipment

According to Figure 1 depreciation deductions for the production equipment per year will be 34,800 rubles. The calculation of the cost of organizing the production (per month) is presented in Figure 2.

Figure 2. Costing to organize production (per month, rubles)
The total cost of the product is determined by the amount of out-of-production costs and the production cost. The wholesale price of the products is determined on the basis of the mark-up, which is 20%. Profit from production can be found as the difference between wholesale price and cost.

Based on the data obtained from the manufacturer, it is established that the next range of the bakery products, presented in Table 5, is produced daily.

### Table 5. Bakery range produced daily in the company

| The name of the product       | Issue of the day (p.) | Release in 30 days (p.) | Total cost per month (ruble.) |
|-------------------------------|-----------------------|-------------------------|------------------------------|
| Tagansky Bread                | 50                    | 1,500                   | 16,635                       |
| Tritikaly bread               | 50                    | 1,500                   | 14,873                       |
| Moskvoretskaya buns           | 150                   | 4,500                   | 11,128                       |
| Taganskaya buns               | 150                   | 4,500                   | 32,019                       |
| **Total:**                    |                       |                         | **74,655**                   |

The calculation of the cost of production of bread and buns is given in Tables 6 and 7. When calculating the cost, the data from Table 3, for simplicity, are evenly distributed for each type of the products [7].

Table 6 shows that the monthly profit, in case of selling the planned amount of bread "Tagansky", will be 11,994 rubles, i.e. about 8 rubles per a unit of goods. If the cost of production is about 11 rubles per a unit of goods, we get a yield about 70%, when the sale price of the manufacturer is 41 rubles per a unit of goods. The monthly profit, in case of selling the planned amount of bread "Tritikaly" will be 11,434 rubles, i.e. about 7.6 rubles per a unit of goods. If the cost of production is about 10 rubles per a unit of goods, we get a yield about 76%, when the sale price of the manufacturer is 39 rubles per a unit of goods.

### Table 6. Calculating the cost of bread production

| The name of the cost          | Units of Measurement | Tagansky Quantity | Cost (rub.) | Tritikaly Quantity | Cost (rub.) |
|-------------------------------|----------------------|-------------------|-------------|-------------------|-------------|
| **Bread**                     | pcs.                 | 1,500             | 16,635      | 1,500             | 14,873      |
| **Transportation costs**      | %                    | 20                | 3,327       | 20                | 2,974       |
| **Support material costs**    | %                    | 4                 | 665         | 4                 | 594         |
| **Wages**                     | people               | 1                 | 10,000      | 1                 | 10,000      |
| **Depreciation deductions**   | rub.                 |                   |             |                   |             |
| **Deductions on social services needs** | % | 30                | 3,000       | 30                | 3,000       |
| **General factory expenses**  | rub.                 |                   |             |                   |             |
| (according to production data) |                     | 12,500            |             | 12,500            |             |
| **Full cost**                 | rub.                 |                   | 46,852      |                   | 44,666      |
| **Wholesale price**           | %                    | 20                | 56,222      | 20                | 53,599      |
| **Wholesale price with VAT**  | %                    | 10                | 61,844      | 10                | 58,958      |
| **Revenue from production**   | rub.                 |                   | 14,992      |                   | 14,292      |
| **Total income tax rate**     | %                    | 20                | 2           | 20                | 2,858       |
| **Profit**                    | rub.                 |                   | 11,994      |                   | 11,434      |

Table 7 demonstrates that the monthly profit in case of selling the planned amount of "Moskvoretskaya" buns will be 10,245 rubles, i.e. about 2.3 rubles per a unit of goods. If the full production cost is about 9 rubles per a unit of goods, we get a yield about 26%, when the sale price of the manufacturer is 12 rubles per a unit of goods. The monthly profit, in case of selling the planned number of "Taganskaya" buns will be 16,877 rubles, i.e. about 3.8 rubles per a unit of goods. If the full
production cost is about 15 rubles per a unit of goods, we get a yield about 25%, when the sale price of the manufacturer is 19 rubles per a unit of goods.

**Table 7. Bun cost calculation**

| The name of the cost article          | Units, Ism. | Moskvoretskaya Quantity | Cost (rub.) | Taganskaya Quantity | Cost (rub.) |
|--------------------------------------|-------------|-------------------------|-------------|--------------------|-------------|
| Buns                                 | Pcs.        | 4,500                   | 11,128      | 4,500              | 32,019      |
| Transportation costs                 | %           | 20                      | 2,226       | 20                 | 6,403       |
| Support material costs               | %           | 4                       | 445         | 4                  | 1,280       |
| Wages                                | people      | 1                       | 10,000      | 1                  | 10,000      |
| Depreciation deductions              | rub.        |                         | 725         |                    | 725         |
| Deductions on social services needs  | %           | 30                      | 3,000       | 30                 | 3,000       |
| General factory expenses (according to production data) | rub. | 12,500                 | 12,500      |                    | 12,500      |
| Full cost                            | rub.        |                         | 40,024      |                    | 65,927      |
| Wholesale price                      | %           | 20                      | 48,028      | 20                 | 79,112      |
| Wholesale price with VAT             | %           | 10                      | 52,830      | 10                 | 87,023      |
| Revenue from production               | rub.        |                         | 12,806      |                    | 21,096      |
| Total income tax rate                | %           | 20                      | 2,561       | 20                 | 4,219       |
| Profit                               | rub.        |                         | 10,245      |                    | 16,877      |

Figure 3 provides an assessment of the quality of Tagansky and Tritikaly kinds of bread, as well as Taganskaya and Moskvoretskaya buns, compared to the base samples (Stepnoy bread and Kuntsevskaya bun), using the qualimetric model of the assessment of the bakery products’ quality. It is shown that the generalized comprehensive indicator of the prototypes exceeds the control ones [8].

**Figure 3. Comprehensive indicator of the quality of the developed bread, buns and control samples**

**4. Conclusion**

Comparing the yield for all four types of the products, an average yield on the bakery products of the company that equals 25.5% is obtained. This is a high value, however, it should be taken into account that these indicators are an optimistic scenario, when there are no unforeseen costs or downtime, and 100% of the goods produced are sold. However, these calculations show that the project is resistant to the market fluctuations and it is competitive.
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