The use of iodine-containing additives in bakery production technology

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Abstract. The article proposes recipes for baking a bakery product with the introduction of new food additives: iodized salt, iodo-casein, amiton. The influence of iodine-containing additives on the nutritional and biological value of bread, as well as on their quality, has also been studied. It was found that the introduction of iodine-containing additives caused an increase in the volume yield of bread. So, namely, the introduction of iodized salt increased the volume yield by 12.6 %, iodo-casein caused the increase by 17.6 % and when introducing the parameter was 12.5 % higher than the control. Bread with iodine-containing additives is a complete food product with a high nutritional value: 100 g of bread satisfy a person's need for proteins by 8.9 %, for fat by 2.3 %, for carbohydrates by 14.4 %, and the person's need for iodine. When daily consumption of 200-250 g of bread with iodo-casein, the iodine content will be 78-97.5 μg, or 52-65 % of the recommended physiological norm. Bakery products with iodine-containing additives are a complete food product with a high nutritional value. Therefore, to enrich bakery products with iodine, then iodo-casein, iodized salt, amiton, which contain the amount of iodine necessary for a person, can be recommended as iodine-containing additives.

1. Introduction

An increasing role is played by bread varieties with the addition of biologically important elements - vitamins and minerals, as well as natural food additives from plant raw materials. Oil seeds are often used in bakery products, for example, oil flax, white mustard, and other crops.

Indeed, there should be as much bread as possible, varied in taste and dietary merits. The correct choice of bread is one of the components of rationalizing the diet of a modern person and preventing many common diseases.

Both large scientific teams and individual companies, which take full responsibility to healthy nutrition of the population, work on the creation of bread for medical and prophylactic purposes.

In order to resolve the issue of preventing iodine deficiency in the population, it is necessary to introduce new additional names into the list of iodine-containing products of daily consumption. Bread is the best representative and there are several technologies for iodizing it [1–3].

In accordance with the decree of the Government of the Russian Federation, the Chief State Sanitary Doctor of Russia, in order to prevent diseases associated with iodine deficiency, the food industry has been tasked with organizing the production of mass consumption products (which
primarily include bakery products) enriched with iodine. Regular consumption of iodized bread can provide iodine to all segments of the population.

The most effective and environmentally expedient way to correct the deficiency of trace elements is the enrichment of food products, including bread, with valuable biologically active substances, like iodine.

This research was carried out to study the effect of various iodine-containing additives on the nutritional and biological value of bakery products.

2. Materials and methods

The studies were carried out at "Khlebozavod No. 1" in Ryazan and at the Department of Agronomy and Agrotechnologies of Ryazan State Agrotechnological University named after P.A. Kostychev.

The purpose of the research was to study the effect of iodine-containing additives (iodized salt, iodo-casein, amiton) on the nutritional and biological value of bread, as well as on its quality.

The object was loaf "Sliced". The use of iodized salt in bakery enterprises was carried out by replacing edible salt in the recipe of a certain product with food iodized salt, produced according to TU 919203-007-17028327-96. Edible iodized salt includes edible grade "Extra" salt, which is enriched with iodine in the form of potassium iodate in an amount of 40 $\mu$g of iodine per 1 g of salt [4–6].

Due to the fact that the main purpose of the research was the enrichment of the bakery product with iodine, loaf "Sliced" without iodine-containing additive was taken as the basis (control variant).

Loaf "sliced" was made from premium wheat flour. The weight of the product was 0.4 kg, the shape of the finished product was oblong-oval and the surface had oblique cuts. The crust was not burnt and its colour varied from light yellow to brown. Moisture was not more than 42 %, acidity was not more than 2.5 °H and porosity was not less than 73 %.

All studies were carried out according to standard, generally accepted methods, in accordance with regulatory documents.

3. Results and discussion

The production of experimental baking was carried out according to the standard technology, which includes the following set of operations: preparation and dosing of raw materials in accordance with the recipe, kneading the dough, fermenting the dough, cutting the dough, proving the dough pieces, baking bread at a certain temperature and time regime (Table 1).

Table 1. Stages and modes of technology for the production of loaf "Sliced", including the production recipe

| Raw materials, modes and indicators of the process | Parameter |
|---|---|
| Baking wheat flour, premium, kg | 100 |
| Pressed bakery yeast, kg | 3.0 |
| Salt, kg | 1.5 |
| Sugar, kg | 4 |
| Vegetable oil, kg | 2.1 |
| Initial temperature of the semi-finished product, °C | 26(+1) |
| Moisture of semi-finished product, % | 42.5 |
| Duration of fermentation, hour | 2.5 |
| Final acidity of the semi-finished product, deg. | 2.5-3 |
| Dough piece weight, kg | 0.46 |
| Proofing time, min. | 50 |
| Duration of baking, min | 21 |
| Baking temperature, °C | 260 |

Dough production had one stage, when all raw materials necessary for the production recipe were used at once. The fermentation process took about 2.5 hours, observing the temperature regime in the
range from 28 to 32°C. Kneading was carried out two times during the fermentation process in 1 and 2 hours after its kneading.

Due to the fact that the main raw material of bakery production is premium wheat flour, the quality of which effects the entire technological process, it became necessary to determine the quality of the flour used [7, 8]. The results of the analyzes are presented in Table 2.

Table 2. Quality indicators of premium wheat bakery flour

| Indicator           | Norm according to GOST 26574-2017 | Fact             |
|---------------------|-----------------------------------|------------------|
| Organoleptic        |                                   |                  |
| Colour              | White or creamy white             | Creamy white     |
| Odour               | Peculiar to wheat flour, free of foreign odours, not musty, not mouldy | Peculiar to this type of flour |
| Taste               | Normal, without sour, bitter and other extraneous tastes | Normal |
| Crunch              | No crunch should be felt when chewing | No crunch       |
| Moisture, % not more | 15.0                             | 13.0             |
| Raw gluten: amount, % | not less 28.0                    | 28.0             |
| Acidity, °H         | -                                 | 1.52             |

As a result of the research, it was found that organoleptic characteristics of the flour corresponded to the standards in accordance with GOST 26574-2017 “Wheat bakery flour. Technical conditions”.

This flour was used to bake products with various iodine-containing additives according to the variants of the experiment:
1. Control (without iodine-containing additives)
2. With iodized salt
3. With iodo-casein
4. With amiton.

Iodized salt is well combined with components included in the production recipe, while not exerting a negative impact on organoleptic and physical-chemical indicators of the quality of finished bakery products in comparison with the control. In addition, edible salt, being enriched by potassium iodate that is a strong oxidizing agent, improves a number of indicators of bread quality: specific volume, shape stability and porosity. Dough dilution and slackness are reduced and the structure of gluten network is strengthened.

Food additive iodo-casein is approved for production, supply, sale and use on the territory of the Russian Federation. There is a hygienic conclusion of the Ministry of Health of Russia, No. 0169720, dated 01.07.99, for the production of bread and bakery products enriched with iodized protein [9, 10].

The use of iodo-casein for additives in bakery products will not affect the technology of production of bakery products, will not require the cost of restructuring production due to the scanty amount of the preparation used (5 g per 1 ton of bread).

Additive "Amiton" is a yellowish powder. Due to high concentration of iodine in the additive, it is used to enrich bakery products in relatively small quantities (25 g per 50 kg of flour), which excludes the impact on the organoleptic characteristics and physical-chemical indicators of the finished product. Iodine compounds that make up "Amiton" are absorbed directly into the mucous membrane of the gastrointestinal tract, easily and completely absorbed by the body.

Organoleptic and physical-chemical indicators of the quality of test baking in accordance with the experiment design are presented in Tables 3 and 4.

The surface of all types of bakery products is smooth without cracks and oven breaks, correct symmetrical. The state of the crumb is well baked, not sticky, not wet by touch, without lumps and traces of impurities, elasticity is good and crunch is not felt. The taste and smell of all variants are characteristic of a product made from wheat flour. The product has no foreign tastes and smells and
the light color.

Table 3. Organoleptic indicators of the quality of experimental baked food

| Quality indicator | Control with iodized salt | with iodo-casein | with amiton |
|-------------------|---------------------------|----------------|-----------|
| Crunch colour     | Light-brown, Developed, without voids and seals, thin-walled | Light-brown, Fine, uniform, thin-walled | Light-yellow, Medium, uniform, thin-walled |
| Grain             | Light-yellow, Medium, uniform, thin-walled |

During the research, more significant changes occurred in the physical-chemical quality indicators (Table 4).

Table 4. Physical-chemical quality indicators

| Quality indicator | Control | with iodized salt | with iodo-casein | with amiton |
|-------------------|---------|------------------|-----------------|------------|
| Weight, g         | 140.6   | 141.3            | 143.8           | 141.3      |
| Volume yield, cm³/100 g | 295.0   | 332.3            | 347.0           | 331.8      |
| Form stability, h/d | 0.33    | 0.35             | 0.34            | 0.33       |
| Moisture, %       | 42.0    | 42.0             | 41.0            | 42.1       |
| Acidity, °Н       | 2.5     | 2.5              | 2.5             | 2.5        |

It was found that with the introduction of iodine-containing additives, an increase in the volume yield of bread was observed. Namely, with the introduction of iodized salt, the volume yield increased by 12.6 %, with the introduction of iodo-casein by 17.6 % and with the introduction of amiton by 12.5 % in relation to the control.

The stability, moisture and acidity of products for all variants did not practically change.

Thus, one can conclude that the iodine-containing additives studied in the work had a significant effect on the volume yield of bread and do not worsen the quality indicators of bakery products. Additive iodo-casein has a more positive effect.

The nutritional value of bread is determined by the calorie content, digestibility and the presence of additional nutrients (essential amino acids, vitamins, minerals). The systematic use of baked goods together with other food products has a significant physiological meaning, since baked goods give the food consumed the necessary structure and consistency, which contributes to a more productive work of the digestive system, including more complete saturation of food with digestive juices. Based on this, one can conclude that bakery products are not only a source of essential nutrients, but also play a significant role in the physiology of human nutrition.

The physical properties (porosity structure of the crumb) of baked goods are also an important factor in their digestibility. With a larger volume of bread crumb, its porosity is correspondingly greater, as a result of which it is better and faster soaking with digestive juice, which contributes to better digestibility by the human body. In this regard, the study of the elements of the nutritional value of bread is combined with the moments associated with the assessment of its quality, and the latter should be based on indicators of the nutritional value of bread (Table 5).

Based on Table 5, one can conclude that bread with iodine-containing additives is a complete food product with a high nutritional value: 100 g of bread satisfy a person's need for proteins by 8.9 %, for fat by 2.3 %, for carbohydrates by 14.4 %, and the person's need for iodine is also satisfied. With daily consumption of 200-250 g of bread with iodo-casein, the iodine content will be 78-97.5 μg, or 52-65 % of the recommended physiological norm. With the daily consumption of 200-250 g of bread with iodized salt, the iodine content will be 68-85 μg, or 45.3-56.7 % of the recommended physiological norm. With the daily consumption of 200-250 g of bread with amiton, the iodine content will be 44-55 μg, or 29.4 - 36.8 % of the recommended physiological norm.
Table 5. Chemical composition, nutritional and energy value of the investigated products (per 100 grams of the product)

| Indicator                  | Contained in 100 g of the product | Daily requirement | The degree of satisfaction of the daily requirement, % | with iodized salt | with iodocasein | with amiton |
|----------------------------|-----------------------------------|-------------------|-------------------------------------------------------|-------------------|----------------|-------------|
| Proteins, g                | 7.6                               | 85.0              | 8.9                                                   | 8.9               | 8.9            | 8.9         |
| Fat, g                     | 2.36                              | 102.0             | 2.3                                                   | 2.3               | 2.3            | 2.3         |
| Digestible carbohydrates, g| 55.0                              | 382.0             | 14.4                                                  | 14.4              | 14.4           | 14.4        |
| Indigestible carbohydrates, g | 3.8                              | 50.0              | 7.6                                                   | 7.6               | 7.6            | 7.6         |
| Minerals:                  |                                    |                   |                                                       |                   |                |             |
| Calcium, mg                | 18.25                             | 800.0             | 2.3                                                   | 2.3               | 2.3            | 2.3         |
| Phosphorus, mg             | 93.61                             | 1,200.0           | 3.7                                                   | 3.7               | 3.7            | 3.7         |
| Potassium, mg              | 65.73                             | 2,500.0           | 5.5                                                   | 5.5               | 5.5            | 5.5         |
| Magnesium, mg              | 12.84                             | 400.0             | 3.2                                                   | 3.2               | 3.2            | 3.2         |
| Iron, mg                   | 0.91                              | 14.0              | 6.5                                                   | 6.5               | 6.5            | 6.5         |
| Iodine, mg                 | -                                 | 150.0             | 22.7                                                  | -                 | 26.0           | 14.7        |
| Vitamins, mg:              |                                    |                   |                                                       |                   |                |             |
| Thiamine (B<sub>1</sub>)   | 0.1                               | 1.7               | 5.9                                                   | 5.9               | 5.9            | 5.9         |
| Riboflavin (B<sub>2</sub>) | 0.03                              | 2.0               | 1.5                                                   | 1.5               | 1.5            | 1.5         |
| Niacin (PP)                | 1.1                               | 19.0              | 5.8                                                   | 5.8               | 5.8            | 5.8         |
| Calorie content, kcal      | 276.83                            | 2,775             | 10.0                                                  | 10.0              | 10.0           | 10.0        |

According to modern scientific principles of food enrichment with micronutrients, this product using these iodine-containing additives can be classified as an enriched food, since it provides more than 30% of the average daily requirement for this trace element. Moreover, the addition of iodocasein is the most optimal variant for enriching bakery products with iodine.

It was found that iodized salt had an inhibitory effect and inhibited the development of bacteria and molds grown both on nutrient media and on bread samples. The data obtained give reason to recommend edible salt, enriched with potassium iodate, for increasing the microbiological purity of bakery products, preventing moldy bread and the development of rope spoilage.

4. Conclusion

Based on the studies carried out, it is possible to conclude that the introduction of various iodine-containing additives has in no way affected the organoleptic characteristics of the finished product.

It was found that with the introduction of iodine-containing additives, an increase in the volume yield of bread was observed, namely, with the introduction of iodized salt, the volume yield increased by 12.6%, with the introduction of iodine-casein by 17.6% and with the introduction of amiton by 12.5% in relation to the control.

Bakery products with iodine-containing additives are a complete food product with a high nutritional value [11, 12]. Therefore, to enriching bakery products with iodine, it is recommended to use iodocasein, iodized salt and amiton, which contain the amount of iodine necessary for a person.

Considering the positive effect of iodine-containing additive iodocasein on the structural and mechanical properties of the dough, organoleptic indicators of the quality of finished products, as well as the benefits brought to the human body, it is advisable to use iodocasein when enriching bakery products with iodine.

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