Biochemical aspects of obtaining yeast dough using a concentrate from germinated wheat grain

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Abstract. Sprouted wheat has an increased nutritional value and is well suited for enriching bakery products. Yeast dough from wheat flour is defined as an object of research. The process of testing was carried out using a steam convection apparatus. The technological processes occurring in a yeast dough with conducting concentrate from germinated wheat grain in the amount of 5-25% by weight of pre-ferment were studied. The study was carried out as part of a grant provided by the expert centre «PORA» for the project "Bread of increased nutritional value with sprouted wheat grain for the Arctic zone of the Russian Federation". The article shows the effects of concentrate in an amount of 5-25% by weight of pre-ferment on the duration of fermentation, as well as on the organoleptic and physico-chemical characteristics of the finished semi-product. As a result, based on a comprehensive quality indicator, the recipe for yeast dough with a concentrate of germinated wheat grains in the amount of 10-20% by weight of the pre-ferment will be optimal by technology using a steam convection apparatus.

1. Introduction

In the conditions of current ecological situation, it is important to have sufficient intake of nutrients in the human body, which leads to the need to create products of enriched composition. Bakery products are well suited as enrichment items to which various types of additives can be applied. The nutritional value of finished products from yeast dough depends on the content of nutrients in them (carbohydrates, proteins, vitamins, macro- and microelements) and on ensuring the optimal flow of technological processes at all stages of dough preparation. The use of natural herbal supplements intensifies the microbiological and biochemical processes in the dough, improves the properties of gluten, the structure of the dough, improves the quality indicators of finished products, organoleptic characteristics: taste and aroma [1, 2].

Germinated wheat grain is a source of nutrients, vitamins, macro- and microelements, it also normalizes metabolic processes in the human body. Due to its ability to be easily digested through the biochemical destruction of complex components to simpler ones, germinated wheat grain is well suited as an enriching additive for bakery products. To obtain the structural and mechanical properties of the required quality by the dough and to comply with the ongoing physical, chemical, biochemical and microbiological processes at all stages of preparation, it is important to add germinated wheat grain in the form of a concentrate with a uniform, spreading consistency. Therefore, it was decided to

use a concentrate of sprouted wheat grains with a dry matter content of 45% as an additive to the yeast dough [3-6].

The purpose of the study is to develop the technology and formulation of sponge yeast dough with the addition of concentrate from germinated wheat grain for the production of high nutritional value products.

2. Materials and methods

As object of study a concentrate from germinated wheat grains was taken with the following parameters: solid matter content - (45 ± 0.04)%, protein - (12.4 ± 0.05)%, fats - (1.93 ± 0.003) %, starch - (26.4 ± 0.02)%, fiber - (1.8 ± 0.05)%, sugar - (1.65 ± 0.03)%, ash - (1.03 ± 0, 03)%, consistency is a homogeneous spotting mass with small inclusions without coarse particles; color – beige with small inclusions of brown; smell – characteristic of a healthy grain of this type; taste – sweetish, characteristic of a healthy grain of this type [6]. Also, the object of the study was determined yeast dough from wheat flour with the addition of concentrate from germinated wheat grains in the amount of 5-25% by weight of pre-ferment.

The process of yeast development was studied by the intensity of fermentation, which was determined by the change in the height of pre-ferment and dough (every 30 minutes after the crumping). The dough preparation process was carried out according to the technology using the steam convection apparatus SCC61WE-3NAC 400V50/60 (using the specified humidity, temperature and time parameters). Organoleptic characteristics of finished semi-products were determined on a 5-point scale. Physico-chemical parameters were determined in accordance with existing regulated methods using the ELVIZ-2C moisture analyser and the Expert-001 liquid analyser. To optimise the recipe composition of yeast dough with a concentrate of germinated wheat grains, we used a modified standard qualimetric method from determining the dynamic complex quality parameter by the formula:

$$K_{\sum}(t) = \sum_{i=1}^{n} \mu_i k_i(t) \quad (1)$$

Where $K_{\sum}(t)$ is a dynamic complex parameter of the quality of the process; μ_i is the weight coefficient of the i-th unit parameter; $k_i(t)$ is the single parameter value of the technological process quality; n – is the number of unit parameter; t – is the period of time from which individual quality parameters and a dynamic complex parameter of the quality of the technological process are determined.

The following indicators of the quality of the production process were selected: $k_1(t)$ – an parameter of organoleptic evaluation; $k_2(t)$ – is an parameter if the height of the lift; $k_3(t)$ – moisture parameter; $k_4(t)$ – is the pH value of acidity; $k_5(t)$ – is an parameter of the content of crude gluten.

A single parameter of the quality of the process was calculated by the formula:

$$k_i(t) = \frac{x_i}{\max x_i} \quad (2)$$

where x_i – significant signs; $\max x_i$ – the corresponding maximum values [7].

Statistical processing of the results was carried out in the «Microsoft Excel» and «Statistica 6.1» programs using the non-parametric Kolmagorov-Smirnov criterion. The difference in the comparison of mean was considered significant at $p < 0,05$.

3. Results and discussion

Yeast dough was prepared in a sparse manner, which at the beginning involved the preparation of the sponge, and then the direct kneading of the dough. The use of dough gives flexibility to the process, stimulates the activation and reproduction of yeast. Pre-ferment was prepared according to the recipe used with the introduction of a concentrate from germinated wheat grains. The fermentation intensity was determined by changing the height of the pre-ferment. It is known that digestible carbohydrates, which they receive by fermentation of disaccharides and polysaccharides, are a nutrient medium for

the development, growth, and reproduction of yeast. In the process of life and development. Yeast secrete ethyl alcohol and carbon dioxide. Alcohol gives products a taste; carbon dioxide forms volume and porosity. With an increase in the dosage of the concentrate from the germinated wheat grain, the amount of di- and polysaccharides if the dough increases, which are an additional nutrient medium for yeast. During the study of dough with the replacement of its part with a concentrate of germinated wheat grains in the amount of 5-25%, changes in the duration of fermentation were noted. The growth of pre-ferment in all samples containing concentrate from germinated wheat grains is much more active than in the control sample. The maximum height of the dough was observed with the introduction of a concentrate from germinated wheat grain in an amount of 15%, 109% more that in the control sample. The introduction of 5-10% of the concentrate to the mass of the pre-ferment increased the height of the pre-ferment by 59-77%, respectively, compared with the control for the same time period. In the sample with a concentrate of 20-25%, an intensive growth was observed at the beginning of fermentation, but by the end of the fermentation the height of the pre-ferment increased by 84% compared with the control sample.

After fermentation, the dough was kneaded, and the fermentation process was analysed by the height of the pre-ferment rise (0,5 h after each baking). The results showed that when concentrate was added in an amount of 15-20% to the weight of the pre-ferment, the maximum height of the dough was observed, while in comparison with the control sample for the same period of time it increased by 92-96%, respectively. When concentrate is introduced in an amount of 5-10%, the height of the dough increases by 33-66%, respectively, compared with the control sample for the same period of time. In the sample with 25% concentrate. Intensive growth was observed at the beginning of fermentation, but by the end of the fermentation the height of dough increased by 74% compared with the control sample. This can be explained by the continued active development of yeast in the dough, the appearance of additional bonds at the sites of contact of the proteins and polysaccharides of the dough. In this regard, it can be assumed that the addition of a concentrate from germinated wheat grain leads to the formation of bonds that strengthen the structure of the dough.

All ready-made samples of pre-ferment and dough were organoleptic evaluation according to the following parameters: surface condition, degree of looseness, consistency, colour, smell. The resulting date is displayed in figure 1.

According to the experts, a high overall score (4.8 – 4.9) was noted in the samples of pre-ferment and dough with a dosage of 10-20% concentrate from sprouted wheat grain, while the obtained semi-products have a convex surface, a mesh structure and a good looseness, which shows a normally flowing fermentation process. Samples of pre-ferment and dough with a dosage of 25% concentrate has a convex surface, a mesh structure of the dough and good looseness, also noted a sour smell and taste, which significantly reduced the assessment.

Moisture, acidity (pH) and crude gluten content were determined from the physico-chemical parameters of the finished pre-ferment and dough samples.

Increasing humidity promotes the development of yeast and lactic acid bacteria, which in turn accelerates the fermentation process, but excessive humidity of the dough can lead to deterioration of the quality of finished products from it. The humidity of the finished samples with a concentrate content of sprouted wheat grain 5-25% is shown in figure 2. Dynamics of humidity changes: introduction a concentrate from germinated wheat grain into the formulation of pre-ferment yeast dough increases the humidity of the finished semi-product as the administered dosage increases. Thus, the moisture content of pre-ferment containing 5-20% concentrate from sprouted wheat grain increases by 10.9 – 21.8%, respectively, which subsequently increases the humidity of the finished dough by 4-0,7%, respectively. In the support with 25% concentrate content, the increase in humidity compared to the control sample was 29,4%, which led to an increase in the humidity of the finished dough by 14,7%.

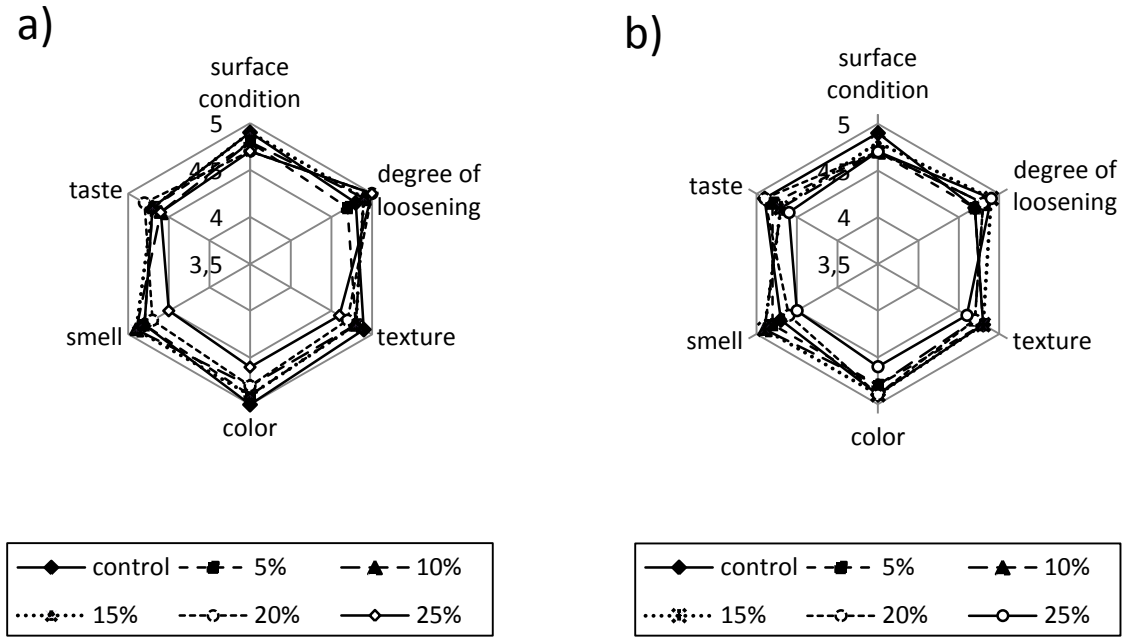

Figure 1. Organoleptic characteristics of a) pre-ferment and b) dough with different content of wheat sprouted grain concentrate (M±m) (n=6).

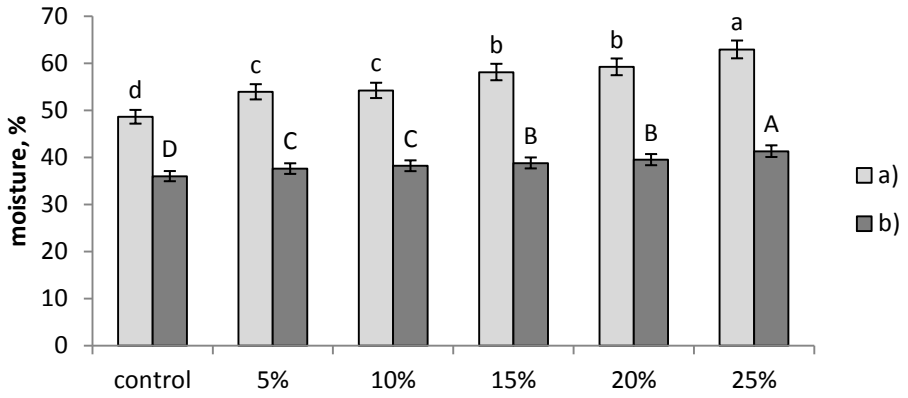

Figure 2. Humidity of finished a) pre-ferment and b) dough with different content of wheat sprouted grain concentrate (M±m) (n=6) (intra-group differences, multiple comparison of averages designated by different letters, LSD test, $p<0,05$).

Increased acidity indicates that the dough during fermentation formed an excessive amount of lactic acid, which leads to a decrease in looseness of the dough, deterioration of the quality of finished products and the appearance of sour taste. The acidity of the pre-ferment and the finished dough containing 5-15% concentrate from sprouted wheat grain practically does not change in comparison with the control sample. The support with a content of 20-25% concentrate acidity increases by 21-23%, respectively, which contributes to a slight increase in the acidity of the finished dough by 8,7-12%, respectively. The data obtained are presented in figure 3.

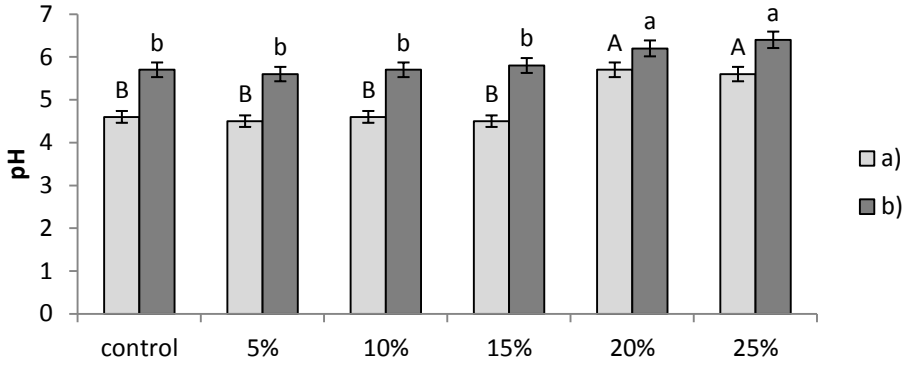

Figure 3. Acidity of finished a) pre-ferment and b) dough with different content of wheat sprouted grain concentrate (M±m) (n=6) (intra-group differences, multiple comparison of averages designated by different letters, LSD test, p<0,05).

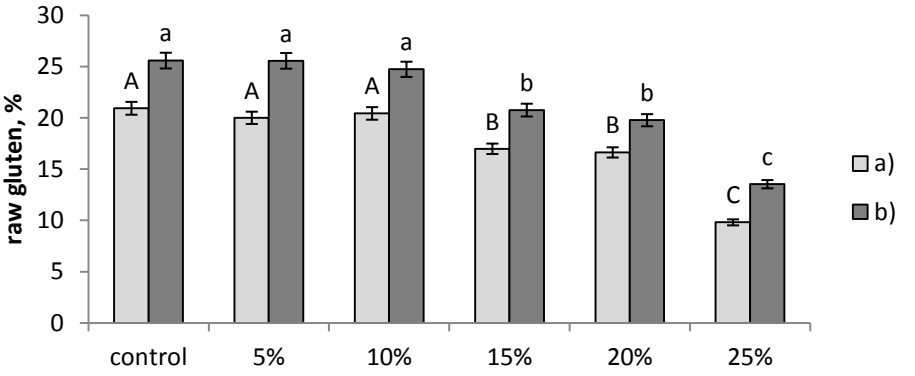

Figure 4. The amount of crude gluten in the finished samples of a) pre-ferment and b) dough with different content of wheat sprouted grain concentrate (M±m) (n=6) (intra-group differences, multiple comparison of averages designated by different letters, LSD test, p<0,05).

A decrease in the amount if crude gluten is observed in the samples of pre-ferment and dough as the amount of introduced concentrate from sprouted wheat grain increases. The data is displayed by figure 4. The amount of raw gluten pre-ferment and finished dough with a content of 5-10% concentrate from sprouted wheat grain does not change in comparison with the control sample. Whereas in samples containing 15-20% of the concentrate, the amount of crude gluten in the pair is reduced by 19,2-20,6%, and in the dough by 17,2-21,2%, respectively. A significant decrease in the amount of gluten is observed in samples containing 25% concentrate from sprouted wheat grain in the sponge by 53,2% in the dough by 46%. It can be assumed that the decrease in gluten is associated with the action of proteolytic enzymes, probably contained in a concentrate from germinated wheat grains, which break down proteins according to their peptide bonds.

The values of dynamic quality parameters of yeast sponge dough with different content of wheat sprouted grain concentrate are presented in figure 5.

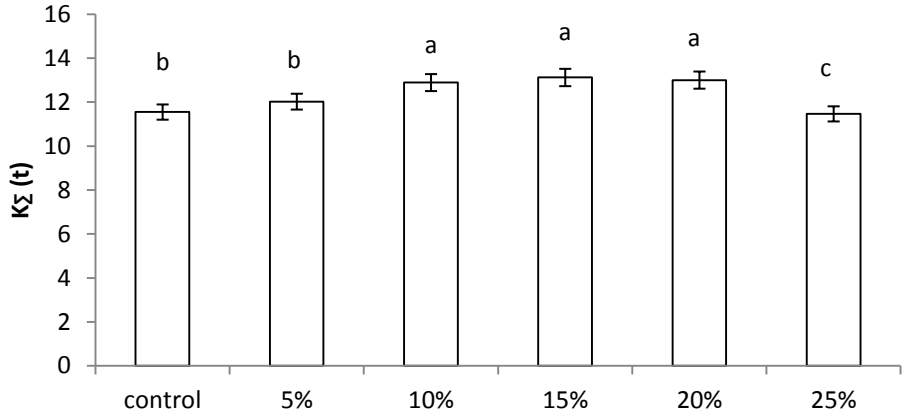

Figure 5. Dynamic complex parameter of technological process quality of yeast sponge dough with different content of wheat sprouted grain concentrate (M±m) (n=6) (intra-group differences, multiple comparison of averages designated by different letters, LSD test, p<0,05).

The analysis of the data showed that the best results are observed in semi-finished yeast dough with a content of concentrate from sprouted wheat grain in the amount of 10-20%.

To substantiate the formulation of products from yeast sponge dough with a concentrate of sprouted wheat grain, samples were baked, in which organoleptic and physico-chemical parameters were determined.

4. Conclusions

As a result of the study a positive effect of wheat sprouted grain concentrate on reducing the duration of fermentation by technology using a steam convection apparatus was noted. The technology and formulations of semi-finished yeast dough containing a concentrate of sprouted wheat grain 5-25% by weight of pre-ferment. All semi-finished products of pre-ferment and dough with an increase in the introduced concentrate increases the humidity and acidity (pH) at the same time they reduce the amount of raw gluten. On the basis of the calculated dynamic complex quality index, the optimal percentage for the preparation of semi-finished products from yeast sponge dough will be the introduction of a concentrate from sprouted wheat grain in an amount of 10-20% by weight of the pre-ferment.

References

[1] Vasyukova A T and Puchkova V F 2008 *Modern technology of bread-making* (Moscow: Dashkov & Co.)
[2] Karachkina S Y *New types of flour and confectionery products* (Orel: Trud)
[3] Mujoriya R 2011 A study on wheat grass and its nutritional value *Food science and Quality Management* **2**
[4] Singh N, Verma P and Pandey B R 2012 Therapeutic Potential of Organic Triticum aestivum Linn. (Wheat Grass) in Prevention and Treatment of Chronic Diseases, an Overview *International Journal of Pharmaceutical Sciences and Drug Research* **4(1)** 10-4
[5] Safronova T N, Kasina V V and Safronova K V 2017 Development of technological parameters of wheat germination *Technique and technology of food production* **1 (44)** 37-43
[6] Kasina V V and Safronova T N 2019 Development of technology for obtaining concentrated product from sprouted wheat grain for the public catering system *Food industry* **9** 24-8
[7] Antset V U and Vitchuk N A 2017 Methods of qualimetric assessment of the quality of production processes *News of TulSU. Technical science* **8-1** 324-30