



The Study of the Possibility of using the Additive of Plant Origin for Improvement the Quality of Yeast and Wheat Bread

Elena V. Savelyeva^{1*}, Elena E. Zinurova¹, Zamira Sh. Mingaleeva², Alexandr V. Maslov²,
Oksana V. Starovoitova², Svetlana V. Borisova², Olga A. Reshetnik²

¹ Institute of Fundamental Medicine and Biology, Kazan Federal University, Kazan, Russia

² Department of Food Production Technology, Kazan National Research Technological University, Kazan, Russia

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Abstract

The effect of the additive of plant origin on the fermentation activity of pressed bakery yeast *Saccharomyces cerevisiae*, the impact of activated yeast on the fermentation process in dough semi-finished products and on the quality of white bread, made from premium wheat flour, were investigated in the work. The efficiency of yeast was evaluated, based on the rising power and fermentation activity of yeast. The impact of activated yeast on the fermentation process was determined by the acidity of dough semi-finished products. The quality of white bread, made from premium wheat flour, was evaluated according to organoleptic and physico-chemical parameters (moisture content, acidity, grain of crumb). It was found, that with the increase in concentration of the additive of plant origin, there were the improvement of rising power of yeast, and the intensification of acidity accumulation in dough semi-finished products. According to the organoleptic and physico-chemical evaluations, it is recommended to use the additive of plant origin in the process of yeast activation, at a dosage of 7% to the mass of flour, without the deterioration of consumer properties of bread, compared to the control sample.

Keywords: Bakery yeast, Preliminary activation, Fermentation activity, White bread made from premium wheat flour

1 Introduction

In the production of pressed bakery yeasts *Saccharomyces cerevisiae*, they are cultivated by aeration on a sucrose medium, to accelerate the growth of biomass. As a result, they have active respiratory enzymes and low-active fermentation enzymes. When kneading the dough, yeast comes to the anaerobic maltose medium. A certain period of time is required for the adaptation of yeast to new conditions. In order to reduce this time, the preliminary activation of yeast is performed. This is the process of transformation of the enzymatic complex of yeast from respiration to fermentation (1). Preliminary activation of yeast allows to reduce the time of dough fermentation and to improve the quality of finished bakery products (2, 3).

There are chemical and physical methods for the preliminary activation of yeast, which differ in the nature of the effect on yeast cells. Chemical methods consist in the activation of the enzyme systems of yeast cells, due to the addition of activators, accelerating metabolism, to the

nutrient medium (RF patents No. 2656397, No. 2388227). Physical methods involve the improvement of throughput capability of cell membranes under the influence of electromagnetic, ultrasonic, acoustic, and laser processing (RF patents No. 2200194, No. 2184145, No. 2288262, No. 2272420). It is promising to use the powders from cereals, containing nutrients necessary for yeast cells, as the activators (RF patents No. 2358007, No. 2257406).

The studied additive of plant origin contains maltose, enzymes, vitamins, microelements and other biologically active substances. In the presence of maltose in a nutrient medium, the quantity and activity of maltopermaeae and α -glucosidase enzymes gradually increase in the cells of yeast. The maltopermaeae enzyme catalyzes the transfer of maltose through the cell membrane inside the cell, where, under the action of α -glucosidase, the disaccharide is hydrolyzed into two glucose molecules. Then, under the effect of enzymes of zymase complex, glucose decomposes with the formation of ethyl alcohol, carbon dioxide, and with the release of energy (4). In comparison with premium wheat flour, the additive of plant origin is characterized by a high content of thiamine, minerals: magnesium, zinc,

Corresponding author: Elena V. Savelyeva, Kazan Federal University. E-mail: lenazinurva@yandex.ru.

iron, copper and phosphorus.

Thiamine is a part of the enzyme pyruvate decarboxylase, which is necessary in the process of alcoholic fermentation for decarboxylation of pyruvic acid into acetaldehyde; it participates in nitrogen metabolism, stimulates the hydrolysis of maltose and the fermentation activity of yeast in general (4, 5). The ions of magnesium, zinc and iron in the yeast cell are the coenzymes, and are involved in the process of activation of many reactions. Magnesium regulates the metabolism of pyruvic acid; it is necessary as the coenzyme and activator of a number of glycolytic enzymes; it contributes to the stability of cell membranes and the resistance of the yeast cell to ethyl alcohol, high temperature, increased concentration of dry substances and osmotic effect. Zinc is involved in the carbohydrate, nitrogen and phosphorus metabolism of the yeast cell. It stimulates the consumption of maltose and maltotriose by the yeast, promotes the synthesis of riboflavin, and stimulates the proliferation of cells. Iron and copper are necessary for the yeast in order to synthesize the respiratory enzymes, to increase the fermentative activity of yeast, and to stimulate the budding of cells (in small quantities). Phosphorus is a part of nucleic acids, ATP, phospholipids, cell wall polymers; it can be accumulated in cell in the form of polyphosphates (4, 5).

The purpose of the work is to study the effect of the additive of plant origin on the fermentation activity of yeast, the quality of dough semi-finished and finished products, prepared with the use of preliminary activated yeast.

2 Materials And Methods

The following raw materials were used for the research:

- pressed bakery yeast "Lux Extra" TU 9182-038-48975583-2011;
- premium bread wheat flour "Makfa" GOST R 52189-2003;
- edible salt GOST R 51574-2018;
- white sugar GOST 33222-2015;
- drinking water GOST R 51232-98.

In this work, pressed bakery yeast was previously activated in a nutrient medium, which was prepared by mixing of water and the additive of plant origin.

Preliminary activation of the yeast was carried out in the following way: the nutrient medium with a moisture content of 70% was prepared using the additive of plant origin and water. During the study, three variants of the composition of the nutrient medium were applied (Test No. 1, Test No. 2, Test No. 3), in which the content of the additive of plant origin was gradually increased. Shredded pressed yeast was added to the prepared nutrient medium in the amount, necessary for the analysis. The resulting mixture was stirred and kept at a temperature of 32 °C for 10, 20, 30, and 40 minutes. In the process of doughing of test samples, premium wheat flour was added in such

amount, that the total mass of wheat flour and plant origin additive, used for the preliminary activation of yeast, was equal to the mass of flour, used for the doughing of the control sample.

The fermentation activity of yeast was determined by the following indicators:

1. rising power;
2. fermentation activity: zymase and maltase.

The rising power of yeast was defined in an accelerated manner (6,16).

Determination of zymase and maltase activity of yeast was carried out according to standard methods. The unit of activity was the time in minutes, spent on the release of 10 cm³ of carbon dioxide by the yeast, during the fermentation of a glucose or maltose solution, with a concentration of 5%, at a temperature of 35°C (6). To exclude the influence of sugars, contained in the additive of plant origin, on the measurement results, the samples with the introduction of plant origin additive in glucose and maltose solutions were taken as control, without preliminary activation of yeast in the nutrient medium. The results of measurement of maltase and zymase activities after the activation of yeast in the nutrient medium were considered as the experiment.

The effect of activated pressed yeast on the maturation of dough semi-finished products was assessed by the increasing of dough titrable acidity. Before kneading the dough, preliminary activation of yeast was carried out in a nutrient medium, containing the additive of plant origin. The dough was kneaded, following the recipe for white bread, made from premium wheat flour, according to GOST 26987-86. The containers with dough semi-finished products were placed in a thermostat with a temperature of 32°C for fermentation. To determine the acidity, the samples were taken every 30 minutes. The acidity of the dough semi-finished products was defined by the titration with an aqueous solution of NaOH, with a concentration of 0.1 mol/ dm³, in accordance with GOST 27493. Acidity was stated in degrees.

The assessment of the quality of finished bakery products was carried out, based on the following indicators:

1. physico-chemical;
2. organoleptic.

Physical and chemical indicators. The moisture content in the crumb of bakery products was determined according to GOST 21094, by placing the sample in a drying cabinet SESH-ZM; it was stated as a percentage. The acidity of the crumb of bakery products was determined according to GOST 5670, by the titration with an aqueous solution of NaOH, with a concentration of 0.1 mol/ dm³; it was stated in degrees. The crumb grain of the products was determined according to GOST 5669; it was stated as a percentage.

Organoleptic indicators. The shape, surface condition, color, state of the crumb (baking, kneading, grain), taste and aroma of bakery products) were defined according to

GOST 5667, by the organs of senses, and were evaluated on a scale of one to ten. The average score was calculated taking into account the weight coefficient.

3 Results

At the initial stage, we studied the dependence of the rising power of yeast on the amount of plant origin additive, used in the nutrient medium (Test No. 1, Test No. 2, Test No. 3), and on the duration of preliminary activation, i.e. on the time of the yeast exposure in the nutrient medium (10, 20, 30 and 40 min). After holding the yeast in the nutrient medium, the rising power was determined according to the methodology. The results of measuring of the rising power of yeast are presented in table 1.

Table 1: The effect of the nutrient medium composition and the duration of activation on the rising power of yeast

Time of activation, min	Control	Test No. 1	Test No. 2	Test No. 3
10	43.3 ± 1.0	25.7 ± 0.6	24.7 ± 0.7	22.9 ± 0.8
20		21.0 ± 1.0	20.1 ± 0.9	21.6 ± 0.3
30		20.6 ± 0.6	18.7 ± 1.0	23.2 ± 0.2
40		24.0 ± 0.2	21.3 ± 0.2	23.2 ± 1.0

It follows from Table 1 that with the increase in the duration of activation, there is the improvement of the rising power. However, with the duration of activation of 40 minutes, the rising power began to decline. The optimal time for activation of pressed yeast in a nutrient medium was 30 min. As a result of activation, the rising power of pressed yeast has increased on average by 52%, relative to the control sample.

The effect of various concentrations of the additive of plant origin in a nutrient medium on the activity of yeast enzymes of the zymase complex and maltase, with the optimal duration of the activation process of 30 min is presented in Table 2. The variants of measuring of the zymase and maltase activity, with the use of plant origin additive in glucose and maltose solutions, but without holding the yeast in a nutrient medium containing this additive, were taken as the control. It follows from Table 2 that with the increase in the concentration of additive of plant origin in the nutrient medium, there is the improvement in the zymase and maltase activity. With regard to these indicators, the optimal variant is the composition of nutrient medium, used in the Test No. 3. The increase in zymase and maltase activity with this composition of the nutrient medium was 42.9% and 49.4%, respectively.

Table 2: The effect of the additive of plant origin on zymase and maltase activity of yeast

Time of activation, min	Test No. 1	Test No. 2	Test No. 3
Zymase activity, min			
0	22.5 ± 0.5	23.1 ± 0.5	21.7 ± 0.5
30	14.9 ± 0.5	13.5 ± 0.5	12.4 ± 0.5
Δ, %	33.8	41.6	42.9
Maltase activity, min			
0	29.7 ± 0.5	31.3 ± 0.5	32.8 ± 0.5
30	20.1 ± 0.5	18.5 ± 0.5	16.6 ± 0.5
Δ, %	32.3	40.9	49.4

Further researches were aimed at studying the effect of activated yeast on the rate of acidity accumulation during the fermentation of dough semi-finished products. The variants of the composition of nutrient medium were presented in the form of the concentration of the additive of plant origin, as a percentage to the mass of flour for the formula of white bread, made from premium wheat flour, which amounted to 5%, 7% and 10% to the mass of flour. Preliminary activation of yeast was carried out before kneading the dough with premium wheat flour. At the end of fermentation, the acidity of dough should be 3.0 degrees, according to the standards. Figure 1 shows the dynamics of acidity accumulation in dough semi-finished products over 150 minutes.

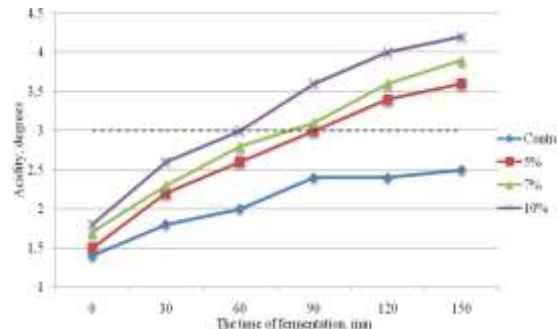


Figure 1: The dynamics of acidity accumulation in dough semi-finished products

As can be seen from Figure 1, the test sample with a concentration of the additive of 5% to the mass of flour reached the required acidity in 90 minutes of fermentation; the sample with a concentration of 7% - in 75 minutes; the sample with a concentration of 10% - in 60 minutes of fermentation. Moreover, the control sample did not reach the required acidity in 150 minutes of fermentation. Figure 2 presents the data on the increase in acidity of dough semi-finished products. The increase in acidity of dough semi-finished products with a concentration of plant origin additive of 5% to the mass of flour was 2.1 degrees, in the test sample with 7% of the additive - 2.0 degrees, in the

sample with 10% of the additive - 2.4 degrees. With regard to the control sample, the increase in acidity was 2.2, 2.5 and 2.8 degrees, respectively. Table 3 presents the effect of the additive of plant origin on the physicochemical parameters of finished bread.

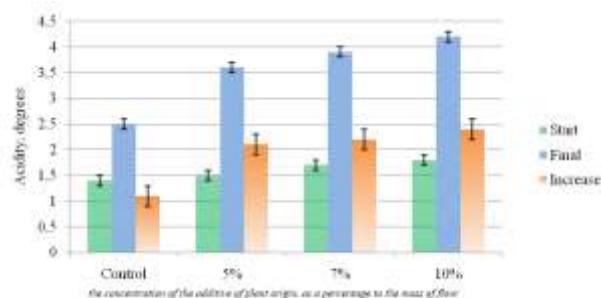


Figure 2: Accumulation of acidity over 150 minutes of fermentation of dough semi-finished products

Table 3: Physico-chemical characteristics of the finished product

Indicator	Control	The concentration of the additive of plant origin to the mass of flour, %		
		5	7	10
Moisture content, %	40.4±0.5	41.2±0.5	40.2±0.5	39.3±0.5
Grain, %	78.4±1.0	83.0±1.0	82.5±1.0	81.5±1.0
Acidity, degree	2.2±0.1	2.3±0.1	2.4±0.1	2.4±0.1
Shrinkage for 1 hour, %	1.6±0.1	1.4±0.1	1.2±0.1	1.8±0.1

As follows from Table 3, the moisture content in the test sample, with a concentration of the additive of 5% to the mass of flour, was higher by 2.0%, compared to the control. In the experimental samples with the concentrations of the additive of plant origin of 7% and 10%, the indicator of moisture content decreased, compared to the control, by 0.5% and 2.7%, respectively. This was due to the increase in the content of free water in dough semi-finished products, as a result of hydrolytic effect of amylolytic enzymes of the additive on the starch flour grains (7-11-12).

The greatest increase in crumb grain of the finished product (by 5.9% relative to the control sample) occurred when the concentration of the additive was 5% to the mass of flour. The acidity of the test samples, compared with the control, was higher by 0.1-0.2 degrees. The value of shrinkage in experimental samples with the concentrations of the additive of 5% and 7% to the mass of flour has

decreased in relation to the control by 12.5% and 25%, respectively. The data obtained are explained by the effect of enzymes of plant origin additive on the starch flour grains. The result is a partial disturbance of their structure and the accumulation of dextrins that provides a lesser degree of retrogradation of starch and the decrease in water loss during the storage of finished products. In the sample with the concentration of the additive of 10% to the mass of flour, the value of shrinkage has increased by 12.5%, relative to the control. This is due to the higher content of enzymes, compared with other samples. The structure of starch grains is destroyed to a greater extent. The increased amount of dextrins is formed, which are not able to hold a sufficient amount of water. As a result, there is more intensive evaporation during the storage of bread that increases the rate of shrinkage (8-10-14).

Organoleptic analysis showed that the experimental samples of bread had more intensely colored crust, compared to the control, rich taste and aroma of freshly baked bread. This is due to the action of amylolytic enzymes, contained in the additive of plant origin. Compared to the control, the experimental samples had a darker crumb that was associated with the dark color of the additive. The crumb grain in all samples was uniform; well developed crumb grain was observed in the sample with the concentration of the additive of 7% to the mass of flour. According to the results of organoleptic analysis, the experimental sample of bread, with the concentration of the additive of plant origin of 7% to the mass of flour, received the highest score (15, 17, 18, 19, 20).

4 Summary

1. It was established, that the preliminary activation of pressed bakery yeast for 30 minutes in a nutrient medium, containing the additive of plant origin, allowed to increase the rising power of yeast by an average of 52%, and to increase the zymase and maltase activity, relative to the control, by an average of 39% and 41%, respectively.

2. It was found, that the use of activated yeast in the process of making of dough semi-finished products contributed to the reduction in fermentation duration by an average of 195 minutes, compared to the control sample.

3. It was determined, that the application of the additive in the amount of 7% to the mass of flour in the formula for white bread, made from premium wheat flour, made it possible to increase the crumb grain by 5%, and to reduce the shrinkage by 25%, relative to the control. This sample was characterized by a more developed crumb grain, compared to other samples.

4. According to the results of organoleptic analysis, it was defined, that the experimental sample of bread, with the concentration of the additive of plant origin of 7% to the mass of flour, received the highest score.

5 Conclusion

Thus, the use of the studied additive of plant origin at a concentration of 7% to the mass of flour, in the process of preliminary activation of pressed bakery yeast, contributed to an increase in the fermentation activity of yeast, the intensification of fermentation process in dough semi-finished products, the improvement of physicochemical parameters and consumer properties of the finished products.

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