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The Effect Of An Enzymatic Agent On The Rheological Properties Of Wheat Dough After Kneading

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Abstract.

The formation of wheat dough during kneading is reduced primarily to the formation of a vector of numerical parameters that uniquely describe its rheological properties. Determination of these parameters is a metrological basis for building a rheological dough model. Establishing the relationship between the regulatory influences on the state of wheat dough biopolymers and the coefficients of the rheological model will further allow controlling the physicochemical properties of the dough and, as a consequence, the quality of finished bakery products.

Keywords: Farinograf E, Strukturometr, wheaten flour, wheat bread.

Introduction.

Food raw materials and their semi-finished and finished products have various rheological properties [1, 2], which depend on many factors, such as chemical composition, temperature, humidity, intensity, and duration of mechanical and thermal effects.

Food materials are organic products, i.e. biologically active materials. During processing, they undergo biochemical, microbiological, colloidal-chemical processes, which change their structure and mechanical properties. Research and application in production of various combinations of such processes can provide a given level of rheological characteristics throughout the entire production process, which will stabilize the yield of products and obtain ready-to-use products of constant, predetermined quality [3].

In baking, wheat flour is the most unstable raw material; therefore, finished products with given texture parameters can be obtained only by controlling the rheological properties of semi-finished products, considering the baking properties of raw materials and the formulation of products.

The first and one of the main operations in bread production is dough kneading [4] and flour quality, during which the rheological properties [5-8] of the semi-finished product are formed, which subsequently ensure the formation of the structure of finished products.

When assessing the quality of bakery products, the consumer pays special attention to their texture [9]. Considering the fact that wheat flour is the most unstable raw material; therefore, finished products with given texture parameters can be obtained only by controlling the rheological properties of semi-finished products, considering the baking properties of flour [10] and the formulation of products. Among the factors used to regulate the state of the carbohydrate-amylase complex, Fungamil 2500 BG, an amylolytic enzyme agent, was chosen.

Materials and Methods.

Research was carried out using the following three instruments for measuring the qualities of the wheat dough:

- the «Farinograf E» which determines the changes in the consistency of dough during kneading, setting the time it is ready for baking, and adjusting the amount of mechanical energy expended during tests [11-13];

- the «Strukturometr ST-2M» which determines the complex rheology of the wheat dough after mixing;

- the "Amilotest AT-97" to determine the autolytic activity of rye and wheat grains, as well as all varieties of wheat and rye flour by the indicator number of drops [14, 15].

Results and Discussion.

In our research we used top-grade wheat flour, FN equal to 370 s (Table 1).

Table 1 Quality indicators of premium wheat flour

Name of indicators	The value of indicators
Humidity, %	13.2
Acidity, degrees	2.4
Raw gluten content, %	28
General gluten deformation, device units GSG (gluten strain gauge)	55
Flour Whiteness, device units Blick-P3	56
Drop number, s	370

Within the study on the effect of an amylolytic enzyme agent on the falling number of wheat flour, the experiments were carried out in compliance with the requirements of GOST 27676-88 using Amilotest AT-97 (ChP-TA).

Fungamil 2500 BG was added as a solution. Its dosage was varied in the range from 0.0002 to 0.006% with a pitch of 0.002%. Table 2 shows the experimental data.

Table 2 The effect of the dosage of the enzyme drug Fungamil 2500BG on the number of drops of flour

Volume of the enzyme drug, ml	The amount of the enzyme drug, % by weight of flour	Number of drops, s
0	0	370
2	0.0002	340
4	0.0004	322
6	0.0006	302
8	0.0008	283
10	0.001	270
12	0.002	235
14	0.004	205
16	0.006	160

The experimental data obtained were used to plot a fall number to enzymatic agent dosage curve (Fig. 1).

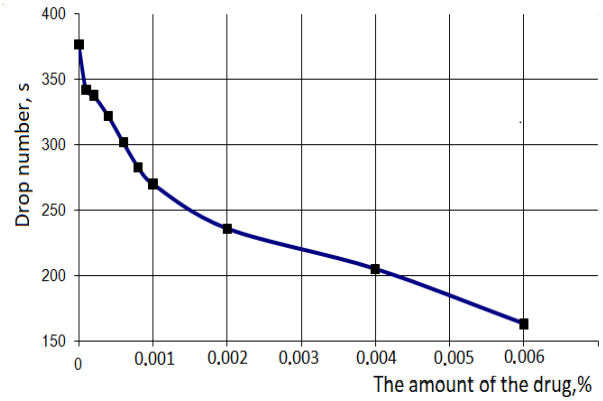

Fig. 1. Change in the number of drops of premium wheat flour depending on the dosage of the enzyme drug Fungamil 2500BG

The analysis of the experimental data showed that the addition of 0 to 0.006% of an enzymatic agent to the flour mass led to a decrease in the falling number from 370 s to 160 s, while the curve of the change in falling number is “exponential”.

Given that the falling number is a direct indicator of the sugar-forming ability of flour, the accumulation of some amount of maltose significantly affects the rheological behavior of wheat dough. To determine the rational dosage of the enzymatic drug, we have studied the changes in the rheological properties of the dough [4, 5] and the quality of bread, depending on the amount of Fungamil 2500 BG.

The rheological behavior of the dough was studied just for some dosages of the enzymatic agent; but for dosages of 0.002 and 0.006% and without the enzyme preparation, three samples of flour were prepared, with the "falling numbers" equal to 370; 235, and 160 s, respectively.

Further, a 640 EF dough was kneaded using three samples of wheat flour and the rheological behavior was determined by adhesion stress, total, elastic, and plastic deformations, and other characteristics.

Figure 2 shows an adhesive stress curve for the wheat dough made from flour samples with different “falling numbers”.

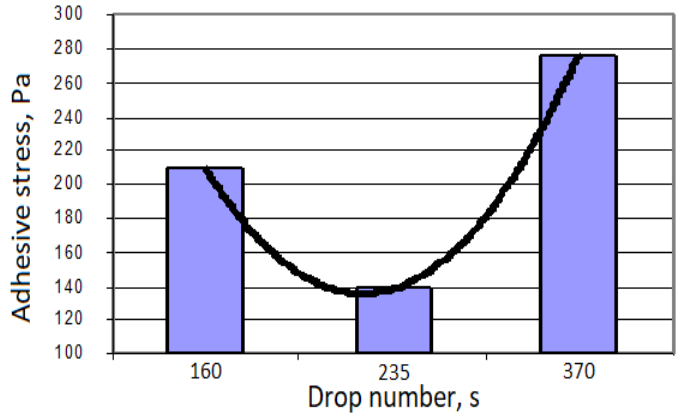

Fig. 2. The effect of the number of drops of wheat flour on the change in the adhesive stress of the dough

We have found that adding 0.002% of the amylolytic enzymatic agent gives the lowest adhesive stress of the dough after kneading. This confirms that premium wheat flour, falling number 235 s, has optimal properties.

The study of the effect of the "falling number" of wheat flour on the change in rheological criteria Δh and λ (Fig. 3 and 4) has found that the relative deformation of flour dough with a falling number of 235 s was Δh - 0.7, and the stress relaxation rate λ - 0.3 s^{-1}.

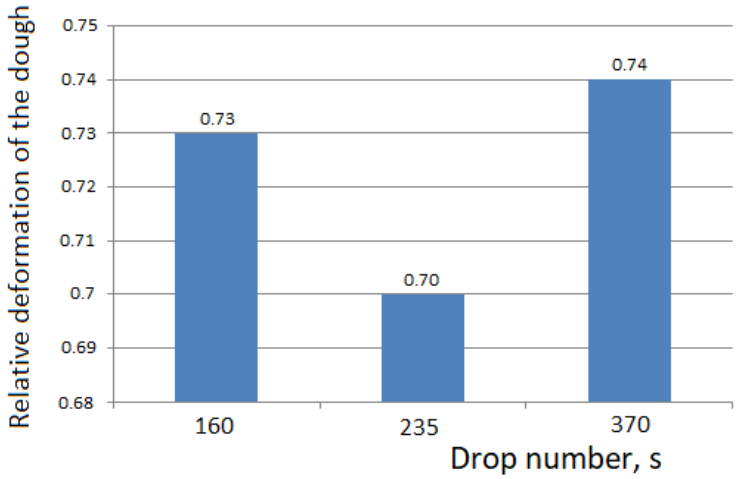

Fig. 3. Change in the relative deformation of the dough after kneading, depending on the indicator of the number of drops of flour

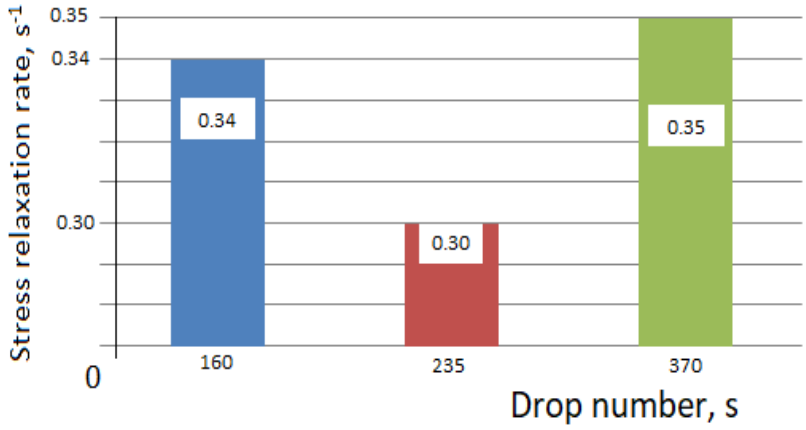

Fig. 4. Change in the stress relaxation rate of the dough after kneading, depending on the indicator of the number of drops of flour

Trial laboratory baking of a bakery product has established that the crumb of finished products made of premium wheat flour, falling number 235 s, had the highest modulus of elasticity (Fig. 5) and the lowest crumbling index (Fig. 6).

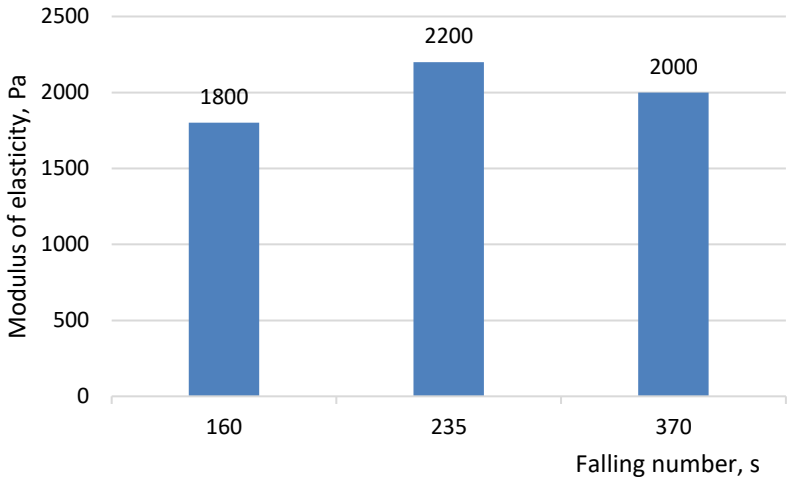

Fig. 5. Change in the modulus of elastic as a function of the number of drops of flour

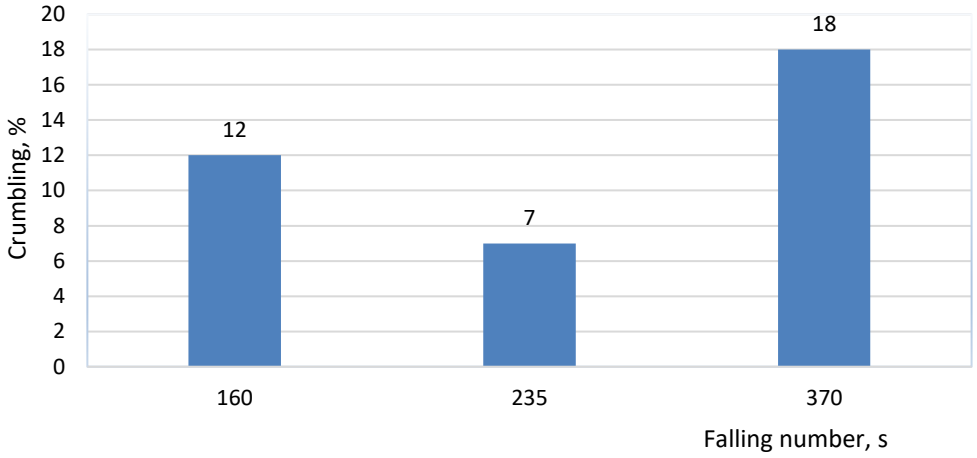

Fig. 6. The change in bread crumbling depending on the indicator of the number of drops of flour

Conclusion.

Thus, the optimization of the state of the carbohydrate-amylase complex of wheat flour (based on the falling number equal to 235 s) makes it possible to obtain at the kneading stage a dough with the following characteristics:

- consistence – 640 EF;
- relative deformation value Δh – 0.70;
- relaxation rate λ 0.30 s^{-1}.

Wheat dough with such rheological characteristics ensures the best quality of bread, with the highest elastic modulus and the lowest crumbling index.

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