Determination of the viscosity of wheat dough, using a rotary viscometer «BROOKFIELD DV-II + PRO»

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Physical and mechanical properties of wheat dough occur during their deformation and fracture flow. Among the set of physical properties that lead to product quality, rheological are overarching; they often determine the behavior of products in a variety of industrial processes and energy fields, are the outward expression of the inner nature of the objects, that is characterized by aggregation state, dispersion, structure, structure and type of interactions within the product.

Wheat dough, depending on the composition, structure and composition of the particulate have different flow properties and textural distinguishing features. Depending on simple or complex milling wheat dough is made from different types of flour.

Most species of wheat dough are a dispersed system consisting of two or more phases, thus forming a dispersed mixture, which can be modeled in the form of loose body Newtonian and non-Newtonian fluids, as well as a number of special models [1].

The manufacturing process of wheat dough includes mechanical and physico-chemical changes. The main task of preparing wheat dough is to manage the mechanical processes of formation, deformation and fracture of dispersed systems of various types [2].

The role of rheological laws and their changes is the basis for the calculation of the working bodies, reduce of energy and metal food machines, improving the quality of the products.

Rheological properties of wheat dough depend on such factors as temperature, humidity, intensity and duration of the mechanical effect on feed formulation, method of preparation and duration of biological processes. Therefore, the choice of technological regimes during processing is important to know a lot of patterns of change in the rheological properties of dough. [3]

The purpose of this work - dependence of the rheological properties (shear stress and viscosity) of wheat dough.

The objectives of the work:

- Determination of the viscosity using a rotational viscometer «BROOKFIELD DV-II + PRO»;

- Dependence of the rheological properties (shear stress and viscosity) of wheat dough.

Tests were conducted in the laboratory, "Biochemical and spectral analysis of food products" Don State Technical University.

Study was carried out on a rotary viscometer «DV-II + PRO». The strain rate was varied from 0 to 150.

Temperature - one of the parameters which affect the rheological properties of wheat dough, as in a production environment process control can be carried out only as a result of changes in temperature. Investigations were carried out at temperatures of 30⁰C, 45⁰C and 60⁰C [4].

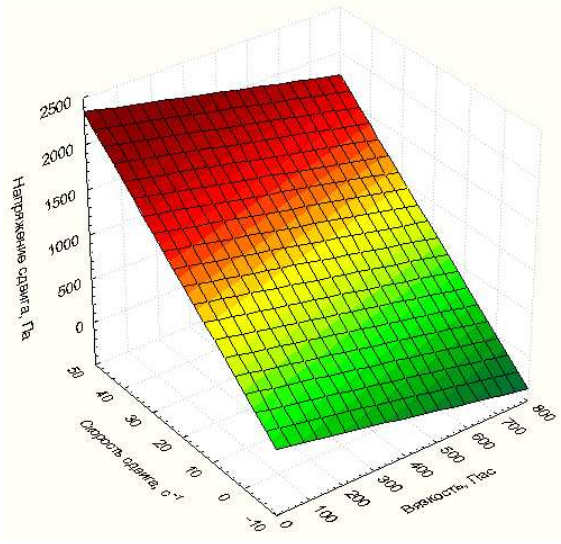
New portion of the mixture was selected at each temperature. Before each experiment, the mixture was subjected to laboratory analysis for moisture. Before the measurements were carried out in the temperature control of the sample mixture for 15 minutes with an accuracy of 0.1

Measurement error does not exceed ± 3%.

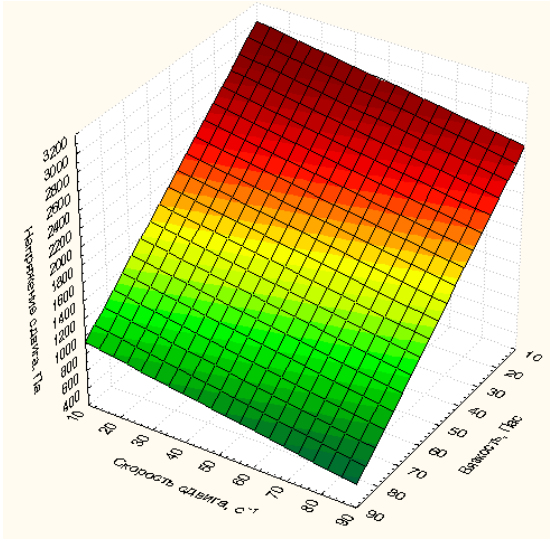
The results of studies of the relationship of shear stress and tangential effective dynamic viscosity of wheat dough on the strain rate at various temperatures are shown in Table 1. The results are presented graphically using the «Statistica 10" Fig.1-Fig.3

Table 1 - Results of viscosity and shear strain rate

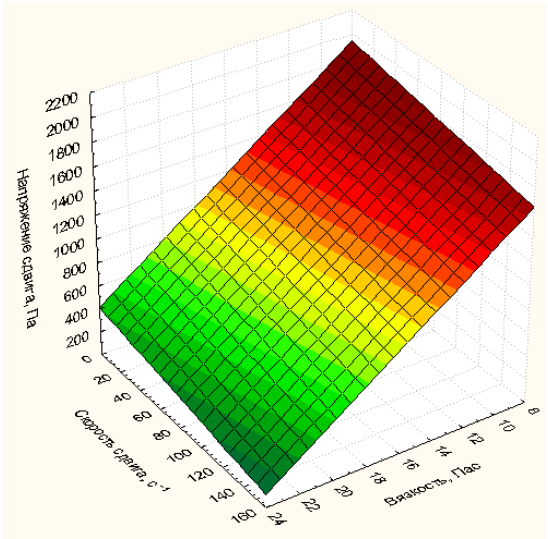
Shear strain rate $\dot{\gamma}$, .	Shear stress τ,	Viscosity, η,
Temperature of the mixture $T = 30^0 C$		
0,150	110,1	704,5
1,1	270	315,4
10,3	914,5	100,3
25,1	1546,0	77,7
45,9	2101,8	43,11
Temperature of the mixture $T = 45^0 C$		
15,6	1100,9	79,6
50,1	1943,8	44,5
66,3	2055,7	37,9
75	2156,4	27,6
84,3	2215,1	18,9
Temperatre of the mixture $T = 60^0 C$		
17,3	498,5	22,5
48,9	598,9	20,8
84	715,5	19,1
104,5	1257,9	14,5
150	1421,4	9,7



Drawing 1. Dependence of the shear stress from the shear strain rate at the temperature of 30 ⁰C



Drawing 2. Dependence of the shear strain stress from the shear rate at the temperature of 45 ⁰C



Drawing 3. Dependence of the shear stress from the shear strain rate at the temperature of 60 ⁰C

Analysis of the experimental data shows that with increasing temperature the wheat dough and the strain rate increases the shear stress and the viscosity decreases exponentially. This can be attributed to the non-Newtonian mixture investigated elastic-viscous-plastic bodies and to conclude that it has a critical shear stress corresponding to the elastic component of deformation.

The effective viscosity decreases with increasing strain rate, due to a large randomly distributed particles in a stationary environment.

With increasing strain rate increases the shear stress at 45 ⁰C more than at 30⁰C and 60⁰C, and the viscosity decreases more at 60⁰C than at 30⁰C and 45⁰C. Thus, with increasing strain rate effect of temperature on the viscosity of the mixture changes gradient weakens, since there is a weakening of the strength of the intermolecular coupling of the mixture and decrease the resistance.

Depending on the strain rate and shear stresses effective dynamic viscosity of wheat dough significantly changed. For example, at a temperature of a mixture of 30ºC and increasing strain rate from 0.150 to 45.9 , the dynamic effective viscosity decreases with 704.5 43.11 to more than 16 times, and the shear stress at the same change in the velocity gradient increases from 110.1 to 2101.8 more than 19 times.

With increasing temperature, the mixture dynamic effective viscosity at the same velocity gradient decreases. For example, the mixture at temperatures of 45 and 60ºC and the same deformation rate equal to 84, the effective dynamic viscosity of wheat flour, respectively, equal to 18.9 and 19.1, i.e. 1 time varies. This is determined by the fact that the viscous forces overcome by increasing the kinetic energy of the molecules.

It can be assumed that the investigated mixture is partially compressed due to crowding out and compression absorbed components of the mixture of gaseous inclusions. Partially destroyed, which corresponds to plastic flow.

So, according to studies received, a decrease in the dynamic of the effective viscosity of wheat dough with increasing temperature and increasing strain rate, due to the partial destruction of the structure of the mixture.

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