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Influence of the Use of Activated Water during Hydrothermal Treatment on the Quality of Bread

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abstract: Wheat grain grinding technologies currently used at mill enterprises, recommended by the rules for organizing and conducting technological processes in mills, are not effective enough for regions with a hot climate, including Uzbekistan. The grain is supplied to the mills with an initial moisture content of 11.0% or less, with increased glassiness. The storage of the grain mass is carried out at an elevated temperature, up to +480 C. Lowered initial humidity, high temperature, low efficiency of hydrothermal treatment of grain are the main reasons for the natural deterioration of the quality of flour, especially in summer.

The article provides a theoretical basis, research methods and results of experiments carried out in order to study the effect of water activated by ultrasound on the baking properties of flour. Activated water was used at the stage of preparation for grinding grain grown in the dry and hot climate of Uzbekistan.

Keywords: grain of wheat; technology; quality indicators; activated water; quality change.

INTRODUCTION

In accordance with the strategy of industrial and innovative development of the Republic of Uzbekistan, the economic independence of the state is determined by an increase in production efficiency, an increase in labor productivity, an improvement in the quality of manufactured high-tech products through the use of resource and energy-saving technologies (Babaev, 2009).

Among food products, grain and its processed products are of dominant importance: flour, cereals, bread, bakery, pasta, flour confectionery, etc.

Modern grain processing production is a dynamic, constantly evolving system that includes material, technical, organizational, scientific and information support. A stable and rather flexible technological process of grain processing predetermines the possibility of managing it depending on the initial properties of raw materials, technological factors of production, hardware and equipment, the type and purpose of the product obtained.

Wheat grain grinding technologies currently used at mill enterprises, recommended by

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the rules for organizing and conducting technological processes in mills, are not effective enough for regions with a hot climate, including Uzbekistan. The grain is supplied to the mills with an initial moisture content of 11.0% or less, with increased glassiness. The storage of the grain mass is carried out at an elevated temperature, up to +480 C (Babaev, Ergasheva, Ravshanov, 2014).

Decreased initial moisture content, increased temperature, low efficiency of hydrothermal treatment of grain are the main reasons for the regular deterioration of the quality of flour, especially in summer.

The increased demand for processed wheat grain products requires a constant increase and expansion of their range and quality improvement. This has become the most pressing problem for agricultural workers, grain processing enterprises and scientists (Ergasheva, 2000).

The Republic of Uzbekistan is actively implementing a state program to increase the production of wheat and other grain crops. This is important for providing the country's population with food products balanced in terms of basic food ingredients (Babaev, 2009).

Wheat cultivated in the natural and climatic conditions of our country has specific properties. The technological instructions and rules for organizing the technological process in mills operating in the flour and cereals industry do not ensure grain processing at a sufficiently high technological level (Radzhabova, 1999; Ergasheva, 2002).

A characteristic feature is that locally produced grain is characterized by low moisture content and high glassiness. Therefore, the processes of hydrothermal treatment in the preparation of grain for grinding need to be improved.

As a result of consideration of various methods of hydrothermal treatment of grain, our attention was attracted by the research of scientists on the study of the properties of activated water. In recent years, a large amount of experiments have been carried out on the use of activated water in various sectors of the national economy, including the food industry (Volokhova, 2003; Naumenko, 2007).

Activated water is known to us from folklore sources as "dead" and "alive".

"Living" water has the ability to maintain the acid-base balance in the human body. "Dead" water, being anolyte, has good bactericidal properties, it can be used for infectious diseases (influenza, ARVI). "Living" water is a catholyte, it is a natural biostimulant, it is able to restore the immune system, especially in combination with the use of vitamins.[1-5]

Many devices and devices have been developed that allow water to be restructured and used in medicine, cosmetology, various industries and agriculture.

MATERIALS AND RESEARCH METHODS

Under existing conditions, improving the quality of bread is mainly due to the use of various food additives (Dremucheva, Karchevskaya, Polandova, 2000), which changes its

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characteristic organoleptic characteristics. The purpose of our work is to find ways of efficient processing of grain at the stage of its preparation for grinding and to develop the most perfect system for managing the quality of finished products (Radjabova, 1999).

An integral part of grain preparation for grinding is hydrothermal treatment, the most common method of which is cold conditioning (Ergasheva, 2000).

Our work is based on the fundamental research of Ya.N. Kupritsa, V.L. Kretovich, G.A. Egorova, P.P. Tarutina, I.A. Naumov and other scientists who proposed methods of grain conditioning with the supply of thermal energy (heated water or saturated steam), which entails significant material costs and complicates the technological process.

In recent years, the effectiveness of using water activated by various methods has been established to improve the quality of flour and bread (Korchagin, 2000; Golubeva, 2000).

G.A. Egorov proved that the use of electrochemically activated water in the conditioning of grain can reduce the heating time and improve the quality of flour (Egorov, 2000, Egorov, 2002).

The object of the study was grain samples of common wheat, selected according to the standard method and cleared of grain and trash impurities (Table 1). Таблица 1

Initial quality of the studied grain

Wheatgraintype	Glassiness,%	Naturalweight, g / l	Humidity,%	Weightof 1000 grains, g	Ashcontent,%	Glutencontent,%	Glutenquantity, unit IDK
IV	66	830	10,8	35,8	1,94	27	93

All indicators were determined according to the generally accepted standard method.

Devices and equipment for research:

Vitreousness: diaphanoscope "Yantar" (Russia);

Color: R3-BPL device (Russia);

Natural weight of grain: 1 liter purka PH-1 (Russia);

Humidity: drying cabinet SESH 3M (Russia);

Ash content: laboratory muffle furnace SNOL 8.2 1100 C (Russia);

Gluten content: U1-MOK-1M (Russia);

Gluten quality: IDK-5M (Russia);

A set of laboratory sieves and sieves RL-3 (Russia).

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Weighing was carried out on an electronic laboratory balance CASXE - 1500 (South Korea).

The samples were milled on a COMBINED Mill-Y 16 laboratory mill (Turkey).

The treatment and activation of water was carried out at the UZDN-2T installation (Russia) by exposure for 60 seconds at a frequency of 80, 100, 150 and 200 Hz.

Hydrothermal treatment was carried out in accordance with the Rules for the organization and conduct of the technological process in mills in three stages.

The amount of water required to achieve the required moisture content during grinding is calculated using the formula:

$$W = m\left(\frac{100 - w_1}{100 - w_2} - 1\right);$$

where m– grain sample weight, g;

w_1 – initial grain moisture, %;

w_2 – required grain moisture,%. (Ravshanov, Kodirov, Ramazanov, Musaev, 2019).

THEORETICAL JUSTIFICATION

The most significant volumetric part and the most important component of the composition of any food product is water and, accordingly, water has a significant effect on the quality, consistency and structure of the processed product (Golubeva, 2000; Volokhova 2003; Naumenko, 2007). The conditions for the interaction of organic substances with water in biological systems are determined by the structural energy state, which in a living cell is set by the conditions for diffusion of liquid through biological membranes (Abramov, 2000; Poland, 2002). When studying the processes of biological transformations in grain, it is necessary to take into account the constant variability of the structure of water due to the presence of many hydrogen bonds, which makes it the basis for all biophysical and biochemical processes (Shestakov and Volokhova, 2000). The nature of changes in the properties of water depends on its relative content in the product, in our case, in the grain. In accordance with this, “forms of communication” have been identified (Shestakov, 2003). Depending on the value of the binding energy, moisture in the grain is subdivided into crystalline hydrate (chemically bound), adsorption bound, and capillary bound (Shestakov, 2001). Due to intrasystemic hydrogen bonds, water has an associative structure (Fig. 1), since it consists mainly of associates rather than monomolecular water molecules, ie. most of the water is represented by unstable polymer structures of the (H2O) n type (Volokhova, 2003).[6-12]

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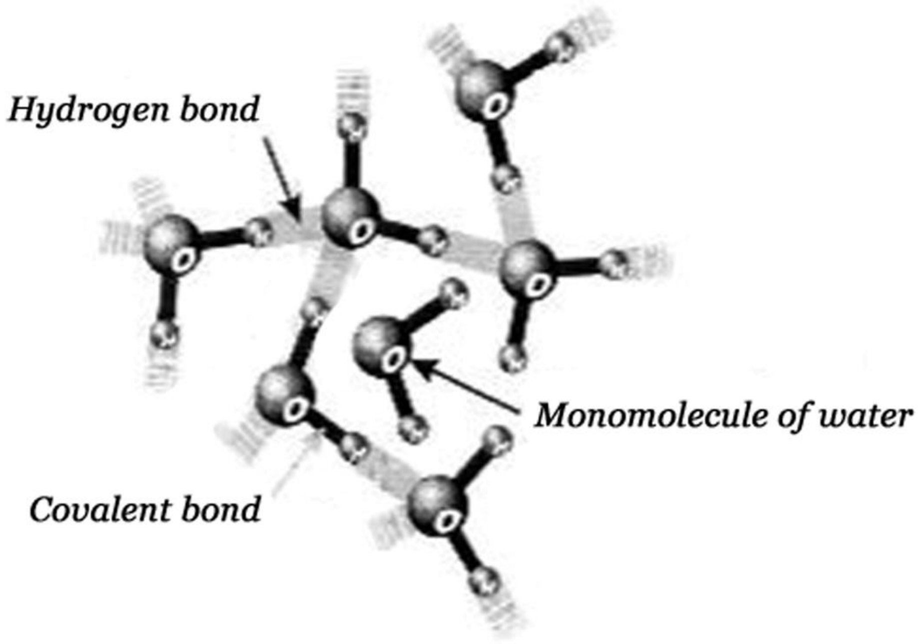

Fig. 1. Associative structure of water

The structure of water in the liquid phase is very unstable; therefore, external influences easily lead to a change in its physicochemical properties (Shestakov, 2002, p. 193). Water retains its structure if it is not influenced by factors with an energy exceeding the energy of a hydrogen bond. Water that is not part of the associates is called unstructured and can form bonds with other molecules.

Activated water molecules do not form bonds with molecules of other substances, from which it follows that the hydration activity of water depends on the ratio of microphases, which can change towards an increase in the unstructured monomolecular microphase by heating or other methods of destructuring (Shestakov, 2001; Naumenko, 2007).

There is a known activation method based on the phenomenon of cavitation integration, which makes it possible to obtain water with increased diffusion capacity (Ravshanov, Kholmuminov, Musaev, Baltaev, Ismatova, 2018.74-78pag). The method is carried out using a cavitation reactor. The source is powerful ultrasound emitted into an acoustically closed space filled with the medium to be treated (Shestakov, 2001). Ultrasound promotes the synthesis of hydrogen peroxide and changes the valence of ions of substances dissolved in water.[13-22]

The use of activated water for moistening grain accelerates the physicomechanical and biochemical processes occurring in grain and flour, therefore, it is important to study the processes occurring during the interaction of grain with water and compare the methods of grain conditioning in relation to improving the baking properties of the flour obtained from it

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(Ravshanov, Musaev ,Safarov, 2018; Ravshanov, Rakhmanov, Kodirov, Ramazanov, Musaev, Turdiev, 2020).

RESULTS OF THE STUDY

The introduction of new and improvement of existing technologies in the milling industry should ensure the rational use of wheat grain with an objective assessment of its baking properties. Therefore, one of the tasks currently facing researchers is to study the effect of activated water on the baking properties of flour (Ravshanov, Musaev, Safarov, 2018).

On the basis of the laboratory resources of the Tashkent Chemical-Technological Institute and the Bukhara Engineering-Technological Institute (Fig. 2), we carried out research, the results of which are shown in Table 2; 3; four.Таблица 2

Change in the natural weight of grain when treated with activated water

Watersample	Initialmoisture, %	Initialnature, g / l	1 hour	2hour	3hour	4hour	5hour	6hour	8hour
thecontrol	10,8	830	751	763	787	789	789	794	780
80 Hz	10,8	830	742	780	786	789	792	792	779
100 Hz	10,8	830	750	780	785	789	790	791	779
150 Hz	10,8	830	750	775	784	786	786	788	779
200 Hz	10,8	830	749	774	783	785	788	788	779

Table 3

Influence of activated water on the vitreousness of grain with different duration of heating

Watersample	Initialmoisture, %	Initialglassiness, %	Humidity / 1 hour	Humidity / 2hour	Humidity / 3hour	Humidity / 4hour	Humidity / 5hour	Humidity / 6hour	Humidity / 8hour
thecontrol	14	60	15/59	15,5/58	16/57	17/57	17/57	17,5/56	17/55
80 Hz	14	60	15/59	15,5/57	16/56	17/56	17/54	17,5/53	17/52
100 Hz	14	60	15/58	15,5/56	16/55	17/53	17/53	17,5/52	17/51
150 Hz	14	60	15/58	15,5/56	16/55	17/53	17/53	17,5/52	17/51
200 Hz	14	60	15/58	15,5/55	16/54	17/53	17/53	17,5/51	17/50

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As can be seen from the results shown in table. 2 and 3, intensive penetration of moisture into the grain is carried out by heating for 8 hours with water activated at a frequency of 100 Hz.

Next, let's consider the effect of activated water on flour quality.

The laboratory baking results are presented in Table 4.

Table 4

Effect of activated water on the baking quality of flour

Samples	Gluten, %	IDK, units	Color, units device RZ-BPL	Humidity,%	Bread volume, cm³	The porosity of the crumb, %	Mass of bread, gr
Untreated water	31	81	56,9	14,6	550	68	224,15
80 Hz	30	74,6	56	14,5	600	69,3	224,84
100 Hz	30	78,3	60,7	14,4	640	66	224,94
150 Hz	29	73,4	60,6	14,4	720	72	223,80
200 Hz	29	67,8	60,2	14,3	700	69	225,28

Analysis of the data (Table 4) shows that the change in the quality of flour obtained from grain treated with water, which has undergone acoustic cavitation activation in the process of preparing it for grinding, improves.

The increase in the whiteness of flour is explained by the more complete separation of the shells from the endosperm and the oxidative effect of oxygen obtained by the interaction of hydrogen peroxide with grain enzymes, which gives the flour bleaching effect (Ravshanov, Tsoi, Musaev, 2019).

The baking properties of flour mainly depend on the gluten content in the grain, its structural and mechanical properties, as well as the methods and modes of hydrothermal treatment. These properties are due to the strength of flour, its gas-forming ability, color, grinding size (Ravshanov, Rakhmatov, Musaev, 2019).

The main criteria are gas-generating and gas-holding capacity, which are clearly demonstrated by the results of test baking (Fig. 3).

The gas-forming ability of flour is the ability to form carbon dioxide during the fermentation of dough as a result of the activity of yeast and enzymes of the flour itself. This ability depends on the state of the carbohydrate-amylase complex, the presence of fermenting sugars in it and the ability to form them.

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Gas retention capacity is the ability to retain carbon dioxide formed during fermentation and it depends mainly on the quantity and quality of gluten. The efficiency of grain treatment with activated water during conditioning is explained by the properties of intensification of the diffusion activity of structured water and, as a consequence, the better separation of parts with increased amylolytic activity (Ravshanov, Kholmuminov, Musaev, 2018).[23-29]

The improvement in the baking properties of flour is explained by a change in the quality of gluten due to the oxidation of amino acids and glutathione by hydrogen peroxide and an increase in the water absorption capacity of flour. In this case, the activity of water structured under the action of ultrasound increases, as a result of which the ability to dissolve substances is intensified, more actively penetrating through the hydration shell of protein molecules. This process leads to an increase in the properties of the dough (Korchagin, 2000).

Thus, we have described the process of preliminary grinding of wheat grown in a dry climate for the production of flour of various varieties with high potential bread properties using hydrothermal treatment in combination with ultrasonic water treatment. Anomalous physical and chemical properties of water for preliminary processing of wheat grain have been studied. Methods of water activation using ultrasonic waves during hydrothermal treatment for preliminary grinding are proposed. The influence of various frequency modes of ultrasonic treatment on the physicochemical properties of water for the hydrothermal process of preliminary grinding of wheat grown in Uzbekistan was studied in the frequency range from 80 Hz to 43 kHz. In the case of hydrothermal treatment of wheat grains with low transparency, wetting up to 15% with water subjected to ultrasonic treatment at a frequency of 80-100 Hz turned out to be effective. This treatment has been studied to improve the yield and baking properties of flour (Ravshanov, 2020).[30-36]

Based on the foregoing, it can be assumed that the use of cavitation-activated water in grain conditioning will improve the efficiency of the use of grain resources.

Fig. 2. In the process of work

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Fig. 3. Results of test baking

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