ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Volume 10
Issue 1
2025

Google Scholar Crossref doi SLIB.UZ Scientific library of Uzbekistan

THE EFFECT OF STORING WHEAT GRAIN IN OPEN WAREHOUSES ON THE "AGING" PROCESS OF BREAD PRODUCTS

MUSTAFAEV OYBEK

Student of Tashkent State Technical University, Tashkent, Uzbekistan
Phone.: (0894) 577-0058, E-mail.: oybek.mustafayev1990@gmail.com

RAVSHANOV SUVANKUL

Docent of Tashkent State Technical University, Tashkent, Uzbekistan
Phone.: (0897) 156-4926, E-mail.: suvankulravshanov@gmail.com

DZHAKHANGIROVA GULNOZA

Professor of Tashkent State Technical University, Tashkent, Uzbekistan
Phone.: (0893) 506-1799, E-mail.: djaxangirova77@mail.ru

KANOATOV XAYRULLO

Docent of Namangan Institute of Engineering and Technology, Namangan, Uzbekistan
Phone.: (0897) 335-8086, E-mail.: kanoatov8086@mail.ru
*Corresponding author

Abstract: The article presents an analysis of the influence of wheat grain storage in open warehouses on the aging process of bakery products. The purpose of the studyduring the post-harvest ripening period of wheat grainohBread products stored in waste warehousesThe study consists of a comparative analysis of the effect of the “staleness” process. The AP - 4/1 penetrometer method, which characterizes the most widespread physical and mechanical properties, was used to assess the degree of staleness of bread. Closedgrain stored in warehouseThe volume of bread produced from the flour taken from the sample is 30 - 40 cm^3, the relative volume is 0.21 - 0.28 g/cm^3, the porosity of the kernel is 2 %, and the organoleptic quality of the bread is 3 - 4 points higher than the others, which indicates that storing wheat grain in closed warehouses during the ripening period after harvest is of great technological importance. It was found that the staleness of bread is related to the technological properties of flour. The interaction of starch and protein, which provide the technological properties of flour, reduces the rate of staleness, but is of less importance than starch retrogradation. The interaction of starch and protein, which provide its technological properties, reduces the rate of staleness, but is less important than starch retrogradation. The results of the researches show that it is advisable to store the flour used in the production of bread products in a closed way. Storage of the grain pile in a closed manner has a positive effect on the physical - mechanical and rheological parameters of the bread product and ensures greater microbiological stability during its storage.

Keywords: wheat, open warehouse, food, aging, bread, deformation, elasticity, kernel, physical mechanics, microflora.

Introduction. Reasonable and efficient use of wheat grain is the main foundation for ensuring food security of any country, which makes it possible to produce high-quality bread and flour confectionery products.

Improving the quality of grain and bakery products to the required level can be achieved, on the one hand, by increasing the quality of wheat grain, and on the other hand, by using it purposefully, rationally and effectively [1-2]. Thus, it is necessary to develop a technological regime that takes into account all the characteristics of wheat grain not only in its processing, but also in its storage. Therefore, today, one of the most urgent tasks is to search for innovative technologies aimed at saving raw material resources in the production of high-quality bread and bakery products and preserving

its physiologically valuable components to the maximum. Especially in the conditions of the Republic of Uzbekistan, where the population's consumption of bakery products is high, and the climate is very hot in the summer months, it is important to use effective technologies in production and effective methods of storage to extend the shelf life of bakery products. [3].

Among the factors that determine the technological properties of raw materials used in the production of bread and bakery products, the importance of the degree of microbiological deterioration and the quantity and quality of its chemical components L.Ya. studied by Auerman [4].

In the storage of bread products, it can increase the intensity of aging and the manifestation of diseases as a result of violation of sanitary-technological regimes in grain storage, processing, bread preparation and sale [5].

Saprophytic microflora, which accelerates the aging process during the storage of bread products, are present in any stored grain mass, and they are represented by: field microflora and storage microflora. Each of them has been analyzed for its effect on the microbiological processes occurring in grain masses during storage, on the quality indicators of raw materials and processed products [6]. This is explained by the fact that the grain contains a variety of nutrients, and is a favorable substrate for the development of microorganisms, the presence of which ranges from several hundred to several thousand per gram [7].

It has been established that the development of microorganisms leads to a decrease in the quality of wheat and other grains during storage, and changes in the number and species composition of microflora can vary depending on the conditions of their storage. It has also been noted that the causative agent of potato blight disease during the storage of bread products is the spore-forming bacteria Bacillus subtilis and their physiological and morphological variant Bacillus mesentericus, which accumulate mainly on the grain during the harvest period, dust, soil particles, and develop during the bread making process, leading to its spoilage [8]. Studies have shown that active amylolytic (including amylase) and proteolytic (proteinase, polypeptide) enzymes in potato blight lead to a change in the properties of bread dough, and are associated with a profound change in protein substances under the influence of proteolysis [7-8].

The intensity of microbiological contamination of wheat grain mass depends on soil-climate conditions, post-harvest processing technology, storage period and conditions (temperature, humidity and type of storage), grain surface cleaning quality, etc., was studied by L. Tokhtieva [9].

From the analysis of the above studies, it can be seen that one of the important tasks is to study the effect of post-harvest ripening and subsequent storage of wheat grain grown in the Republic of Uzbekistan in open warehouses on the microbiota of products obtained from it.

The effect of temperature on the mass fraction of gluten, glassiness, falling number, and fatty acid number during storage of wheat grain was studied [10]. According to it, the most significant changes in the quality parameters of soft wheat grain were noted at

temperatures of 30 and 40 ºC. That is, the mass fraction of gluten and glassiness of soft wheat grain decreased, and the falling number and fatty acid number increased [11]. Regression analysis of the obtained data allowed us to determine the dependence of these parameters on storage conditions, and the most favorable temperature regime was determined as 10 ºC [10]. A similar study was conducted, in which the temperature of the vertical layers of wheat grain mass stored in open warehouses during the post-harvest ripening period was determined for 120-150 days (at 9:00, 13:00, and 17:00). It was experimentally studied that on 22 of the first 30 days, the temperature at a depth of 5 cm in the vertical layer of a wheat grain heap exceeded 50 ºC, and the temperature at a depth of 30 cm exceeded 40 ºC [11].

The effect of groundwater microflora on the microbiota of flour, bran and bread products during the preparation of wheat grain for milling, storage aging, and flour yield and quality was analyzed. It was found that microorganisms such as molds and bacteria (Aspergillus, Penicillium, Fusarium) accelerate physiological processes, leading to hydrolysis of biopolymers and self-heating of the dough. This can lead to the production of mycotoxins that pose a threat to human health and reduce the ability to ensure sustainable food security [12].

The effect of using activated water in dough mixing and baking on the quality and microbiological deterioration of bread made from wheat flour has been analyzed [13-14]. According to it, the use of activated water as a cathode in the preparation of bread dough and as an anode in the treatment of the surface of baked hot bread products is of great importance in slowing down the development of potato disease and the formation of mold mycelium in the finished product, improving its microbiological safety [13].

It has been found that the contamination of grains and their processed products with microorganisms increases mainly due to storage (CFU/g·103*200) and the influence of dust and secondary raw materials generated during processing (CFU/g·103*70-200) [15-16].

The unpleasant smell of rotting potatoes, which is caused by the stretching, sticky, and foul-smelling crumb of bread, is caused by the action of sporulating microorganisms of the genus Bacillus mesentericus (potato sticks) and Bacillus subtilis (hay sticks) [17]. It has been established that in order to destroy the spores of Bacillus mesentericus (potato sticks) and Bacillus subtilis (hay sticks), it is necessary to expose them to steam at a temperature of 100 °C for 5-6 hours, at a temperature of 109-113 °C for 45 minutes, and at a temperature of 122-123 °C for 10 minutes. The fact that the spores of these microorganisms are completely destroyed by steam at a temperature of 130 °C was shown in this study [18]. It was found that the temperature of the bread crumb in the oven did not exceed 100 °C, as a result of which the spores of Bacillus mesentericus and Bacillus subtilis did not lose their viability during baking [19].

Studies have shown that lowering the storage temperature of bread from 37 °C to 25 °C can delay the disease for a certain period of time, while storing it at 16 °C can completely prevent the disease, and that high moisture content in bread is the main cause of its infection with potato blight [20].

The optimal temperature for the growth and survival of spores of Bacillus mesentericus (potato bacilli) and Bacillus subtilis (hay bacilli) is 35-50 °C [21], and the temperature of grain heaps stored in open warehouses in our Republic [11] indicates that these conditions are favorable for the development of these spores. Therefore, it is appropriate to conduct a comparative analysis of the effect of the microflora of wheat grain heaps stored in open warehouses during the post-harvest ripening period in our Republic on the microbiological indicators of bread products during storage.

During storage, the taste and aroma of bread change simultaneously with the physical properties of the crumb, and the loss of some odorous substances is associated with the decomposition of these substances in the flour, and the appearance of a characteristic taste and smell of stale bread has been reported in studies [22-24].

From the analysis of the above studies, it can be concluded that the storage of wheat grains in open warehouses during the post-harvest ripening period is important in accelerating the aging process of bread products. Hence the purpose of the studyduring the post-harvest ripening period of wheat grainohChanges in microflora during storage of bread products in warehousesIt was determined to consist of a comparative analysis of the impact on the "introduction" process.

Research methods. The most widespread methods for determining the degree of staleness of bread are based on determining the physicomechanical properties of bread. According to the presented method, the structural and mechanical properties of the core of bread products were determined using the automated AP-4/1 penetrometer and ST-2 structureometer [25-26]. In the structureometer device, rheological properties are measured using a strain gauge and various indenters attached to it, which are determined by the class of controlled parameters and the textural characteristics of the product. Methods for monitoring rheological properties are based on measurement parameters that reflect the dynamics and kinetics of the rheological behavior of the sample under study.

L. Ya. Auerman and M. G. Baciev noted that the total deformation index of bread crumb compaction (ΔN_{total}) determined by a penetrometer coincides with the organoleptic score of bread crumb compaction by tasters [27]. They calculated the ΔN_{total} values corresponding to each point of the five-point scale. The freshness indicators of the bread samples selected for the study were evaluated using the methods described above.

Research results and discussion. From the above analysis, it became clear that the influence of the technological regime of wheat grain storage on the aging process of bread products is of great importance. Also, slowing down the aging process of bread products is very important for regions with a hot climate, such as the Republic of Uzbekistan. Therefore, the effect of storing locally grown wheat grain samples in warehouses under various conditions on the aging of bread products was experimentally studied. In this case, the selected conditions for the study were open and closed, as well as"Don People's Food" JSC Samples taken from grain heaps stored in the open area of the enterprise for 80 days (from June 20 to September 9, 2024) were weighed on the CD 1 MILL (Chopin technology, France) device in the Food Technology Laboratory of the Tashkent Chemical

and Technological Institute according to the AFNOR/CEN/lSO standard (ISO 27971:2015) [28] and were subjected to the following tests according to GOST 27669-88 bread was baked and technological quality indicators were determined[29]. The results obtained from the experiments are presented in Table 1.

Table 1. The effect of storage of wheat grain in different warehouses during the post-harvest ripening period on the technological properties of bakery flour samples

Indicators	Sample bread was baked, bakery flour was weighed, warehouses where samples of wheat grains were stored		
	Open warehouse	In an open field in the mill area	In a closed warehouse
Bread volume, cm^3	650	640	660
Bread moisture, %	43.7	44.1	43.3
Bread's H/D index	0.52	0.51	0.54
Core porosity, %	67	67	69
Relative density of bread, g/cm^3	2.81	2.74	3.02
Core size, 0N	3.2	3.3	3.3
Evaluation of bread quality, score	72	71	75

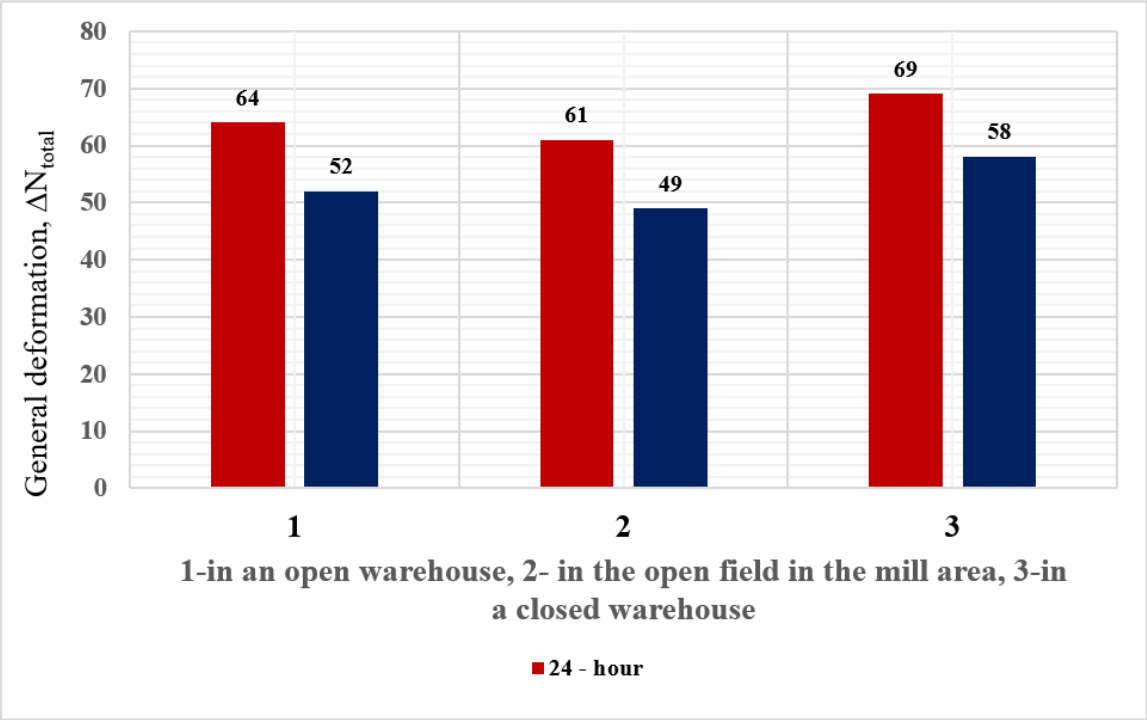

Figure 1. Changes in the penetrometric parameters of bread samples during storage

As can be seen in the table, closedstored in storageThe volume of bread produced from the sample flour was 20-30 cm^3, the relative volume was 0.21-0.28 g/cm^3, the kernel porosity was 2%, and the organoleptic quality of the bread was 3-4 points higher than the

others, which indicates that storing wheat grain in closed warehouses during the ripening period after harvest is of great technological importance. The results obtained were analyzed for their dependence on the aging process of bread samples. For this purpose, the rheological properties of bread samples stored for 24 and 48 hours after baking were measured in the AP-4/1 penetrometer information-measuring system. The results of the experiment conducted on the AP-4/1 penetrometer are presented in the graph in Figure 1.

The results of penetrometric studies are closed.stored in storageThe bread sample produced from the flour taken from the sample showed high overall deformation indicators. This confirmed the existence of a relationship between the bread volume, relative volume, crumb porosity and organoleptic indicators and the results of the penetrometric study, which are presented in Table 1, during bread aging.

Conclusion. It was found that the staleness of bread is related to its technological properties. The interaction of starch and protein, which provide its technological properties, reduces the rate of staleness, but is less important than starch retrogradation.

The results of the researches show that it is advisable to store the flour used in the production of bread products in a closed way. Storage of the grain pile in a closed manner has a positive effect on the physical-mechanical and rheological parameters of the bread product and ensures greater microbiological stability during its storage.

References

1. Влияние состава помольных смесей на выход и качество пшеничной хлебопекарной муки / М.В. Евсенина, Д.В. Виноградов, Е.И. Лупова, А.А. Пеньшин / / Известия Дагестанского ГАУ, 2020. - № 4 (8). - С. 16-20.

2. Качество пшеничной муки в зависимости от условий ее хранения / А.А. Пеньшин, Д.В. Виноградов, Е.И. Лупова, М.В. Евсенина // Экологическое состояние природной среды и научно-практические аспекты современных агротехнологий: материалы IV Международной научно-практической конференции. Рязань, 2020. - С. 329-334.

3. Ауэрман, Л. Я. Технология хлебопекарного производства: [учеб. для вузов по специальности "Технология хлеба, мучных кондитер. и макарон. изделий"] / Л. Я. Ауэрман. - Изд. 9-е, перераб. и доп. - СПб. : Профессия, 2005. - 415 с.

4. Медведев П. В., Федотов В. А. Факторы обсемененности зерна спорами Bacillus subtilis и Bacillus mesentericus // Вестник Оренбургского государственного университета. – 2011. – № 12. – С. 341-343.

5. Vaičiulytė-Funk, Lina & Žvirdauskienė, Renata & Šalomskienė, Joana & Sarkinas, Antanas. (2015). The effect of wheat bread contamination by the Bacillus genus bacteria on the quality and safety of bread. Zemdirbyste. 102. 351–358. 10.13080/z-a.2015.102.045.

6. Омельченко, В.Д. Зерна, поврежденные и испорченные микроорганизмами и самосогреванием как критерий санитарно гигиенического состояния пшеницы и кукурузы / В.Д. Омельченко Автореф. дисс. канд. техн. наук.

M., 1991. – С. 19.

7. Тохтиева Л.Х. Влияние самосогревания на хлебопекарные качества зерна озимой пшеницы сорта васса / Л.Х.Тохтиева, Э.А.Тохтиева // В сборнике: Вестник научных трудов молодых учёных, аспирантов, магистрантов и студентов ФГБОУ ВО "Горский государственный аграрный университет" Владикавказ, 2018. С. 149-151.

8. Tokhtieva L.Kh. Changes in Baking Qualities of Vassa Winter Wheat grain Because of the Violation of Storage Conditions / L.Kh.Tokhtieva, E.A.Tokhtieva // News of Science and Education. 2018. Vol. 12. № 6. С. 037-039.

9. Гурьева К.Б., Белецкий С.Л., Хаба Н.А. и Шилкова О.С. "Исследование влияния температурных режимов хранения на показатели сохранности и технологические показатели пшеницы" хранение и переработка сельхозсырья, no. 2, 2020, pp. 8-21.

10. Ravshanov S. Pardaev Z. and Ergashev A. (2024) "Effect of storage of wheat grains in open warehouses during post-harvest ripening on physico-chemical parameters,"Chemistry and chemical engineering: Vol. 2023: No. 1, Article 11. DOI: 10.34920/cce2023111.

11. Ravshanov S and Nurmatov I. (2024) "The study of physicochemical, microbiological and toxicological parameters of groundwater samples used in the process of geotechnical testing of wheat grain for varietal grinding," chemistry and chemical engineering: Vol. 2022: No. 4, Article 21. DOI: 10.34920/cce2022410. 60-65.

12. Васильева Н.В. Изменение химического состава воды при электрохимической обработке и ее влияние на сохраняемость хлеба и хлебобулочных изделий / II В Васильева // Экономика и социум на рубеже веков материалы межвузовской V научно-практической конференции - Челябинск - 2005. 18-20 с.

13. Равшанов С.С., Мирзаев Дж.Д. Влияние размера частиц муки, мелких и механически поврежденных зерен крахмала на функциональные свойства муки пшеничной хлебопекарной // Universum: технические науки. 2023. №1-3 (106).

14. Юсупов, Р.Х. Картофельная болезнь хлеба и способы её предупреждения / Р.Х. Юсупов, Б.А. Матвеев и др. // Материалы XLII научно-технической конференции ЧГАУ. – М., 2003. – С. 374.

15. Микробиологический контроль на хлебопекарных предприятиях / соек: Г.1. Юсупова, О.А.Сидорова, О Л. Тарутина, Р.Д. Поландока, О.В. Афанасьева. - М.: ГОСНИИХП, Московская типография №2. - 2008 г. - 334 с.

16. Setlow P. 2005. Spores of Bacillus subtilis: their resistance to and killing by radiation, heat and chemicals. Journal of Applied Microbiology, 101 (2006): 514-525.

17. Coleman WH, Chen D, Li YQ, Cowan AE, Setlow P. How moist heat kills spores of Bacillus subtilis. J Bacteriol. 2007 Dec;189(23):8458-66. doi: 10.1128/JB.01242-07. Epub 2007 Sep 21. PMID: 17890306; PMCID: PMC2168948.

18. Медведев П.В., and Федотов В.А.. "Факторы обсемененности зерна спорами Bacillus subtilis и Bacillus mesentericus" Вестник Оренбургского государственного университета, no. 12 (131), 2011, pp. 341-343.

19. Bosmans, Geertrui & Lagrain, Bert & Fierens, Ellen & Delcour, Jan. (2013). The impact of baking time and bread storage temperature on bread crumb properties. Food chemistry. 141. 3301-8. 10.1016/j.foodchem.2013.06.031.

20. György, É.; Laslo, É. Microbiological Quality Assessment of Some Commercially Available Breads. *Foods* 2024, *13*, 3271. https://doi.org/10.3390/foods13203271.

21. Cho, In & Peterson, Devin. (2013). Chemistry of Bread Aroma: A Review. Food science and biotechnology. 19. 575-582. 10.1007/s10068-010-0081-3.

22. Qhairul, Nor & Hansen, Åse & Petersen, Mikael. (2016). Volatile compounds in whole meal bread crust: The effects of yeast level and fermentation temperature. Food Chemistry. 210. 10.1016/j.foodchem.2016.04.110.

23. Raffo, Antonio & Carcea, Marina & Castagna, Claudia & Magrì, Andrea. (2015). Improvement of a Headspace Solid Phase Microextraction-Gas Chromatography/Mass Spectrometry Method for the Analysis of Wheat Bread Volatile Compounds. Journal of Chromatography A. 1406. 10.1016/j.chroma.2015.06.009.

24. Пучкова, Л.И. Лабораторный практикум по технологии хлебопекарного производства. 4-е изд., перераб. и доп. / Л.И. Пучкова - СПб.: ГИОРД, 2004. - 264 с.

25. Черных, В. Я. Лабораторный практикум по реологии сырья, полуфабрикатов и готовых изделий хлебопекарного и кондитерского производства / В. Я. Черных, А. С. Максимов - М.: ИК МГУПП. - 2004. – 163 с.

26. Ауэрман Л.Я., Васиев М.Г. Методы органолептической оценки качества пшеничного хлеба / В сб.: Научно-технический реферативный сборник. Серия 14. Хлебопекарная, макаронная, дрожжевая промышленность. М.: ПНИИТЭИпищепром, 1981. 35 с.

27. International Organisation for Standardization. ISO 27971:2015: Cereals and cereal products - Common wheat (Triticum aestivum L.) - Determination of alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology. ISO, Geneva, 2015.

28. ГОСТ 27669-88 Новвойчилик буғдой уни. лабораторияда текшириш учун нон ёпиш усуллари.

CONTENTS

CHEMICAL SCIENCES

TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING