# Preparing Mixes of High Dirtary Fiber Backed and Studying their Effect on the Storage Properties of Resulting Bread

**Abdulbasit F. Al Ali[1], Nawfal A. AlHelfi[2], Roudha M. Al Ali[3]**

*[1]Assist. Lecturer, M.Sc., [2]Prof. Dr., [3]Assist. Prof. Dr., Department of Food Science - University of Basra, Iraq*

## Abstract

Five types of grain available in local markets have been selected , viz : Barleys, Oat, Sorghum millet and wheat bran. They were milled in the form whole grain and replaced with proportions 5,10,15,and 20% of wheat flour extraction 72% with the control mixture 100% Wheat flour ştored at laboratory temperature and Cooling for 24-72 hours and studied the effect of dietary fiber on the changes that occur during storage and Staling. it was found that the moisture of the crust increase when storing at laboratory temperature for a period of 24 hours and the increase continued after 72 hours until the equilibrium state was reached. As for the Crumb moisture , sediment value, Swelling Power, pH, Electrical conductivity and turbidity decreased rapidly after 24 hours at both temperature and continued to decrease slowly after 72 hour. this is due to the occurrence of starch retrogradation the transformation of the starch from the amorphous state to the Crystalline state with loss of moisture in the bread crumb accompan by increase in the moisture content of the crust.

***Keywords:*** *Effect, Dirtary fiber, storage properties, bread.*

## Introduction

Bread is one of the staple and important foods in developed and developing countries. Because it is an important component of the human diets a sources of Carbohydrate, Proteins, minerals and vitamins [13] , bread is an important staple food made of wheat flour, salt and Yeasts, [6]. Bread Contains a wide range of important nutritional components which provide a positive effect on human health. The most important factor that was considered by researchers and manufactures was Producing bread high quality and long shelf life . Bread quality may undergo physical and chemical changes which called staling [5,7] These changes caused decrease of bread firmens , flavor losses, and resulting in product determination. This phenomenon is frequently attributed to starch reterogradation, a tern used denot partial recrystallization [8] . These changes differ from those that can occur to bread by the action of microorganisms [9].

Whole grain are used in the bakery industry to add dietary fiber which is important in reducing the risk of developing some chronic diseases such as diabetes and stroke (Wetlon *et al* ., 2005; Montonen *et al* .,2003) Colon Cancer, Obsity [10] .

Dietary fiber increases the absorption of the bread dough with water, which in turn helps preserve the thirst of bread for a long period of time during storage and reduce the accurrence of Staling.

## Materials and Method

The whole grain was ground into five types of available in the local market have been selected viz: Barley, oat, sorghum millet and wheat bran, replaced by the ratio,

15, 10, 5 and 20% from wheat flour 72% extraction. It is used to make four types of bread:

First mixture: 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

Second mixture: 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

Third mixture: 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

Fourth mixture: 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM**) .

**Storage Test**

**Staling tests**

**Moisture in the crumb and crust**

Moisture in the crumb and crust estimated according to the method mentioned in ACCC (2000).

**Estimation the Swelling Power in the crumbs**

The swelling power in bread crumb was determined to the method mentioned by AACC (1998) (20-50) with a weight of2 gram in 50 ml centrifuge tubes, added 20 ml distilled water, mix the contents well for 30 minutes, centrifuged the tube with sediment and determined this swelling Power from the equation :

Swelling Power = (A+ B) – D/ B

A: weight centrifuge tube.

B: weight of the sample.

D:weight the sediment with the tube.

**Determinations of pH**

pH values of the Crumb was measured according the method of AOAC (2007(.

**Electrical conductivity**

Electrical conductivity according to the methods described in Bales *et al*. (2011) [3] ,Weight 10 gm of the selected backed and added 75ml of distilled water, mix well for 15 minutes and left 60 minutes, The filtrate was drained in to a glass cylinder and electrode of the apparatus was immersed in the solution the reading was recorded in mili Moz, The final was taken from the product of the device reading in the correction factor in special tables.

**Turbiding**

Turbiding according to the method described in Sobolewskaand Fortuna (2010) [16]. added 75 distilled water to 10 gm from backed Crumb, Mix well for 15 minutes, left for one hour, the filtrate was drained into glass cylinder, take 5 ml from filtrate and put in tube for the device with the additions of 5 ml of distilled water, the tubs were closed tightly, the device reading recorded after the tubes were placed in NTU unite.

## Statistical Analysis

The experiments were performed in a completely randomized design . All experiments were conducted in triplicates and the mean values and standard deviations were reported. Analysis of variance) ANOVA) was performed and results were Separated using the Multiple Ranger Duncan's test ($p > 0.05$) using Statistical Software of Statistical Package for the Social Science (SPSS), Version 16 (SPSS Inc. New Jersey, USA(.

## Results and Discussions

**The effect of adding dietary fiber on the bread staling**

**staling tests**

**The effect of adding dietary fiber on the moisture content of the crust and Crumb of bread stored at different temperatures and time periods**

The tables (1) (2) showed the moisture of the crust and the crumb stored for a period of 24 and 72 hours at a room temperature and in a refrigerator at 5°C. Table (4-15) shows that there was significant differences ($p < 0.05$) in the percentage of moisture between the baked crust and control treatment. The results revealed an increase in the percentage of crumb moisture in the bakery products (WWbB,WWbBO,WWbOS, and WWbBOSM ).The

percentage of crumb moisture was 17.1 - 20.3 and 18.7 - 21.5% for WWbB,WWbBO,WWbOS and WWbBOSM respectively for a period of 24-72 hours at a room temperature and in a refrigerator at 5°C. The results also found an increase in the percentage of control sample compare to the bakery products. The moisture of the crust in in the bakery products increased faster within 24 hours of storage due to the migration of moisture from the crumb to the crust. In Contrast, the increase in the moisture became slower after 72 hours of storage.

**Table (1) moisture of crust in room temperature and cooling period 24-72 hours.**

| mixtures | moisture crust room 24 hour % | moisture crust room 72 hour % | moisture crust cooling.42 hour % | moisture crust cooling.72 hour % |
|---|---|---|---|---|
| control | 20.6 | 22.8 | 23.7 | 24.1 |
| 1 | 16.4 | 17.1 | 18.2 | 18.7 |
| 2 | 16.7 | 18.8 | 19.4 | 19.8 |
| 3 | 19.7 | 20.3 | 21.0 | 21.5 |
| 4 | 17.1 | 18.6 | 19.1 | 20.6 |
| LSD | 0.4 | 0.2 | 0.3 | 0.8 |

Control : 100% Wheat flour .

1-: 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3- 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4- 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM**).

Table (1-2) shows significant differences in the moisture of the crumb of the bakery products stored for a period of 24 and 72 hours at a room temperature and in a refrigerator at 5°C. The results noticed that the percentage of moisture of the crumb in the bakery products was decreased after 24-72 hours at a room temperature and in a refrigerator at 5°. The highest value of moisture was in the first sample 24.8%, which decreased to the 23.6 % after 24 hours at a room temperature. It continued to decline from 23.3% to 23.1% after 72 hours in a refrigerator at 5°C. It was also noticed that all the bakery products was better than the control sample of 23.5 and 22.1% after 24 hours at the room temperature to reach 21.6 and 21.2% in a refrigerator at 5°C after 72 hours of storage. The results also exhibited that the water content of the stored bakery products was decreased faster at room temperature for a period of 24 hours than the products stored in refrigeration after 72 hours.

The Tables (1) and (2) show an increase in the percentage of crust water content in the manufactured bakery products in the laboratory. Thereafter, the water content was decreased during the storage due to the addition of dietary fiber in different proportions that contain groups of hydroxyl that have the ability to The connection of water by forming the hydrogen bonds between the food fiber and the starch. This leads to a delay in the starch retrogradation, thus the bread retains its freshness for a longer period of time.

The process of amylopectin retrogradation in the starch is mainly responsible for the hardening of the bread crumb.

The phenomenon of staling is a major cause of spoilage of bread during storage, due to the transfer of moisture content from the crumb of bakery products to its crust until reaching a state of equilibrium in the moisture of the crust and crumb during the storage. Then, the transfer of moisture content stopped, which leads to a decrease in the moisture content of the baked crumb [1, 14]

**Table (2) Moisture of Crumb in room temperature and cooling period 24-72 hours.**

| mixtures | crumb moisture% room 24 hour | crumb moisture% room 72 hour | crumb moisture% cooling.24 hour | crumb moisture% cooling.72 hour |
|---|---|---|---|---|
| control | 22.5 | 22.1 | 21.6 | 21.1 |
| 1 | 24.8 | 23.6 | 23.3 | 23.2 |
| 2 | 24.2 | 23.3 | 23.9 | 22.6 |
| 3 | 23.8 | 22.6 | 22.3 | 22.0 |
| 4 | 22.9 | 22.7 | 22.6 | 22.4 |
| LSD | 0.6 | 0.3 | 0.2 | 0.4 |

Control : 100% Wheat flour .

1- 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3- 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4- 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM**)

**Effect of adding dietary fiber on the sediment volume and the pH to mixtures stored at different temperatures and for different time periods**

The results in Table (1-3) showed that there were significant differences in the sediment volume of the water crumb for the manufactured bakery products. The values of the sediment volume in the watery crumb for all manufactured bakery products decreased after 24-72 hours at a room temperature and in a refrigerator at 5°C. The bakery products of the first mixture significantly better than the rest of the bakery mixtures regarding the sediment volume after 24-72 hours at a room temperature and in a refrigerator at 5°C, followed by the bakery products of the second mixture. The results also indicated that the bakery products of all mixtures were significantly better that the control mixture after 24-72 hours at a room temperature and in a refrigerator at 5°C.Whereas, the results showed no significant differences between the bakery products of the first mixture and second mixture at room temperature for a 24 hours due to the high volume of the water crumb sediment. The decrease in the storage capacity to retain the moisture content during the storage period led to the possibility of the phenomenon of starch retrogradation and the shift from the amorphous state to the crystalline state with the possibility of water migration from the bread crumb to its crust. [15]

**Table(3). Sediment value in room temperature and cooling period 24-72 hour**

| mixtures | sediment Value room 24 hour- ml | sediment Value room 72 hour- ml | sediment Value cooling.24 hour- ml | sediment Value cooling.72 hour- ml |
|---|---|---|---|---|
| control | 72 | 70.3 | 68.4 | 66.7 |
| 1 | 77.5 | 75.2 | 73.8 | 72.1 |
| 2 | 77.0 | 75.0 | 73.5 | 71.4 |
| 3 | 72.0 | 71.2 | 69.7 | 68.1 |
| 4 | 74.0 | 74.8 | 72.0 | 69.3 |
| LSD | 1.21 | 0. 64 | 1.33 | 1. 57 |

Control : 100% Wheat flour .

1: -80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3- 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4- 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM**) .

The results of Table (1-4) show that there were significant differences in the pH values of the manufactured bakery products in the laboratory. These products showed a slight decrease in the pH values after 24-72 hours at a room temperature and in a refrigerator at 5°C. The pH of the bakery products of the first mixture was significantly higher among all mixtures. The values of all the bakery products increased compared to the control mixture. The results also were found that the pH of the bakery products mixtures was decline after storage for 72 hours. The pH was used to know what happens during the occurrence of the phenomenon of starch retrogradation and the shift from the amorphous state to the crystallized state. The phenomenon of bread flaking can be followed, as it is possible to follow up on the changes that occur in the starch by studying the effect of acidity on the properties of gels in starch [15]

**Table (4) pH of mixture in room temperature and cooling period 24-72 hour.**

| mixtures | pH - room 24 hour | pH - room 72 hour | pH - cooling . 24 hour | pH - cooling . 72 hour |
|---|---|---|---|---|
| control | 6.15 | 6 11 | 6.09 | 6.06 |
| 1 | 6.28 | 6.24 | 6.23 | 6.21 |
| 2 | 6.17 | 6.16 | 6.14 | 6.13 |
| 3 | 6.19 | 6.18 | 6.16 | 6.15 |
| 4 | 6.22 | 6.21 | 6.20 | 619 |
| LSD | 0.03 | 0.04 | 0. 02 | 0.01 |

Control : 100% Wheat flour .

1: 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3- 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4- 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5% Sorghum, and 5% Millet, (**WWbBOSM**).

**The effect adding dietary fiber on electrical conductivity and turbidity of mixture stored at different temperatures and time periods**

Table (5) shows significant differences in the electrical conductivity of the manufactured bakery products in the laboratory. The electrical conductivity of the manufactured bakery products was decreased after 24-72 hours at a room temperature and in a refrigerator at 5°C. The results showed that the highest electrical conductivity was the bakery products of the first mixture of 3.81 dS / cm, which then decreased to reach 3.73 dS/cm after 24 hours of storage at room temperature, while the electrical conductivity of the bakery products of the first mixture was declined from 3.64 dS / cm to 3.61 dS/ cm in a refrigerator at 5°C for a period of 72 hours. In contrast, the value of electrical conductivity of bakery products for all mixtures was higher the control sample at the same storage conditions. It is also noted that the electrical conductivity of bakery products for all mixtures decreased significantly after 24 hours at a room temperature and in a refrigerator at 5°C, while the decrease was slow after 72 hours. The electrical conductivity test is one of the main modern tests used to monitor the occurrence of the Staling of bread, as the electrical conductivity is a measure of the material's ability to pass the electric current. This test was used often to know the moisture content in the materials. Therefore, measuring the electrical conductivity in the crumb of the bread is an accurate measure of the shelf life of the bread (Saleh *et al*., 2016). This result was in agreement with Bales *et al*. (2011) [3] who found a clear decrease in the electrical conductivity in bagged and unpacked of bread during storage. Chintan and Nagaraju. (2010) mentioned that the electrical conductivity decrease was greater during a 24-hour due to the moisture content and its movement between the crumb and the crust until reaching equilibrium

**Tabte (5) Average electrical conductivity of mixtures stored at room temperature and cooling period 24-72 hours**

| mixtures | Electrical conductivity - room 24 hour dS / cm | Electrical conductivity - room 72 hour dS / cm | Electrical conductivity - cooling.24 hour dS / cm | Electrical conductivity - cooling.72 hour dS / cm |
|---|---|---|---|---|
| control | 3.50 | 3.10 | 2.90 | 3.71 |
| 1 | 3.81 | 3.72 | 3.64 | 3.62 |
| 2 | 3.69 | 3.64 | 3.60 | 3.59 |
| 3 | 3.62 | 3.58 | 3.47 | 3.43 |
| 4 | 3.61 | 3.57 | 3.52 | 3.45 |
| LSD | 0.04 | 0.11 | 0.12 | 0.08 |

Control : 100% Wheat flour .

1: 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3- 80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4- 75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM** .

Table (6) shows the significant differences in the percentage of crumb swelling power in the manufactured bakery products in the laboratory. The results observed that swelling power decreased with increasing the time of storage at a room temperature and in a refrigerator at 5°C. It also found that the swelling power of all bakery products at the room temperature for a period of 24 was 2.32 - 2.65%, which decreased to reach 2.24 - 1.38 after 24 hours at the same temperature. Whereas, the swelling power of the crumb after 72 hours in a refrigerator at 5°C reached 2.20 - 2.41 and 2.18 - 2.38%, respectively. The results showed that all mixtures of the bakery products had higher values compared to the control sample. The results were consistent with [8] who studied the swelling power of crumb in bakery products after storage for four days. They stated that the swelling power was decreased by 13.3% on the second day, while it decreases by 7% on the fourth day due to the occurrence of the staling of starch retrogradation and the shift from the amorphous state to the crystalline state.

**Tabte (6) Average Swelling Power of mixtures stored at room temperature and cooling period 24-72 hours**

| mixtures | Swelling Power room 24 hour | Swelling Power room 72 hour | Swelling Power cooling.24 hour | Swelling Power cooling.72 hour |
|---|---|---|---|---|
| control | 2.18 | 2.16 | 2.12 | 2.10 |
| 1 | 2.65 | 2.58 | 2.41 | 2.33 |
| 2 | 2.45 | 2.34 | 2.39 | 2.35 |
| 3 | 2.32 | 2.24 | 2.20 | 2.18 |
| 4 | 2.57 | 2.46 | 2.38 | 2.32 |
| LSD | 0.12 | 0.11 | 0.07 | 0.02 |

Control : 100% Wheat flour

: - 1 80% Wheat flour , 10 % Wheat bran and 10 % Barley flour.(**WWbB**).

2- 75 % Wheat flour, 5% Wheat bran, 5% Barley, and 15 % Oat flour.(**WWbBO**).

3-80% Wheat flour, 5% Wheat bran , 10 % Oat flour and 5 % Sorghum . (**WWbOS)**.

4-75% Wheat flour, 5%Wheat bran ,5% Barley ,5% Oat,5%Sorghum, and 5% Millet, (**WWbBOSM**).

Table (1-7) shows the significant differences in the average values of turbidity of the solution of the crumb of the manufactured bakery products in the laboratory. The results showed that the manufactured bakery products for mixtures were significantly superior to the control sample. The turbidity values for manufactured bakery products were 293 - 794 NTU and 234 - 701 NTU at a room temperature and in a refrigerator at 5°C after 24-72 hours. The results also found that manufactured bakery products for all prepared mixtures had higher values than the control sample of 307, 277, 246 and 227 NTU respectively at the same storage conditions. A significant decrease in the turbidity value of all bakery products was observed in the first 24 hours of storage, while the decline was slower after 72 hours of storage. The turbidity test can give an idea of the qualitative description of the Staling of retrogradation in the bread, and this test can also be used to know the effects of storage on this Staling and the extent of the effect of the Staling bread on stored bakery products, and this test was also used to find out the effect of adding Maltodextrins on the Staling of starch retrogradation [16]

## Conclusion

In conclusion, the results were consistent with [15] who confirmed an increase in the percentage of moisture in the crust after 72 hours of storage, whereas the percentage of crumb moisture, the volume of the watery crumb sediment, swelling power, pH, electrical conductivity, and turbidity were gradually decreased during the storage period. The reason for the decrease in the ability of the crumb to retain water was due to the occurrence of the staling of starch retrogradation from the amorphous state to the crystallized state and the transfer of water from the crumb of the bread to its crust, therefore, the occurrence of the Staling of bread increases when the swelling power, the size of the sediment in the crumb, pH, electrical conductivity, and turbidity decreases [15]

**Financial Disclosure:** There is no financial disclosure.

**Conflict of Interest:** None to declare.

**Ethical Clearance:** "All experimental protocols were approved under the Department of food science and carried out in accordance with approved guidelines".

## References

1. Abdul Aziz N, Bhat R, Azahari B. Storage studies of bread prepared by incorporation of the banana pseudo-stem flour and the composite breads containing hydrocolloids. CyTA-Journal of Food. 2014; 12(2): 141-149.
2. Arendt E, Ryan, L, Dal Bello F. Impact of sourdough on the texture of bread. Food Microbiology. 2007; 24: 165-174.
3. Bales J, Brenden T, Gibbons, R. White bread based on consumer preferences. Report submitted to the Faculty of the Worcester Polytechnic Institute. London. 2011.
4. Chintan, M, Nagaraju, J. Studies on electrical properties of wheat bread as a function of moisture content during storage. Sens. And instrument .Food Qual. 2010; 4: 61-66.
5. Collar, C, Rosell, C. Bakery and confectioneries. In: Chandrasekaran M, editor. Valorization of by products from plant-based food processing industries. Boca Raton: 1419 CRC Press, Taylor & Francis Group. 2013; 554-82.
6. Fan, L, Zhang, S. Evaluation of antioxidant property and quality of breads containing Auricularia auricula polysaccharide flour. Food chemistry. 2007; 101(3): 1158-1163.
7. Gray, JA, Bemiller, J. Bread Staling: Molecular Basis and Control. 2003.

8. Hojjati, M, Behzad, N, Hossein, J. Chemical Properties Changes of Barbary Bread during Storage. International Journal of Chemical, Environmental & Biological Sciences. 2013; 1: 2320-4087.
9. Katin, K. Sourdough. A tool for the improved flavour, texture and shelf-life of wheat bread. Faculty of Agriculture and Forestry, University of Helsinki, Finland, PhD Thesis. 2005.
10. Lairon, D, Arnault, N, Bertrais, S. Dietary fiber intake and risk factors for cardiovascular disease in French adults. Am J Clin Nutr. 2005; 82:1185–1194.
11. López, E, Pérez, G, Erramouspe, P. Effect of Brea Gum on the characteristics of wheat bread at different storage times. Food Science and Technology. 2013; 33(4): 745-752.
12. Montonen, J, Knekt, P Jarvinen, R, Aromaa, A, Reunanen, A.Whole-grain and fiber intake and the incidence of type 2 diabetes. Am J Clin Nutr. 2003; 77: 622–629.
13. Rosell, C. The science of doughs and bread quality. In Flour and breads and their fortification in health and disease prevention. Academic Press. 2011**;** 3-14**.**
14. Salehifar, M, Fadaei, V. Comparison of some functional properties and chemical constituents of dietary fibers of Iranian rice bran extracted by chemical and enzymatic methods. African Journal of Biotechnology. 2011; 10(80): 18528-18531.
15. Salih, E, Bayan Y. Study the preservation Properties and Microbial Quality of Bread and Flour Produced in Tikrit City. J. Of Takrit Uni. For Agr. Sci. 2016; 14(2).
16. Sobolewska-Zielinska, J, Fortuna, T. Retrogradation of starches and maltodextrins of origin various. Acta Sci. Pol. Technol. Aliment. 2010; 9(1):71-81.
17. SPSS .Statistical paekage for social science ,version 24 .User guide for statistical ,Chicago .USA. 2016.
18. Whelton, S, Hyre, AD Pedersen, B. Effect of dietary fiber intake on blood pressure: a metaanalysis of randomized, controlled clinical trials. J Hypertens. 2005; 23:475–481.