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STUDY OF RHEOLOGICAL AND SENSORY PROPERTIES OF SOFT WHEAT (*TRITICUM AESTIVUM*) AND GERMINATED PRODUCTS

Fatima Ali Fadel and Adnan Wahhab Habeeb Al – Mudhafar

Department of Food Sciences-Faculty of Agriculture - University of Kufa, Iraq.

Abstract

This study included the germination process of the soft wheat (*Triticum aestivum*) and the study of its Rheological and sensory properties. The wheat grains were soaked, germinated, dried, milled then sifted to separate the bran from the flour, where the soft wheat flour was used to prepare laboratory loaf bread and Rakak bread. Furthermore, the Rheological properties water absorption ratio, maturity period, and stability period were estimated by Farinograph device in the germinated soft wheat flour amounted to (54, 1.7 and 1.2), respectively, compared to soft wheat flour (65.8, 3.7 and 3.4), respectively. While the Rheological properties for three rest periods (90, 45 and 135) minutes were estimated by Extensograph, where the unit area in the germinated soft wheat flour was (18, 21 and 22) cm^2, compared to soft wheat flour that reached (35, 22 and 13) cm^2. The extensibility proportion was (91, 103 and 90) mm, while soft wheat flour reached (178, 174 and 143) mm. Moreover, the extension resistance in the germinated soft wheat flour was reached to (97, 116, 154) B.U and in soft wheat flour was (122, 82, 60) B.U. Other properties measured was the falling number, where it reached 62 seconds, while in the soft wheat flour reached to 403 seconds. Finally, the sensory evaluation results of the laboratory loaf test of the germinated wheat flour the final total reached 79.40 degree out of a total of 100 degree, while in Rakak bread the germinated soft flour wheat reached 28.30 out of 40 degrees.

Key words : soft wheat, germinated soft wheat, sensory characteristics, rheological properties.

Introduction

Wheat is the mainstay of the food for many peoples in the world, its cultivation date back to prehistory, which still as the most important grain in the world, its represent about 75% of the grain consumed in Iraqi meals (Saidi, 1983; Lookhart and Bean 1997). Wheat is one of the most important grain crops that used to produce various types of products because of its multiple types, as well as, providing calories from carbohydrates and proteins important to the vital activity of humans. The health benefits of whole-wheat grain consumption are associated with its rich nutritional fiber and bio- phytochemicals such as phenolic compounds, tocopherol, carotenes, and plant sterols. (Ktenioudaki *et al.,* 2015). Grain and legumes are usually handled by germination, fermentation or the use of sensible heat to increase the quantity or availability of nutrients, where the application of the germination process was modern because of the great interest in the nutritional and vital content of grains. As well as, improve the palatability of food and thus may lead the germination to a chemical, natural and sensory changes to increase health benefits and the desire to use whole grains with potentially widespread effects on the population level in alleviating harmful lifestyle diseases (Nelson *et al.,* 2013). The change in the rheological properties of the dough was due to the flour components of starch granules by 75-80% surrounded by a three-dimensional protein network (Weipert, 2006). Farinograph, mixograph and extensograph are the most common experimental tools used to characterize dough rheology, where these tests based on these tools are useful for providing practical information to the baking industries, while its not sufficient to explain the basic behavior of dough processing and bread quality (Janssen *et al.,* 1996; Miller and Hoseney, 1999). Finally, the aim of this study was to change the synthetic traits and its reflecting on the rheological and sensory properties of the germinated wheat.

Author for correspondence : E-mail: anynaldhkryat374@gmail.com

Materials and Methods

Preparation of wheat flour model

Wheat (*Triticum aestivum*), Ibaa 99 variety was obtained from local markets in Iraq that produced in 2017, where the wheat models were kept in the refrigerator (± 4°C) and then subjected to the following operations: Firstly, wheat purification from impurities manually (empty and broken seeds and suspended matter). Secondly, Germination Method, where Germination of soft wheat grains was carried out according to the method mentioned in (AACC, 2000). Where, the seeds were soaked before germination with tap water at a ratio of 1: 3 (grain: water) for 16 hours and then the seed germination was conducted in the incubator at 37°C away from light in trays containing cloth for 72 hours. Finally, the seeds washed and moisten from 2-3 times daily with water and after the end of the germination period, the seeds were washed and dried at a temperature (60-65°C) for (10-12 hours) in the convection oven with the hot air stream. The third stage during the preparation of the wheat flower mode was Determination of moisture in the germinated and non-germinated wheat grain models. The moisture content was estimated using the standard method of the American Association of Cereal Chemists (AACC,2010). Subsequently, Wheat grain models were moistened with tap water in two batches for 48 hours at room temperature to deliver humidity to 15% in closed containers, where, the amount of added water (ml) was calculated according to the following equation = The amount of added water (ml)=((100- model moisture) / (100-required moisture))-1) × the model weight. Furthermore, the models of moisturized wheat were milled by a laboratory mill from the German Brabender company, then the sieving process was conducted by a sieve its hole diameter of 150 microns. At the end, the resulting flour was kept in the polyethylene bags in the refrigerator at a temperature of -18°C until further testing.

Rheological Properties Test

The Farinograph test was carried out at the General Company for Grain Processing (Quality Control Department) according to the method mentioned in (AACC, 2000), where the water absorption ratio, maturity period and stability period were obtained. While the Extensograph Test was used according to the method mentioned in (AACC, 2000) to perform the Extensograph test, where the unit area, extensibility, extension resistance and maximum resistance was obtained. Finally, the Falling number test was conducted using the standard method (AACC, 2000), which is an easy and simple test that is used to read the activity of alpha-amylase enzyme.

Germinated soft wheat products

The Laboratory loaf bread preparation implemented by Straight Dough Method according to the method mentioned in (AACC, 2000, while the Rakak bread was manufactured according to the method described by (Halayatan, 2010). Moreover, the sensory evaluation form of laboratory bread was used as mentioned by (Zubaidi, 2009), and the sensory evaluation of Rakak bread was carried out, and the form was used as mentioned by (Al-Araji 2003).

Results and Discussion

The rheological properties of wheat flour under study

Water absorption ratio

Fig. 1 shows that the rheological properties of the germinated and non-germinated wheat flour that estimated by Farinograph device, where the water absorption ratio in wheat flour varieties (soft and germinated) was (65.8 and 54%), respectively. (Zain Al Abidine, 1979) observed that the water absorption ratio of wheat flour used in baking ranges between (50.7 - 61.1%), while (Maria *et al.*, 1995) indicated that the ability of whole-wheat flour to absorb water by 55-65%.

Maturity period

The maturity period of the germinated and non-germinated wheat flour was (4.9, 1.7) minutes, which is lower than (Al-Mahyawi, 2018) obtained within the studying the varieties of flour (Ibaa 99, Al-Rasheed, Tamus, Abu Ghraib and Turkish flour (Muaamel)). The ratio reached (8.2, 5.3, 5.5, 4.8, and 8.2) minutes respectively, but the results obtained in this study agreed with (Fadel *et al.*, 2010) findings, where the maturity period ranged between (1.5 - 8.43) minutes, and they observed that the decrease in wet gluten content in flour leads to a decrease in dough development period.

Stability Period

The stability period of wheat flour was (3.9, 1.2) minutes, respectively, where (Edwards, 2007) indicated that the stability period of soft wheat flour ranges between 3 - 5 minutes. This was consistent with the period of flour stability of the studied wheat varieties except the germinated soft wheat flour, which its stability period was low and this was consistent with the result of (Mahyawi 2018) about Abu Ghraib verity, which was 1.4 minutes. The stability period of the dough varies from one type to another, depending on several factors, including Gluten, protein percentage and genetic variation of grains (Rosell *et al.*, 2006) as shown in Fig. 2.

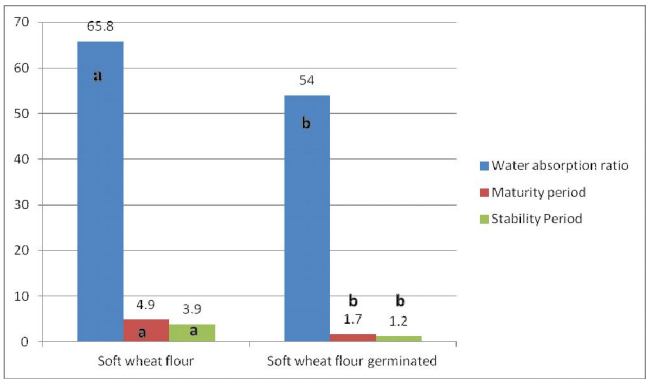
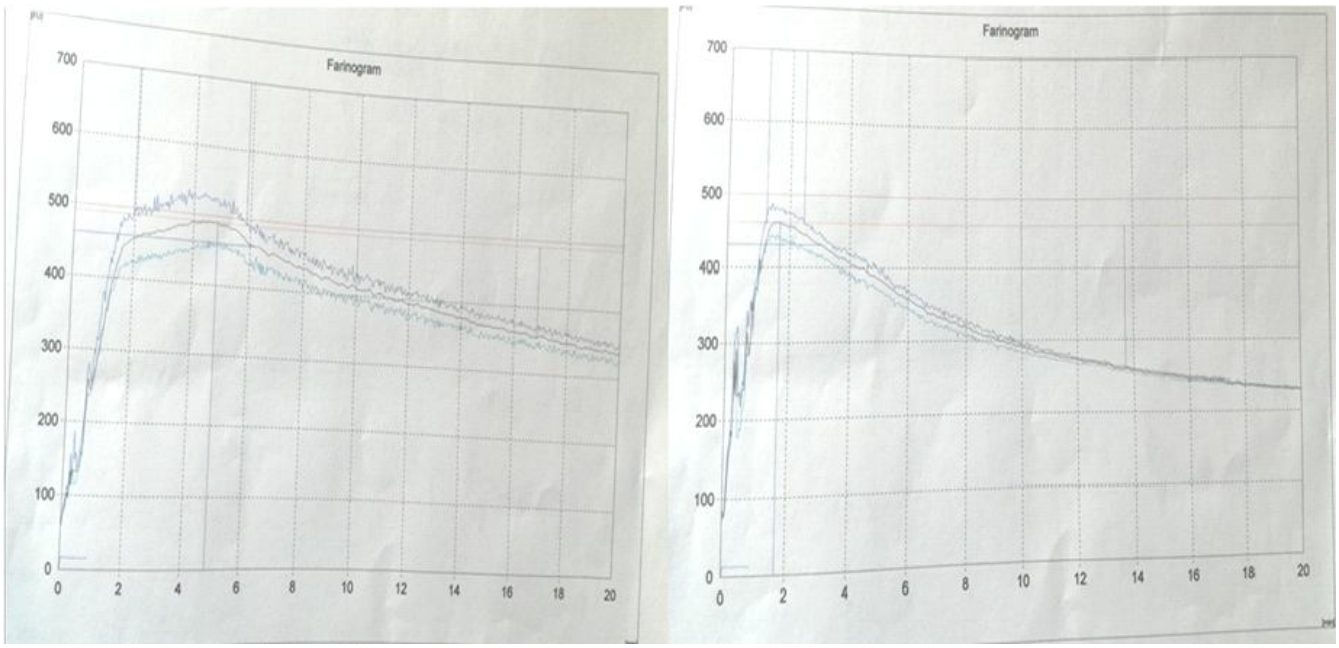


Fig. 1: The Rheological properties of wheat flour varieties estimated by Farinograph device.

the germinated in the rest period of 90 minutes, and the maximum resistance in the soft and germinated wheat at the rest period was 135 minutes.

Extension resistance

Table 2 showed that the extension resistance value in soft wheat flour was (122, 82 and 60) B.U at rest periods (45, 90, 135) minutes and the germinated soft wheat flour was (97, 116, 154) B.U, respectively. Moreover, the results showed that the extension resistance of soft wheat flour in the rest period was reduced by 135 minutes; this is due to the activity of protease enzymes as it works to reduce the resistance (Pomeranz and Matten, 1988).



A B

Fig. 2: Farinograph diagrams of wheat flour varieties under study
A: soft wheat B: germinated soft wheat.

Unit area

Table 1 showed that there were a significant difference in the unit area between the soft wheat flour and the germinated soft wheat flour when they measured with an Extensograph device. The soft wheat flour reached (35, 22, 13) cm^2 for rest periods (45, 90 and 135) minutes respectively, and in the germinated soft wheat flour (18, 21, 22) cm^2.

Maximum resistance

Table 1 showed that the maximum resistance in soft wheat was (127, 83 and 60) B.U respectively, at rest periods (45, 90 and 135) minutes and in the germinated soft wheat (227, 234 and 211) B.U respectively. It was observed that the dough maximum resistance was in the rest period 45 minutes in the soft wheat flour dough and

Extensibility

The results of Table 2 showed that the extensibility value in soft wheat flour at rest periods of (45, 60, 135) minutes were (178, 174 and 143) mm, respectively, and in the germinated soft wheat flour was (90, 103, 91) mm. Furthermore, it was observed from the results obtained, a decreasing in the extensibility value in soft wheat flour and the germinated at rest periods 135 minutes, and a decrease in the extensibility value in the germinated wheat flour less than in soft wheat flour. The decrease in the extensibility value may be attributed to the weakness of the gluten network in wheat flour wheat (Belitz *et al.*, 2009).

Extension resistance / Extensibility

Table 2 showed that the results of the extensibility

Table 1: Unit area, maximum resistance measured by Extensograph.

Variety	Area (cm^2)			Maximum resistance		
	Incubation period (min)			Incubation period (min)		
	45	90	135	45	90	135
Soft wheat flour	35a	22a	13a	127a	83a	60a
Germinated soft wheat flour	18b	21a	22b	227b	234a	211b

Table 2: Extension resistance, extensibility and extension resistance / extensibility measured by Extensograph*.

Flour varieties	Extension resistance (B.U)			Extensibility (mm)			Extension resistance / extensibility B.U/mm		
	Incubation period (min)			Incubation period (min)			Incubation period (min)		
	45	90	135	45	90	135	45	90	135
Soft wheat	122a	82a	60a	178a	174a	143a	0.7a	0.5a	0.4a
Germinated soft wheat	97b	116a	154b	91b	103a	90b	1.1b	1.1a	1.7b

($P<0.05$) *.

value obtained through the study in soft wheat flour at rest periods reached (45, 90, 135) minutes were (0.7, 0.5, 0.4) B.U / mm and in the germinated soft wheat flour (1.1, 1.1, 1.7) B.U / mm. It was observed that the extension resistance / extensibility variation during the rest periods in soft wheat flour, but it was similar in the germinated soft wheat flour at rest periods of 45 and 90 minutes, while in 135 minutes was higher at 1.7, and there was a significant difference between soft wheat flour (non-germinated and germinated). The results of germinated wheat were consistent with the results obtained by (Al-Jilawi 2017), as its result ranged between (1.0- 3.7) for the Al-Rasheed variety as shown in Fig. 3.

Falling number

The falling number is a test conducted for flour to estimate the activity of amylase enzymes in flour, which is an important test for measuring á-amylase enzyme activity. It can be observed from Fig. 2, that there were significant difference in the falling number value between the germinated wheat flour and non-germinated, as the falling number value of the germinated soft wheat flour is (62) seconds, after it was in the non-germinated wheat flour (403) seconds. The results obtained for the germinated wheat flour was consistent with the results obtained by (Ohm *et al.,* 2016) when the germination process was carried out on wheat for (72) hours, where the falling number was (62) seconds. While it was (450) seconds in the non-germinated wheat flour, the results obtained from the non-germinated soft wheat is almost agreed with (Abu Taha 1999) results, where it was ranged between (412-462) seconds.

Sensory properties of loaf bread produced from non-germinated soft wheat flour and germinated

The sensory and external properties of laboratory bread that shown in table 3 are specific properties to the consumer acceptability of the final baked product, especially with regard to the color of the crust of laboratory bread. It depends on the rate of non-enzymatic brown coloring (Maillard reaction), and which depends on the quality and quantity of reduction sugars and the presence of amino groups residual free in dough and the baking temperature (Ashoor and Zent, 1984; Fenemma, 1999). Table 3 also shows the degrees given for the qualitative size trait, crust color, form consistency, baking process consistency, pulp granulation, pulp color, pulp texture, taste and flavor, and the total between the first two treatments (loaf bread of soft wheat flour), which the sensory evaluation values reached (24.40, 8.20, 3.70, 4.00, 7.60, 7.0, 9.00, 15.10, 79.80) respectively. While the sensory evaluation of the second (loaf bread of germinated soft wheat flour), values were (21.20, 8.90, 4.30, 4.50, 8.00, 8.800, 7.30, 16.40, 79.40), respectively, are shown in the evaluation form mentioned in (Zubaidi 2009). There was a significant difference between the treatments, except for the pulp granularity and the form consistency, where there was no significant difference between these two treatments.

As well as, a significant decrease in the specific volume of the loaf bread was observed in the second treatment (loaf bread of germinated soft wheat flour). This means that increasing the protein amount in the germinated soft wheat flour is not an important factor affecting on the loaf size, but that the effect factor is the quality of protein (Shahzadi, 2005). The internal sensory qualities of the loaf are of great importance in quality evaluation, as well as, in the consumer acceptability, but there was no significant difference between the two treatments in the granularity pulp trait. As for the texture, the first treatment was superior to the second treatment, this was due to the high fiber content of the germinated soft wheat flour as indicated table 1, which led to water

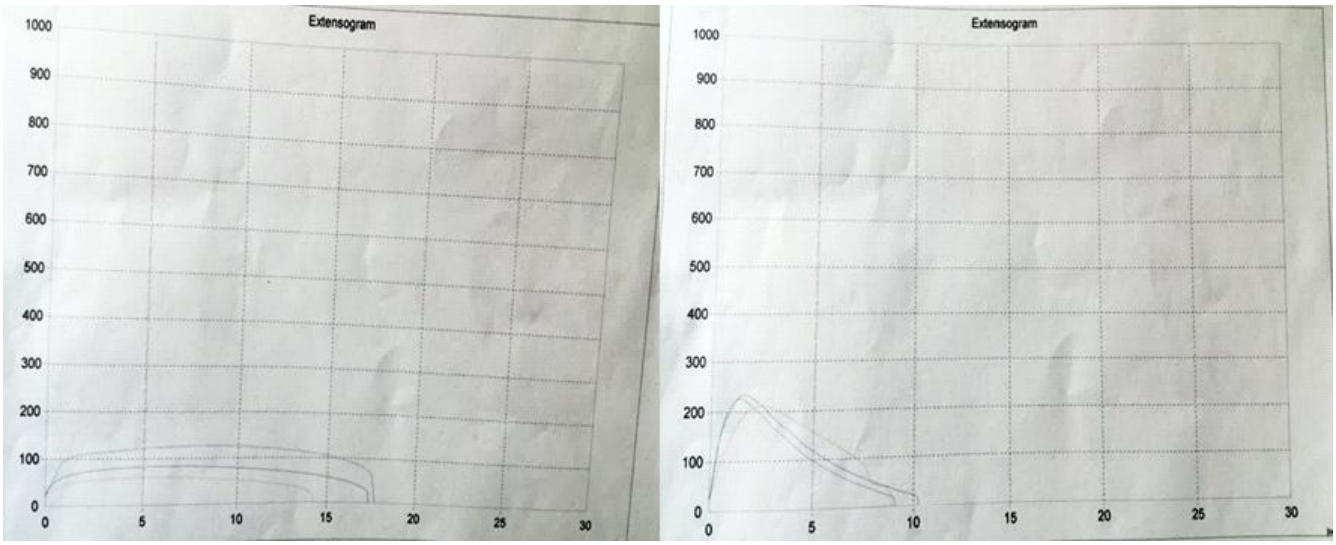


Fig. 3: Extensograph diagrams of wheat flour varieties under study
A: soft wheat flour B: germinated soft wheat flour.

Table 3: Sensory evaluation of loaf bread produced from the soft wheat flour and germinated.

Trait	Degrees	Treatments	
		T_1	T_2
Specific volume	30	24.40a	21.20b
Crust color	10	8.20a	8.90b
Form consistency	5	3.70a	4.30a
Baking process consistency	5	4.00a	4.50b
Pulp granulation	10	7.60a	8.00a
Pulp color	10	.807a	.808b
Pulp texture	10	9.00a	7.30b
Taste and flavor	20	15.10a	16.40b
Total	100	79.80a	79.40a

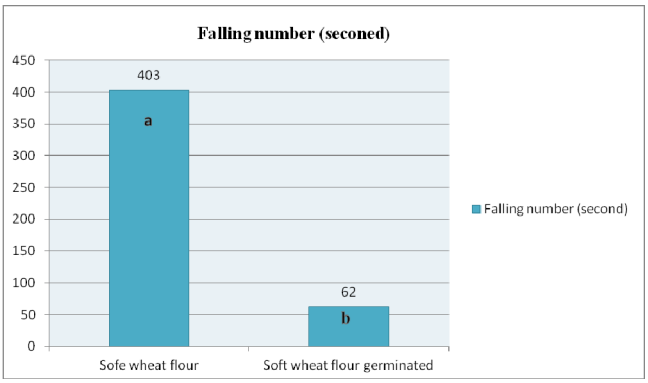


Fig. 4: Falling number / second of wheat flour under study.

Table 4: Sensory evaluation of Rakak bread produced from the soft wheat flour and germinated*.

Treatments	Taste 10 degrees	Color 10 degrees	Flavor 10 degrees	Texture 10 degrees	Total 40 degrees
First treatment	.007a	.008a	8.60a	.307a	.3030a
Second treatment	6.60a	.107b	7.60a	7.00a	28.30b

* Sensory evaluation: average degrees of ten evaluators.Vertically similar letters do not differ significantly at the level of significance (P <0.05).

retention and reduced its evaporation rate. Thereby, not allowing the pulp cells to expand, causing tissue values to be reduced (Sulaka and Zain AlAbidin, 1995).

The sensory properties of Rakak bread produced from the non-germinated soft wheat flour and germinated

Table 4 shows the sensory evaluation of Rakak bread was superior to the first treatment (Rakak bread of fine wheat flour) in which the sensory evaluation values of color, flavor, texture and total was (7.00, 8.00, 8.60, 7.30, 30.30), respectively. The second treatment of (Rakak bread from the germinated fine wheat flour) achieved (6.60, 7.10, 7.60, 7.00, 28.30), but it did not differ significantly over the second treatment except for the color as there was a significant difference between them, as the color of the germinated soft wheat flour by giving a darker color than the non-germinated soft wheat flour. This is due to the drying process carried out on the germinated wheat after the germination process ending. With regard to the degree of the final evaluation, which is the total degrees of evaluation, it was observed that the first treatment superior over the second treatment by obtaining 30.30 out of 40 degrees, while the second treatment achieved 28.30 degrees out of 40 degrees.

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