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Effect of wheat flour protein variations on sensory attributes, texture and staling of Taftoon bread

Efeito das variações proteicas da farinha de trigo nos atributos sensoriais de textura e envelhecimento do pão tipo Taftoon

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Abstract

The quality of flat breads depends in part on the textural properties of breads during storage. These properties are largely affected by flour protein quality and quantity. The present study aimed to examine differences between sensory properties, textural and staling of Tandoori breads made from flours of different quality and different quantities of protein. This was implemented by using three flours with 9.4, 11.5 and 13.5% protein contents and different protein qualities shown by Zeleney sedimentation volume 16.25, 22.75 and 23.25 mL respectively. Bread strips were submitted to uniaxial compression between two parallel plates on an Instron Universal Testing machine, and firmness of the breads was determined. Results indicated the differences in the sensory attributes of breads produced by flours of different protein content and quality, demonstrating that high protein high quality flours are not able to sheet and expand under the high temperature – short time conditions employed in Taftoon bread production and are therefore not suitable for this kind of bread. Results showed that flour with 11.5% protein content, produced bread with better sensory characteristics and acceptable storage time.
Keywords: *flat bread; protein; staling; texture.*

Resumo

A qualidade do pão tipo *flat bread* (pão sírio, pita, chapati, paratha, ataif etc.) depende, em parte, de suas propriedades de textura durante o armazenamento. Tais propriedades são amplamente afetadas pela quantidade e qualidade da proteína da farinha utilizada. Este estudo visa examinar as diferenças entre as propriedades sensoriais, textura e deterioração de pães Tandoori feitos de farinha com diferente qualidade e quantidade de proteína. Para isso, foram usadas três farinhas contendo 9.4, 11.5 e 13.5% de proteína e diferentes níveis de qualidade demonstrados por volumes de sedimentação de Zeleney: 16,25, 22,75 e 23,25 mL, respectivamente. Tiras de pão foram submetidas à compressão uniaxial entre duas placas paralelas em uma Máquina Universal de Ensaios Instron para determinar a firmeza do pão. Os resultados apresentaram diferenças nos atributos sensoriais dos pães feitos de farinha com diferente conteúdo e qualidade de proteína demonstrando que farinhas com proteína de alta qualidade não formam lâminas nem expandem sob alta temperatura – condições aplicadas na produção de pães Tatfoon, mas que não são adequadas para este tipo de pão. Os resultados demonstram ainda que a farinha com 11,5% de proteína produziu pão com as melhores características sensoriais e tempo de armazenamento aceitável.
Palavras-chave: *pão sírio; proteína; deterioração; textura.*

1 Introduction

Flat breads have been baked and consumed as a staple food for many centuries. More than 60 types of flat breads are made worldwide. There is a great diversity of bread types consumed in the Middle East. These breads are known by different names, such as Baladi and Arabic (Pita) in Egypt, Bouri in Saudi Arabia, Kmage and Taboon in Palestine, Arabic and Lavash in Australia and Souri in Libya and North Africa, etc. The most popular flat breads in the Middle East are baladi and Tandoori (Tooner or Taftoon). The most common Tandoori breads are Taftoon of Iran, Roti of Pakistan and Naan of India (HASHEMI; WOOTON, 1995). Distinction between Taftoon bread and some other flat breads is that it has only a single layer (QUAIL; MASTER; WOOTON,1991), round in shape (40-50 cm diameter) with general characteristics such as: flour extraction rate 82-84%, leavening agent yeast or sour dough, fermentation time 90 minutes, oven temperature 315 °C and baking time 2-3 minutes (FARIDI et al., 1982). Understanding the baking process and flour quality specifications in order to ensure greater consistency of product is one of the most important requirements in baking programs (QUAIL, 1996). Generally the bread making performance of wheat flour is governed by the quantity and quality of its proteins. Flours of high protein content often yield bread with good quality. However flours with the same protein content do not necessarily produce breads of similar quality (TOUFEILI et al., 1999).

Quail literatures on the relationship between flour quality and bread characteristics are focused on pan breads with loaf volume considered being the most important quality criterion but there are just a few investigations into flat breads. For pan

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breads made by a baking process optimized for each flour, there is a linear relationship between loaf volume and protein quantity but in flat breads protein quality is more important. Flat breads are baked from dough sheets which are often 1-3 mm thick (QUAIL et al., 1990). They have a short baking time about 2-3 minutes (FARIDI et al., 1982), thus the impact of gluten proteins on the end product characteristics may be different in flat breads compared with pan breads, which bake for longer and have sufficient time to expand (FAERGESTAD et al., 2000).

Martin, Zeleznak and Hoseney (1991) have been shown that generally the consumer acceptability of bread depends in part on its mechanical properties such as firming and staling. It was suggested that starch retrogradation, is also implicated in staling (MARTIN; ZELEZNAK; HOSENEY, 1991). Gluten and its interactions with starch may have a role in the staling process (ARMERO; COLLAR, 1998; ROA; NOSINIWITCH; CHINACHOTTI, 1992). A variety of tests may be used to assess changes in the cellular structure of bread during the staling process. Some measurement of mechanical properties is employed in shelf-life studies for assessing the product quality changes.

Mechanical compression tests can be used as a measurement for staleness (AHLBORN et al., 2005). Paulus (1986) reported that poorer sensory attributes, such as a less desirable crumb structure, a decrease in palatability and staling are more prevalent in low protein breads. In this respect sensory analysis is good but may not be sufficient on its own to characterize the staling process (PAULUS, 1986). Hashemi and Wooton (1995) studied Taftoon bread production and selected the optimum protein content and extraction rate for these breads (HASHEMI; WOOTON, 1995). Toufeili et al. (1999), studied the rule of gluten proteins in the baking of Arabic bread and indicated that highly elastic doughs derived from high quality gluten, are not compatible with the rapid expansion of gases under the high temperature – short time conditions employed in the baking of flat breads (TOUFEILI et al., 1999). Scalon, Sapirstein and Fahloul studied the bread quality of flours with different dough strength (SCALON; SAPIRSTEIN; FAHLOUL, 2000). Results showed that bread crumb structure of stronger doughs was stiffer and compressed less than the breads of weak doughs. Faergestad studied the baking performance of hearth bread and pan bread, using wheat flours with different protein contents and showed that effects of flour quality on bread characteristics were different for hearth bread compared to pan bread (FAERGESTAD et al., 2000). Aamodt, Magnus and Faergestad (2005) studied the effect of protein quality and content on Hearth bread characteristics and indicated that an increased amount of flour with strong quality improved Hearth bread characteristics to a larger extent than increased protein content (AAMODT; MAGNUS; FAERGESTAD, 2005).

The goal of the present work is to understand the flour protein quality and quantity requirements in order to ensure greater consistency of Taftoon bread quality and prevention of wheat flour waste which is the main ingredient for bread. The present work also reports on the effect of protein content and quality on the sensory attributes, firming and staling of Taftoon breads.

2 Materials and methods

2.1 Materials

Among different wheat flour samples, three flours with the same 87% extraction rate were selected. Flours had different protein contents 9.4, 11.5, 13.5% and different protein qualities evaluated by Zeleny sedimentation volume test varied from 16.25, 22.75 to 23.25 mL. These were used for experimental tests, and bread making. For the chemical analysis of flours potassium sulfate, copper sulfate, selenium, sulfuric acid 98%, bromophenol, lactic acid, isopropyl alcohol, potassium hydroxide were obtained from Merk. Chemicals were of the highest commercially available grade. Salt and yeast were purchased from a local market.

2.2 Experimental analysis

Protein, ash, moisture content, Zeleny sedimentation volume and farinograph tests were determined according to American Association of Cereal Chemists (AACC) procedures 46-12, 08-01, 16-44 A, 56-11 and 54-21 respectively (AMERICAN..., 2000).

2.3 Sensory evaluation

The quality of bread samples was evaluated by five assessors with extensive experience in scoring flat bread quality, especially Taftoon (Tandoori) bread quality, according to the confirmed sensory evaluation forms for flat breads (QUAIL et al., 1990).

2.4 Bread making quality

Wheat flours were baked using straight-dough method (approved method 10-10B AACC). The formula used to make breads is as follows: wheat flour (3000 g), bakers yeast 0.4%, sodium chloride 1.5% of flour weight and the optimum amount of water calculated from water absorption which was measured by farinograph. The doughs were mixed for 8 minutes in a Hobart mixer (C100, USA) and then fermented at 30 °C and relative humidity of 85% for 90 minutes. After fermentation, the dough was divided into pieces 250 (g/piece), benched for 15 minutes and then molded. The baking performed at about 315 °C for 90 seconds. Breads were stored at 25 °C, in polyethylene bags for 1, 3, 5, 7 days to determine the changes in firmness (AMERICAN..., 2000).

2.5 Bread firmness and staling

Strips (6×7.5 cm^2 area and 17 ± 1 mm thickness) were submitted to uniaxial compression between two parallel plates on an Instron universal Testing machine with probe diameter 34 mm using for compression tests according to AACC 74-09, load cell: 500 N, extension range: 8 mm, test end point: 6 mm, test speed: 25 mm/minute and maximum point in curves was read (AMERICAN..., 2000).

2.6 Statistical analysis

Results were subjected to analysis of variance (ANOVA). Differences were ascertained by Tukey test when F-values were significant.

3 Results and discussion

General composition analysis of wheat flours showed in Table 1.

Flours p_1, p_2 and p_3 were selected due to different protein quality and quantities. Ash content and falling number of flours had no significant differences and variations in moisture content were just for different environment humidity conditions and did not affect the flour specifications, but differences in protein content and quality were detectable and affected flour characteristics. p_1 had low protein content (9.4%) and quality (Zeleny volume 16.25 mL). p_2 and p_3 had different protein contents, 11.5 and 13.5% respectively but the same protein qualities which was shown by Zeleny numbers 22.75 and 23.25 mL respectively (Table 1).

As shown protein quality and quantity, affect farinograph parameters (Table 2). Water absorption of samples increased with increasing protein content. Water absorption in p_1 flour with protein content of 9.5 was 64.05% compared with flour p_3 with 13.5%, protein was 74.5% which showed significant difference. p_2 and p_3 with the same protein quality, showed different water absorption, around 66.05 and 74.5% respectively. Differences in the water absorptions of p_2 and p_3 were due to the different protein contents. Studies showed that higher protein quality as well as protein quantity, affect dough rheological parameters, but the effect of protein content on water absorption was more detectable. Dough development time and softening in p_2 and p_3 flours had no significant difference but dough resistance showed detectable difference, which was 3.62 and 4.5 respectively. This difference produced doughs with more elastic properties in p_3 compared with p_2, which was probably due to both higher protein content and quality in p_3 flour.

p_1 and p_2 flour had completely different protein quality and quantity, so their farinograph parameters showed significant difference. p_1 and p_3 flours also had the different protein (quality and quantity) and consequently much different farinograph parameters. Flours p_2 and p_3 showed different protein contents but the same protein qualities, which caused different farinograph parameters such as water absorption, and dough resistance.

Dough resistance was higher in p_3 compared with p_1 due to higher protein quality and quantity in p_3 which produced more elastic doughs with higher resistance.

Extensograph parameters showed that p_3 flour with protein content of 13.5% and high quality (Zeleny number 23.25 mL) had the maximum resistance to extension and D factor whereas p_1 flour with protein content of 9.4% and low quality (Zeleny number 16.25 mL) had the least resistance (Table 3). Faergestad showed that increasing protein content as well as protein quality significantly affect the doughs, increased farinograph and extensograph parameters but protein quality is a more important parameter (FAERGESTAD et al., 2000). p_2 and p_3 flours with the same protein quality but different protein contents, showed some different rheological properties and p_3 flour with higher protein content, produced stronger doughs.

Differences in dough characteristics, greatly affect bread texture and staling. Sensory analysis of breads was shown in Table 4. As can be seen, breads from p_2 flour had the maximum scores and breads from p_3 flour had the lowest scores. Dough made from p_3 flour was elastic and not suitable for especially flat breads. Quail et al. (1990) showed that difference exist between the protein requirements of pan breads and flat breads. In contrast to the liner relationship between protein content and loaf volume in pan breads, a parabolic relationship has been reported between protein content and flat breads quality, and protein quality had more important role in the production of such breads (QUAIL et al., 1990).

This difference could be attributed, at least in part to differences in dough characteristics and the time-temperature combinations employed in the baking of these bread types. Pan bread doughs have relatively lower surface area/volume rations, but flat breads are baked from dough sheets which are very thin (1-3 mm) and doughs must have ability to extend. (TOUFEILI et al., 1999).

MacRitchie, Kasarada and Kuzmicky (1991) reported that flat breads require shorter baking time as compared to pan breads and consequently doughs used for flat bread production must expanded fast during the short time of baking (MacRITCHIE; KASARADA; KUZMICKY, 1991). These finding indicate that elastic doughs are not compatible with the rapid expansion of

Table 1. Composition analysis of flours.

Sample	Main constituents				
	Moisture (%)	Ash (%)	Protein (%)	Zeleny volume (mL)	Falling number (seconds)
p_1	11.3[a]	1.3[a]	9.5[a]	16.25[a]	732[a]
p_2	11.4[a]	1.1[a]	11.5[b]	22.75[b]	733[a]
p_3	11.9[b]	1.1[a]	13.5[c]	23.25[b]	718[a]

*All values were means of three replicates; *In each column averages with the same characters (a, b) have no significant differences at 5% level according to Tukey test.

Table 2. Farinograph results.

Sample	Farinograph parameters			
	Water absorption (%)	Dough development time (minute)	Dough resistancy (minute)	Dough softening (20 minutes)
p_1	64.05[a]	1.875[a]	2.25[a]	117[ab]
p_2	66.05[b]	3.625[b]	3.62[b]	117[a]
p_3	74.50[c]	3.625[b]	4.50[c]	110[a]

*All values were means of three replicates; *In each column averages with the same characters (a, b) have no significant differences at 5% level according to Tukey test.

Table 3. Extensograph results.

Sample	Extensograph parameters		
	Resistance to extension (cm)	Extensibility (brabender unit)	D = R/E
p_1	106.66[a]	81.17[a]	1.31[a]
p_2	182.66[b]	129.72[b]	1.42[a]
p_3	210.00[c]	81.00[a]	2.60[b]

*All values were means of three replicates; *In each column averages with the same characters (a, b)have no significant differences at 5% level according to Tukey test.

gases during baking of flat breads. From another point of view, elastic doughs do not have ability to sheet. These properties adversely affect the structure in final product (GIOVANELLI; PERI; BORRI, 1997). As a result p_3 flour produced poor quality Taftoon bread and had the lowest score in sensory analysis (Table 4).

It was suggested that the sensitivity of flat breads quality to changes the elastic character of the dough is at the controlled of both protein quality and quantity and there is a threshold of protein (quality and quantity) beyond which a rapid decline in quality take place. Major questions of interest for flat breads are to find the optimum balance for protein content and protein quality. Both of them of course have to be within certain limitations. Faergestad showed that protein quality is also an important factor for flat breads as it was critical for the ability of the dough to retain proper shape during sheeting and shaping. This effect could not be compensated for by increasing protein content (FAERGESTAD; MOLTEBER; MAGNUS, 2000; ROELS et al., 1993).

Bread firmness and staling during different storage times were shown in Table 5. Bread firming and staling was measured by resistance of samples to compression force. As can be seen, in the first and second day of storage, breads from flour p_3 had the firmest texture among samples which was the consequence of leather – like breads produced from these strong flours. But with longer storage times (fifth day), breads from p_3 flour were softer than breads from p_1 and p_2, which showed the slower staling rate in p_3 due to higher protein content.

Table 4. Results of sensory analysis.

Bread sample from flours	Bread scores (1-5)
p_1	2.45^b
p_2	4.4^c
p_3	2.05^a

* In each column averages with the same characters (a, b,..) have no significant differences at 5% level according to Tukey test; *The score was from 0 to 5 with 5 being the highest quality.

Table 5. Bread firming during storage (using compression test).

Bread sample of flours	Bread firmness (N)			
	Day 1	Day 3	Day 5	Day 7
p_1	43.05^{ab}	96.86^b	232.3^b	199.25^b
p_2	38.69^a	88.55^a	200.1^{ab}	278.00^c
p_3	45.95^b	149.93^c	165.3^a	130.75^a

*All values were means of three replicates; *In each column averages with the same characters (a, b,..) have no significant differences at 5% level according to Tukey test.

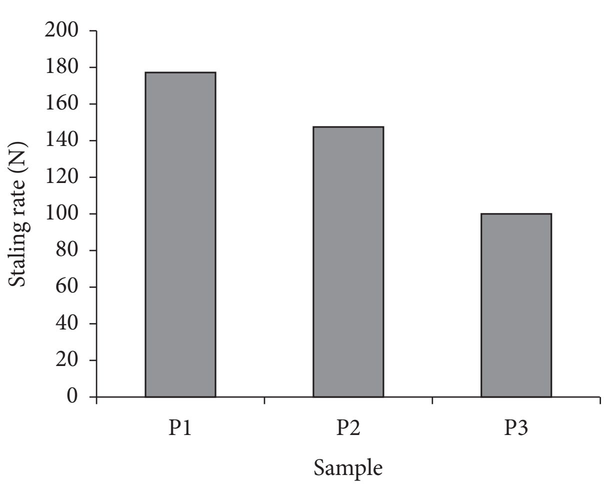

Figure 1. Firming rate of breads.

The firmness of p_1 and p_2 changed from 43.05 and 38.69 on the first day of storage to 232.3 and 200.1 on the fifth day of storage respectively, but the firmness in breads produced from p_3 flour changed from 45.95 on the first day to 165.3 on the fifth day of storage.

This fact indicated the lower rate of staling and firming in the breads with higher protein (quality and quantity). Fessas and Schiraldi (1998). showed that one of the reasons for decreasing in the perceived firmness of breads with higher protein during storage must be due to the dilution of starch that delayed retrogradation, but there is a positive relationship between protein content and water absorption (FESSAS; SCHIRALDI, 1998).

Flours with higher protein content have higher water absorption. Staling and firming of breads is supposed to depend on the moisture content, and in breads richer in water, staling was delayed (SCANLON; SAPIRSTEIN; FAHLOUL, 2000; PIZZA; MASI, 1995).

The staling (firming) rate of flours (calculated from the differences of firmness from fifth and first day of storage), was shown in Figure 1. This showed that the rate of staling in breads from p_3 flour with higher protein (both quality and quantity) was slower.

Decreasing bread firmness on the seventh day of storage was probably due to the deterioration of breads texture by molds. This fact indicates that seventh day storage was not suitable for flat breads because of the short storage time of these kind of breads, bread firmness up to fifth day of storage was important and measurements are based on this fact. In the cases of production of breads with longer storage time, using preservatives in bread formulation is necessary in order to inhibit texture deterioration by microorganism such as molds.

4 Conclusion

Results indicate that protein quality as well as quantity, affect dough rheological parameters, bread firmness and staling. Higher protein content caused flours to have more water absorption and other farinograph parameters were affected largely by protein quality. Flours with higher protein qualities produced stronger doughs. High protein quality and quantity in flours caused very strong flours. Studies indicated that high protein flours (more than 11.5%) with strong qualities are not able to sheet and expand during high temperature - short time conditions employed in the baking of Taftoon bread and produced poor quality Taftoon bread. Sensory analysis showed low scores (bread quality) in breads made from low protein flours which formed very soft and undesirable textures. Breads made from high quality flours proved to have low scores due to leather-like texture. These flours produced highly elastic doughs that are not compatible with sheeting and also rapid expansion of gases during short time baking of flat breads. These breads had poorer sensory attributes, such as a less desirable crumb structure, a decrease in palatability and staling. From another point of view, doughs from such flours are not suitable for all kinds of flat breads. Studied showed that more protein reduces firming and staling of bread during storage. Breads with higher protein content staled later than lower ones.

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