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Effect of different milling processes on Egyptian wheat flour properties and pan bread quality

E.S. El-Porai [a,*], A.E. Salama [b], A.M. Sharaf [b], A.I. Hegazy [b], M.G.E. Gadallah [c]

[a] Holding Company for Food Industries, Egyptian Milling Technology of Center, Cairo, Egypt
[b] Food Science and Technology Dept., Fac. of Agric., Al-Azhar Univ., Cairo, Egypt
[c] Food Science and Technology Dept., Fac. of Agric., Ain Shams Univ., Cairo, Egypt

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Abstract The effects of normal and hard milling and different conditioning times on flour properties of Egyptian wheat Sakha 94 and Gemmeiza 11 were studied. The dough rheological properties of resultant dough were evaluated using farinograph, alveograph and Rapid Visco-Analyzer (RVA) instruments. Data show that normal and hard milling of Gemmeiza 11 at conditioning time 12 h results highest wet gluten 30.1% and 29.5%, respectively, and recorded higher gluten index 96.5% and 96.1% by normal and hard milling at conditioning time 24 h, respectively. The higher damage of starch 7.59% and 7.14% were obtained by hard milling of wheat Sakha 94 at conditioning time 24 and 36 h, respectively. The granule surfaces of starches became damaged, flattened, scratched, cracked, rougher and less rounded at hard milling for both cultivars. The higher values of stability time 16, 15 and 14 min and lower degree of softening 20 BU were given by normal milling of wheat Gemmeiza 11 at conditioning times 36, 24 and 12 h, respectively. Data showed that the higher final viscosity 4969 and 3779 cp were obtained by normal milling at conditioning time 24 h and by hard milling at conditioning time 36 h of wheat Gemmeiza 11, respectively. It was seen that wheat Gemmeiza 11 resulting flour with normal milling at conditioning time 36 h had the highest loaf volume 1675 cm^3 followed by 1475 cm^3 was given by conditioning time 24 h. In addition the higher score of bread softness 114.0 and 110.20 mm were given by hard and normal milling at conditioning time 36 h for Gemmeiza 11. It could be concluded that pan bread produced from Gemmeiza 11 flour was found to have acceptable quality grade for all sensory characteristics than bread produced from Sakha 94 flour.

Introduction

Wheat is the leading cereal grains produced in the world, used for food (67%), feed (20%), and seed (7%). Durum and hard wheat contain more protein (12–16%) than soft wheat (8–10%) (USDA/NASS, 2001). Wheat flour producing by a combination of roll milling and sieving processes. Many varieties of wheat and many processing procedures are necessary in

* Corresponding author. Tel.: +20 01060484156.
E-mail address: EmadMilling@yahoo.com (E.S. El-Porai).

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order to produce commercial wheat flour for various uses (Tang et al., 2000).

The wheat kernel parts, bran, germ and endosperm, were differ in relative toughness and friability, giving different breakage patterns on roller milling. These differences are exaggerated by adding water to the wheat prior to milling, in a process known as conditioning or tempering (Sugden, 2001). Conditioning has five purposes: (i) to toughen the bran, reducing formation of bran powder; (ii) to soften the endosperm, enhancing its mill ability and reducing the power consumed by the reduction rolls; (iii) to facilitate separation of bran from endosperm, reducing the power consumption of the break rolls and consequently reducing evaporative losses; (iv) to ensure easy and accurate sifting of stocks; and (v) to ensure the endosperm moisture content is sufficient to give a final flour moisture content between 14% and 15%. However, the amount of water added and the time scale over which it is allowed to penetrate into the kernel vary widely in practice, with no conditioning regime universally appropriate for all wheat types and milling systems. Typically soft wheat conditioned to 15–15.5% and hard wheat to 16–16.5% (Posner and Hibbs, 1997)

Hard and soft wheat used for producing yeast-leavened bread and rolls as they form strong viscoelastic dough when mixed with water (Posner, 2000).

Starch represents 67–68% of whole wheat grain and between 78% and 82% of the flour which composed of amylose (26–28%) and amylopectin (72–74%) (Feillet, 2000). During milling, some starch granules are mechanically damaged. The degree of damage varies with the severity of the milling process and the hardness of the wheat kernel. Damaged starch granules absorb more water than non damaged starch and more susceptible to enzymatic hydrolysis. Both end-use and rheological properties of dough are greatly influenced by the level of starch damage (Faridi, 1990).

The pasting properties of flour are related closely to starch and also influenced by other flour components including proteins, pentosans and lipids as well as, added ingredients such as sugar, salt and α-amylase activity (Olkku et al., 1978).

Bread Staling includes all processes that occur in both crumb and crust during storage. The crust becomes soft and leathery due to diffusion of water from the crumb to the crust (Courtin and Delcour, 2002). The changes occurring in the bread crumb will result increase in bread firmness. Some theories suggested that bread firming was related to changes in amylopectin within the swollen starch granules (Schoch and French, 1974).

Therefore objective of the present study was to evaluate the effect of normal and hard milling, with different conditioning times on Egyptian wheat flour properties (Sakha 94 and Gemmeiza 11) and quality characteristics of pan bread.

Materials and methods

Materials

Two different types of Egyptian wheat (*Triticum vulgare*) were used in the study, First, Gemmeiza11, was obtained from Wheat Research Dept., Agricultural Research Station, Gemmeiza, Gharbia, Egypt. Second, Sakha 94, was obtained from Wheat Research Dept, Agricultural Research Station, Sakha, Kafr-El-Sheikh, Egypt. Instant active dry yeast, shortening, sugar (sucrose) and salt (sodium chloride) were purchased from the local market Giza, Egypt. All chemicals used in this study for chemical analysis were of analytical grade.

Milling experimental

Wheat samples (48 kg, based on 14% moisture) were-tempered to 16% moisture content for 12, 24 and 36 h. prior to milling through a Buhler, MLU-202, pneumatic mill by **AACC method 26-31 (2000)**. Two transactions for wheat grinding were conducted as in Table 1. Roll spacing was set mechanically using a feeler gauge. Extraction rate of each treatment was calculated as follows: Extraction rate = flour (g)/crude wheat (g) × 100.

Proximate chemical composition of wheat flour

Moisture, protein ($N \times 5.7$), ash, crude fat were determined according to **AACC methods (2000)**.

Gluten parameters, falling number and starch damage determination

According to standard **AACC methods (2000)**, Wet gluten and gluten index were determined using (Glutomatic perten instruments AB type 2200, Huddinge, Sweden) (**38-12**). Falling number of wheat flour was determined using (falling number AB instrument type 1402, No. 539 Stockholm, Sweden) **(56-81).** Starch damage of wheat flour samples was determined using SDmatic procedure (Chopin, Triplette et Renauld, Paris, France **(76-33).**

Granular morphology by Scanning Electron Microscopy

Scanning Electron Microscope (SEM) (JEOL JSM-5200, Tokyo, Japan) was used to study the structure of starch granules after milling conditions. A sample was adhered on a SEM mount using double-sided conductive adhesive tapes and sputter coated with 100–200 Å thick layer of gold (JEOL JFC-1600 Fine Coater, Tokyo, Japan). The mounted sample was then placed on the SEM stage and images were digitally captured at 20 kV with 1000–5000 magnification.

Farinograph test

Farinograph test was carried out to determine the effect of different milling conditions on dough rheology using a farinograph (type 810107, Brabender OHG, Duisburg, Germany) according to the standard **AACC methods 54-21 (2000).**

Table 1 Gap (mm) between roller mill used in normal and hard milling.

Treatment	Break stream			Reduction stream	
	B1	B2	B3	C1	C3
Normal milling	0.4	0.1	0.08	0.07	0.03
Hard milling	0.3	0.08	0.06	0.03	0.02

B: break stage, C: reduction stage.

Parameters measured were water absorption, development time, dough stability, mixing tolerance index and degree of softening.

Alveograph test

Dough elasticity (*P*), dough extensibility (*L*), swelling index (*G*) and work (*W*) were determined by means of the Chopin MA 82 Alveograph according to the standard **AACC method 54-30A (2000).**

Rapid viscosity analysis test

Viscoelastic properties of wheat starch were examined using a Rapid Visco Analyzer-4 (Newport Scientific, Australia) according to **AACC method 76-21 (2000).**

Pan bread processing

To study the effect of different milling processes on the quality of pan bread, the straight dough process was performed in pan bread preparation according to the method as described by Curie et al. (2002). The ingredients were: 100 g wheat flour, 1.5 g instant active dry yeast, 2.0 g salt, 2.0 g sugar, 3.0 g shortening and water (according to farinograph test). All ingredients were placed in a mixing bowel at 28 ± 2.0 °C and mixing for 6 min, after mixing, the formulated dough was rounded manually by folding for 20 times, then the bulk dough was leaved to rest for 10 min. The prepared dough (120 g) was placed in lightly greased a baking pan ($5 \times 9 \times 8$). The dough were proved for 80 min in a cabinet at 30 ± 0.5 °C and 85% relative humidity then baked for 20 min at 250 °C in an electrical oven. Before measurements, the baked breads were cooled for 60 min at room temperature (25 ± 2.0 °C) and then packed in polyethylene bags and stored for 6 days at room temperature (25 ± 2.0 °C).

Physical properties of pan bread

Bread loaf weight (g) was recorded after cooling for 1 h, bread loaf volume (cm^3) was determined by rape seed displacement method as described by AACC (2000). And specific volume (cm^3/g) of bread was calculated by dividing volume by weight.

Sensory evaluation of pan bread

Sensory properties of pan bread were evaluated after cooling by semi training staff members of the Egyptian Baking Technology Center, Giza, Egypt for shape, crust color, crumb texture, crumb color, taste and overall acceptability according to the method described by Pyler (1973).

Struct-o-graph method

Compressibility (softness) of pan bread loaves was determined as follows: the testing bread sample ($6.5 \times 4.2 \times 1.0$ cm) was rested on the sample holder and moved by the table toward a cutter which in connected to a force measuring unit and exits a force on the bread sample. The penetration force is mechanically transmitted to a chart recorder. The area under curve was measured indicating the information about elasticity of the sample. The potentiometer fine adjustment was used at a travel speed of 100 mm/min. the calibrated spring of 500 p were used for measurement (Penfield and Campbell, 1990). The curve drawn indicated the compressibility (softness) represented the length of the curve in (mm) from the start until the top of the curve.

Percentage change in compressibility was calculated from the following equation.

Statistical analysis

Statistical analysis was performed using one way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test with ($P < 0.05$) degree being considered statistically significant. Statistical analyzed were made using the producer of the SAS software system program (SAS, 1997).

Results and discussion

Proximate chemical composition and rate of extraction of wheat flour

Results in Table 2 show that, hard milling for both cultivars gave the higher extractions rate when compared with normal milling. This is agreed with Haque (1991) who reported that decreasing of roll gap increases the grinding zone size, thereby prolonging the grinding action. This also contributes to the increase of the flour yield, while under dominating compressive forces. It could be observed that the higher extraction rate by hard milling at conditioning time 12 h of wheat flour Sakha 94 and Gemmeiza 11 was 72.9% and 72.8%, respectively.

It could be noticed that wheat flour resulting from 36 h of conditioning time had the higher moisture content at normal milling for wheat flour Gemmeiza 11% was 13.9%. Hard milling for both cultivars gave the higher ash content when compared with normal milling. These results are reflecting with Scanlon et al. (1988), who pointed out that roll gap had no influence on flour ash content. The higher protein content 13.54% was found by hard milling at time 12 h following by 13.04% at 24 h conditioning time of Gemmeiza 11.

Regarding fat content, no significant ($P \leqslant 0.05$) difference was found between hard and normal milling for both wheat cultivars.

Results in Table 3 showed that the highest wet gluten 30.1% and 29.5% were given by normal and hard milling at conditioning time 12 h of wheat flour Gemmeiza 11, respectively. For gluten index, High gluten index 96.5% and 96.1% was recorded by normal and hard milling at conditioning time 24 h of wheat flour Gemmeiza 11, respectively.

It could be observed that normal milling at conditioning time 12 and 24 h of wheat flour Sakha 94 had the highest value of falling number 495 and 472 s, respectively. Falling number test affected by endosperm quality and susceptibility of starch to α-amylase i.e. the ease of starch gelatinization and accessibility to enzyme activity (Best and Muller, 1990).

It could be observed that normal milling at conditioning time 12 and 24 h of wheat flour sakha 94 had the highest value of falling number 495 and 472 s, respectively. Falling number test affected by endosperm quality and susceptibility of starch to α-amylase i.e. the ease of starch gelatinization and accessibility to enzyme activity (Best and Muller, 1990).

Table 2 Proximate chemical composition and rate of extraction of wheat flour[a].

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Extraction	72.0	68.5	69.8	72.9	69.3	72.8	72.1	70.9	70.2	72.8	71.9	71.0
Moisture	12.8^{g}	13.7^{b}	13.5^{e}	12.2^{h}	13.2^{f}	13.2^{c}	12.8^{g}	13.3^{d}	13.9^{a}	12.2^{i}	13.2^{f}	13.5^{c}
Ash	0.57^{e}	0.53^{f}	0.54^{f}	0.66^{b}	0.68^{a}	0.64^{b}	0.57^{e}	0.57^{e}	0.54^{f}	0.62^{c}	0.64^{b}	0.60^{d}
Protein($N \times 5.7$)	9.89^{i}	9.92^{i}	9.81^{j}	10.15^{h}	10.36^{g}	10.13^{h}	12.31^{e}	12.4^{d}	11.96^{f}	13.54^{a}	13.04^{b}	12.95^{c}
Fat	0.98^{ed}	0.99^{d}	0.99^{d}	0.98^{e}	0.99^{ed}	0.99^{ed}	1.29^{c}	1.30^{ba}	1.31^{a}	1.28^{c}	1.29^{bc}	1.30^{a}
NFE	88.56^{b}	88.56^{b}	88.65^{a}	88.21^{d}	87.97^{e}	88.24^{c}	85.83^{g}	85.73^{h}	86.18^{f}	84.55^{k}	85.03^{j}	85.14^{i}

Values followed by the same letters in the same raw are not significantly different ($P \leqslant 0.05$). Data are mean, of three replicates.
[a] Expressed on 14% moisture basis. **NFE:** Nitrogen Free Extract.

Table 3 Gluten parameters, falling number and starch damage determination of wheat flour.[a]

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Wet gluten	26.1^{c}	25.9^{c}	25.8^{c}	25.5^{c}	25.4^{c}	25.9^{c}	30.1^{a}	28.6^{b}	28.5^{b}	29.5^{a}	28.3^{b}	28.2^{b}
Gluten index	87.9^{bc}	85.7^{c}	87.5^{bc}	85.6^{c}	86.2^{bc}	86.1^{bc}	90.9^{bac}	96.5^{a}	95.9^{a}	92.3^{ba}	96.1^{a}	95.8^{a}
Falling number (s)	495^{a}	472^{b}	420^{c}	396^{ed}	379^{e}	389^{ed}	399^{d}	391^{ed}	387^{ed}	347^{f}	338^{gf}	328^{g}
Damage starch	5.99	7.1	6.62	6.94	7.59	7.14	3.41	3.74	3.54	4.54	4.08	3.62
Absorption of iodine	95.6	97.1	96.5	96.8	97.6	97.1	92.3	91.7	91.9	93.6	92.09	92.9
Rapid absorption	40	27	39	31	20	23	74	96	78	69	56	54

Values followed by the same letters in the same raw are not significantly different ($P \leqslant 0.05$). Data are mean, of three replicates.
[a] Expressed on 14% moisture basis.

The higher damage starch 7.59% and 7.14% were obtained by hard milling at conditioning time 24 and 36 h of wheat flour sakha 94, respectively. These observations are in agreement with the results obtained by Scanlon et al. (1988) who mentioned that the increased compressive stress causes more starch damage.

Data showed that the higher absorption of iodine 97.6% and 97.1% and lower absorption rapid 20 and 23 s. were given by hard milling at conditioning times 24 and 36 h of wheat Sakha 94, respectively.

Microstructure of wheat starch granules

During the milling process, starch granules are subjected to various forces such as compression, impact, shear, and attrition that are likely to cause physical breakdown of granules, producing a range of fractions (Karkalas et al., 1992; Morrison and Tester, 1994).

Scanning Electron Micrographs (SEM) of wheat flour starch obtained from normal and hard milling at 12, 24, 36 h conditioning times are shown in Figs. 1 and 2. Through milling processes, wheat starch granules remain intact and durable enough for SEM evaluation.

Starch granules showed well defined with diverse size, and showed that the surrounding structures. The field of wheat starch granules contains both A (large > 10 μm) and B (small 2–10 μm) granules. Showing where B granules, protein bodies, and other cellular components were packed tightly together in the wheat endosperm. Wheat starch granules showed bimodal size distributions.

Angold (1975) reported that the starch granules were characteristically embedded in the matrix structure of proteins and soluble solutes. Two distinct populations of starch granule sizes could be envisaged, ones with lenticular shape and the others smaller and with spherical shape, which agree with previous reported two populations of A and B-type of starch granules.

In normal milling, the wheat starch granules are native, had a smooth surface with no fissures and few surface markings. With the increase in the conditioning time the starch granules structure became more distorted surrounding structures. In most of the samples showed numerous granule fragments adhering to granules. Indentations are clearly visible of the starch granules, when normal milling of wheat flour Gemmeiza 11 at 12 and 36 h. When normal milling of wheat Gemmeiza 11at 36 h conditioning time was characterized by having a continuous structure appeared disaggregated and the starch granules were clearly identified.

Drastic changes were observed after hard milling whereas the starch granules structure became more damaged as the pressure roller mill level increase. The hard milling undergoes changes in size and shape of wheat starch granules. Smaller granules were obtained after hard milling, and thus note the number of B-granules appeared to exceed the number of

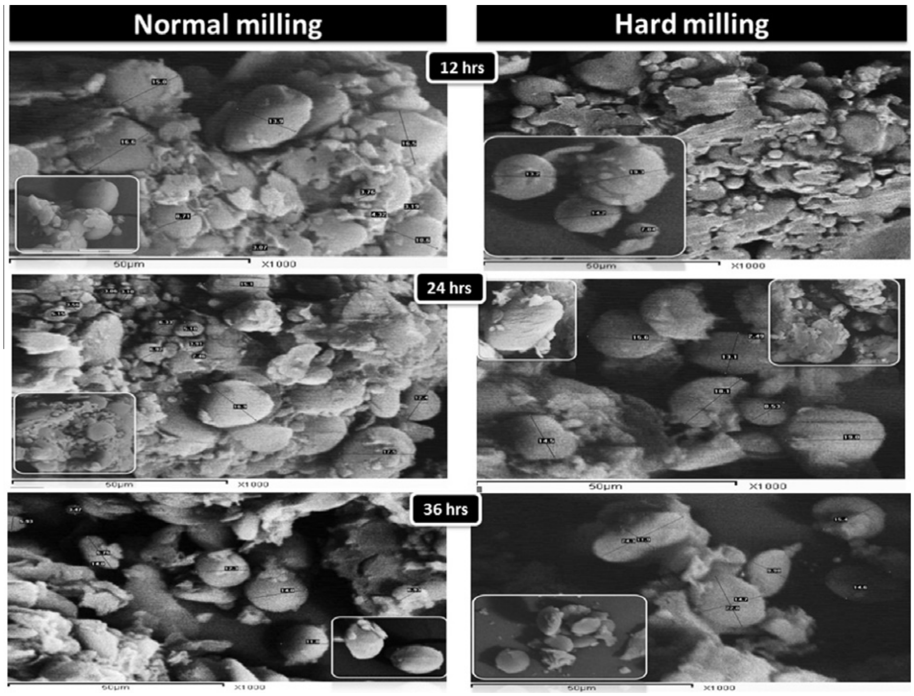

Fig. 1 Scanning electron micrographs (SEM) of wheat starch Sakha 94.

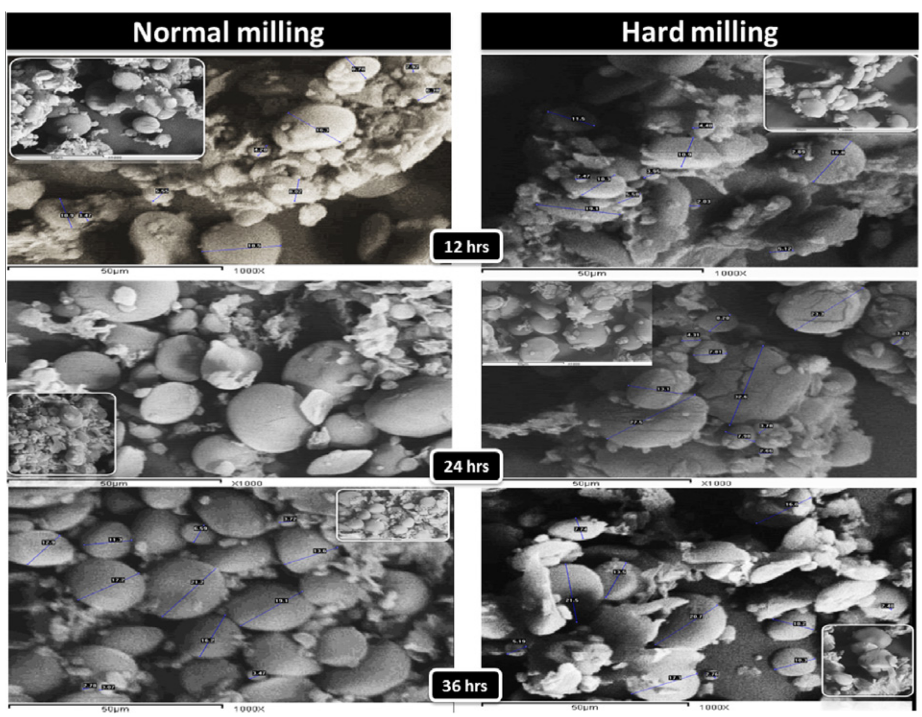

Fig. 2 Scanning electron micrographs (SEM) of wheat starch Gemmeiza 11.

A-granules which leads to increased farinograph water absorption and improved pasta quality these observations are in agreement with the results obtained by Soh et al. (2006). Granules with lower diameter are more susceptible to enzymes than those of higher diameter due to their higher surface area (Tester et al., 2006; Yonemoto et al., 2007).

The granule surface of starches became damaged, flattened, scratched, cracked, rougher and less rounded at hard milling for both cultivars. It is observed that starch granules take the shape of a flattened disk when hard milling for wheat flour Sakha 94 accomplished for 12 h, normal milling for wheat flour Gemmeiza 11 at 12 and 24 h, and hard milling for wheat

Table 4 Effect of milling process on farinogram of wheat flour.[a]

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Water absorption (%)	55.5	58.5	57.0	57.9	60.2	59.2	59.8	60.4	58.5	62.8	62.4	61.3
Dough development time (min)	4.0	2.0	3.5	3.5	3.5	2.0	1.5	1.5	1.5	2.5	2.0	1.5
Dough stability (min)	4.0	4.5	5.5	5.0	4.0	4.0	14.0	15.0	16.0	14.0	12.5	10.0
Mixing tolerance index (BU)	40	40	60	60	60	50	50	40	40	40	40	60
Degree of softening (BU)	70	70	60	90	80	70	20	20	20	20	30	30

[a] Expressed on 14% moisture basis.

Table 5 Effect of milling process on Alveogram properties.[a]

Characteristics	Flour wheat Sakha 94						Flour wheat Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Elasticity value (*P*)	73	87	81	82	102	100	56	71	63	79	66	58
Extensibility value (*L*)	79	69	61	67	50	54	103	142	117	84	100	98
Swelling index	19.8	17.4	18.5	18.2	15.7	16.4	22.6	24.1	26.5	20.4	22.3	22
Deformation energy	175	170	176	167	185	191	239	325	334	275	277	229
P/L value (distortion)	0.92	1.43	1.17	1.22	2.04	1.85	0.54	0.61	0.44	0.94	0.66	0.59

[a] Expressed on 14% moisture basis.

flour Gemmeiza 11 at 24 and 36 h. It could be observed that the granules take on a folding or puckering appearance when hard milling for wheat flour Gemmeiza 11 at 36 h.

Yamamori et al. (2000) reported that the abnormal starch granules might influence on the physicochemical properties of these wheat starches.

Effect of milling processes on farinograph, alveograph and rapid viscosity analysis properties

Results in Table 4 showed that the highest water absorption 62.8% and 62.4% were obtained by hard milling of wheat Gemmeiza 11 at conditioning time 12 and 24 h, respectively. Water absorption of wheat flour is influenced by different factors such as, the protein (gluten) quality, starch properties (damaged starch, enzymatically treated starch, etc.), flour particle size etc. Starch absorbs through capillary action only about 0.3% of water on its mass but in the case of damaged starch, which can arise in milling process, it can be increased up to 10 times more, Rasper and Walker (2000).

For dough development time, the highest value 4.0 min was obtained by normal milling of wheat flour Sakha 94 at conditioning time 12 h followed by 3.5, 3.5 and 3.5 min which were obtained by normal milling at conditioning time 36 h, hard milling at conditioning time 12 and 24 h of wheat flour Sakha 94, respectively.

It is very clear that Sakha 94 dough stability was less than Gemmeiza 11. The higher value of stability time 16, 15 and 14 min and lower degree of softening 20 BU were given by normal milling of wheat flour Gemmeiza 11 at conditioning times 36, 24 and 12 h, respectively. These data was confirmed by wet gluten and gluten index determination where normal milling at selected conditioning times of Gemmeiza 11 resulted higher values compared to other treatments. The decrement in the stability time indicates weakness of dough strength.

Results in Table 5 showed that the higher dough elasticity (*P*) 102 mm was obtained by hard milling of wheat flour Sakha 94 at conditioning time 24 h. These results indicate that the higher dough extensibility (*L*) 142 and 117 mm were obtained by normal milling of wheat flour Gemmeiza 11 at conditioning times 24 and 36 h, respectively. Data showed that the higher swelling index (*G*) 26.50 mm was obtained by normal milling of wheat flour Gemmeiza 11 at conditioning time 36 h. Swelling index of wheat flour Gemmeiza 11 was higher than wheat flour Sakha 94. Data also, showed that the higher deformation energy (*W*) 334 and 325 ($10\ E^{-4}$ J) was obtained by normal milling of wheat flour Gemmeiza 11 at conditioning times 36 and 24 h, respectively.

The hard milling caused a decrease of *L* and *G* parameter, an increase of P/L and *P* for both wheat cultivars. This variation of the rheological parameters can be attributed to the water redistribution process between the system components, because of the higher protein content which in turn retain a larger amount of water meaning a decrease in the mobility of the dough system. Consequently there will be an increase of dough viscosity, which can be seen from the alveograph point of view as a decrease of the *L* parameter and decrease of the extensibility index *G* as reported by Chen and D'Appolonia (1985). These results confirmed also with (Faridi and Rasper, 1987).

Results in Table 6 showed that the onset of gelatinization as defined by the initial rapid increase in paste viscosity, generally occurred at ≈3–5 min. (PaT) was derived from the corresponding RVA temperature program and does not necessarily reflect the true sample temperature. Results showed that the higher value (PaT) 88.05 and 88.05 °C was obtained by hard milling

Table 6 Effect of milling processes on rapid viscosity analysis properties.[a]

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Pasting temp (°C)	67.85	68.60	88.0	69.3	88.0	88.05	85.55	86.40	86.35	85.55	86.40	88.05
Peak viscosity (cp)	3073	2623	2032	2420	2023	1768	4217	3998	4070	3748	3695	3335
Final viscosity (cp)	3662	3158	2552	2960	2565	2254	4663	4969	4518	4236	4232	3779
Breakdown (cp)	1002	851	671	801	640	533	1445	1249	1450	1214	1250	1154
Setback (cp)	1591	1386	1191	1341	1182	1019	1891	1947	1898	1702	1787	1598
Peak time (min)	6.40	6.40	6.20	6.27	6.27	6.20	6.53	6.67	6.47	6.53	6.47	6.53
Trough viscosity (cp)	2071	1772	1361	1619	1383	1235	2772	2749	2620	2534	2445	2181

[a] Expressed on 14% moisture basis, Average of two values.

Table 7 Physical measurements of pan bread.

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Volume (cm^3)	500^g	550^f	500^g	541^f	500^g	500^g	1350^d	1475^b	1675^a	1275^e	1425^c	1350^d
Weight (g)	267^d	273^c	277^{ba}	263^e	275^b	278^a	268^d	262^e	257^f	268^d	262^e	262^e
Specific volume (cm^3/g)	1.87^h	2.01^g	1.81^h	2.05^g	1.82^h	1.80^h	5.04^e	5.62^b	6.51^a	4.75^f	5.43^c	5.15^d

Values followed by the same letters in the same raw are not significantly different ($P < 0.05$). Data are mean, of three replicates.

at conditioning time 36 h of wheat flour Gemmeiza 11 and Sakha 94, respectively.

Results showed that the higher peak viscosity 4217, 4070 cp were recorded by normal milling at conditioning time 12 and 36 h of wheat flour Gemmeiza 11, respectively.

The variation in RVA viscosity of wheat flour may be partly related to differences in starch damage and α-amylase activity, since peak viscosity values tended to decrease with increasing starch damage and α-amylase activity, this explained the severe drop in peak viscosity for flour milling, these results are in agreement with Faridi (1990).

For final viscosity, the last portion of the RVA pasting curve measures the increase in viscosity associated with gelation and retrogradation during cooling. Data showed that the higher final viscosity 4969 and 4663 cp was obtained by normal milling at conditioning time 24 and 12 h of wheat flour Gemmeiza 11, respectively.

Breakdown, the difference between peak and minimum viscosities, was used to examine further the response of starches to shear thinning during the 93 °C hold. Results showed that the higher breakdown 1450 and 1445 cp was obtained by normal milling at conditioning time 36 and 12 h of wheat flour Gemmeiza 11, respectively.

Ming et al. (1997) reported that the increased swelling was observed in starch with reduced amylose content. In increased swelling, more water is absorbed so that less free water was available, therefore resulting in higher pasting viscosity.

Setback correlates with the anti-staling effects, represents the shelf life of the end products. Hard milling presented lower values for setback and starch retrogradation for both wheat cultivars, indicating the decrease of starch retrogradation, and thus delaying bread staling. The results showed that higher value 1947 was obtained by normal milling at 24 h conditioning time for wheat Gemmeiza 11.

Rosell et al. (2007) reported that the flour gave very low consistency during cooling, which indicates very low recrystallization or setback.

Data showed that the higher trough viscosity 2772 and 2749 cp was obtained by normal milling at conditioning time 12 and 24 h for wheat flour Gemmeiza 11, respectively. As well as data showed that with increasing conditioning time from 12 to 24 to 36 h caused a decline in the trough viscosity gradually.

Physical measurements of pan bread

It could be observed that no significant ($P \leqslant 0.05$) difference was found between normal and hard milling at conditioning time 36 h for Sakha 94 in bread weight values 277 g and 278 g, respectively and they higher than 257 g and 262 g which given by normal and hard milling at conditioning time 36 h for Gemmeiza 11, respectively, Table 7.

For bread volume, it was seen that wheat Gemmeiza 11 resulting flour with normal milling at conditioning time 36 h had the highest loaf volume 1675 cm^3 followed by 1475 cm^3 was given by conditioning time 24 h. Also data showed that no significant ($P \leqslant 0.05$) difference was found in normal and hard milling at 36 h for wheat flour Sakha 94 which recorded 500 cm^3. These data are coincides with higher values of wet gluten, gluten index and dough stability time of Gemmeiza 11 flour produced by normal milling (Table 7).

The same results indicated that pan bread produced from flour Gemmeiza 11 was found to have a higher specific volume

Table 8 Sensory characteristics of pan bread.

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Shape (5)	2.00^{c}	1.90^{c}	2.10^{c}	1.8^{c}	2.0^{c}	2.1^{c}	4.30^{a}	4.30^{a}	4.40^{a}	3.40^{b}	4.20^{a}	3.90^{ba}
Crust color (10)	5.40^{cb}	4.80^{c}	5.80^{cb}	6.2^{b}	5.3^{cb}	5.7^{cb}	8.20^{a}	8.30^{a}	7.80^{a}	7.70^{a}	7.60^{a}	7.60^{a}
Crumb texture (10)	6.10^{c}	5.90^{c}	5.70^{c}	6.4^{bc}	5.8^{c}	5.3^{c}	7.70^{a}	7.50^{ba}	7.60^{ba}	8.10^{a}	7.50^{ba}	8.00^{a}
Crumb color (20)	8.00^{c}	7.80^{c}	8.30^{c}	8.5^{c}	8.2^{c}	8.0^{c}	14.70^{b}	16.10^{a}	16.50^{a}	14.50^{b}	15.60^{ba}	16.20^{a}
Taste (20)	9.10^{d}	11.8^{b}	11.3^{cb}	10.3^{cd}	11.7^{b}	14.1^{a}	13.50^{a}	14.30^{a}	14.60^{a}	14.10^{a}	13.70^{a}	14.10^{a}
Overall acceptability (100)	47.5^{c}	51.5^{cb}	52.8^{b}	51.6^{cb}	52.3^{cb}	55.0^{b}	81.90^{a}	84.30^{a}	85.20^{a}	81.70^{a}	82.80^{a}	83.00^{a}

Values followed by the same letters in the same raw are not significantly different ($P < 0.05$). Data are mean, of 10 replicates.

Table 9 Sensory characteristics of pan bread during storage at room temperature.

Characteristics	Sakha 94						Gemmeiza 11					
	Normal milling			Hard milling			Normal milling			Hard milling		
	Conditioning time (h)						Conditioning time (h)					
	12	24	36	12	24	36	12	24	36	12	24	36
Zero time (mm)	26.8^{ed}	26.6^{ed}	27.2^{ed}	18.0^{e}	36.6^{d}	22.0^{ed}	103.2^{ba}	79.2^{c}	110.2^{a}	100^{ba}	93.4^{b}	114^{a}
Two day (mm)	17.2^{e}	10.6^{g}	14.6^{f}	15.8^{fe}	14.4^{f}	8.6^{g}	46.0^{c}	44.6^{c}	93.8^{a}	32.8^{d}	49.4^{b}	49.0^{b}
Four day (mm)	12.8^{e}	8.4^{g}	10.8^{e}	7.8^{g}	7.2^{hg}	6.2^{h}	29.2^{d}	33.2^{c}	41.8^{a}	29.4^{d}	34.2^{c}	35.4^{b}
Six day (mm)	11.8^{e}	6.2^{h}	10.2^{f}	7.6^{g}	7.0^{hg}	7.2^{hg}	26.2^{d}	26.6^{d}	34.2^{a}	26.8^{d}	28.0^{c}	30.6^{b}

Values followed by the same letters in the same raw are not significantly different ($P < 0.05$). Data are mean, of three replicates.

than bread produced from flour obtained from Sakha 94. This may be due to flour Gemmeiza 11 had a higher level of α-amylase activity than Sakha 94. Results showed that no significant ($P \leqslant 0.05$) difference was found in specific volume between normal and hard milling at 36 h conditioning for Sakha 94, and at 12, 24 and 36 h conditioning for Gemmeiza 11.

Sensory evaluation of pan bread

Table 8 showed the effect of different milling conditions the two wheat varieties on the sensory characteristics of pan bread. No significant ($P \leqslant 0.05$) difference was found in bread shape between normal and hard milling at 24 and 36 h for Gemmeiza 11. At the same trend no significant ($P \leqslant 0.05$) difference was found in bread shape between normal and hard milling for Sakha 94, which recorded lowest values 1.8 and 1.9 were given by hard milling at 12 h and normal milling at 24 h for Sakha 94, respectively.

Data also, showed that no significant ($P \leqslant 0.05$) difference was found in crust color between normal and hard milling for both wheat cultivars, and the higher value 8.30 and 8.20 were given by normal milling for Gemmeiza 11 at 24 and 12 h, respectively, while lowest value of crust color 4.80 and 5.30 were given by normal milling and hard milling at 24 h for Sakha 94, respectively.

Data also, showed that no significant ($P \leqslant 0.05$) difference was found in crumb texture and crumb color between normal and hard milling for both wheat cultivars, and was higher value of crumb texture 8.10 and 8.00 were given by hard milling for Gemmeiza 11 at 12 and 36 h, respectively. While lowest value of crumb texture 5.30 and 5.70 were given by hard and normal milling at 36 h for Sakha 94, respectively. The higher value of Crumb color 16.50 and 16.20 were given by normal and hard milling for Gemmeiza 11 at 36 h. while lowest value of crumb color 7.80 were given by normal milling at 24 h for Sakha 94 wheat.

From the same results, it could be noticed that pan bread produced from flour of Gemmeiza 11 were found to have excellent quality grade for all the evaluated characteristics than bread produced from flour obtained from Sakha 94.

Compressibility (softness) of pan bread

Data of compressibility (softness) of pan bread prepared from different milling conditions during storage at room temperature (25 ± 2.0 °C) was calculated and presented in Table 9.

At zero time, the higher score of bread softness 114.0 and 110.20 mm were given by hard and normal milling at conditioning time 36 h for Gemmeiza 11, respectively. On the other hand, the lowest compressibility 18.0 mm was given by hard milling at 12 h for Sakha 94. Data showed that the hard milling of wheat Gemmeiza 11 have positive impact on compressibility at 24 and 36 h while the hard milling of wheat Sakha 94 have negative impact on bread softness.

After 6 day of storage, it was seen that the highest value of compressibility 34.2 and 30.6 mm were given by normal and hard milling of Gemmeiza 11 at 36 h. In addition, it could be noticed that significant ($P < 0.05$) difference was found between normal and hard milling for Gemmeiza 11 at 24 and 36 h. The lowest bread softness 6.2 mm was given by normal milling at 24 h conditioning time for Sakha 94.

Conclusion

Based on the above results, it could be concluded that the two milling process, which include different conditioning times and various clearance between rolls had a noticeable effect on the characteristics of wheat flour. On the other hand, the pan bread produced from flour of Gemmeiza 11 was found to have excellent quality grade for all the evaluated characteristics than bread produced from flour obtained from Sakha 94. It could be concluded that the flour obtained from wheat sakha 94 is unsuitable for production of pan bread with high volume due to its low damage starch percent and low enzyme activity which resulted in dough having low ability of gas retainment.

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