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Physico-Chemical, Rheological and Technological Evaluation of New Bread Wheat Varieties Grown in Toshka, Aswan (Egypt) by Mixolab

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ABSTRACT

This study was conducted to assess the quality of three different varieties of wheat sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3(ICARDA 4, Gemmeza 7),which was cropped in the south of Egypt (Toshka, Aswan Governorate, Egypt) comparing with control (Giza 168), these varieties were evaluated for physical, chemical, rheological and baking characteristics. Characteristics of the physical paste evaluated using new Mixolab rheological technique; determination of the relationship between Mixolab features and other qualitative measurements of wheat flour and grains, between physical and chemical properties (moisture, protein, fat, ash, fiber and carbohydrate), falling number, and Gluten content is significantly different. Most wheat varieties have a significant effect on the rheological varieties (arrival time, water absorption, dough stability, dough development time, departure time, and softening paste) by Mixolab. The characteristics of the bread were evaluated by estimating the weight of the loaf and the size of the loaf and a certain size. The results of the sensory evaluation referred to in the bread of the sample 3 (ICARDA 4, Gemmeza 7) were the most acceptable, and did not differ significantly in terms of admissibility compared to control (Giza 168).

Keywords: Bread of wheat, Mixolab, baking, flours, Falling number, gluten index.

INTRODUCTION

For thousands of years, wheat (*Triticum spp.*) Is one of the most important foods in human nutrition, both the peeled diploid einkorn (*T. monococcum L.*) and tetraploid emmer (*T. dicoccum SCHRANK*) are the oldest cultivated wheat species (Feldman, 2001). In Egypt we found a gap between production of wheat and people consumption. So, new wheat varieties like Gemmiza 7, Giza 168, Sohag 3 and Sakha 93 which developed by National Program for Wheat Research had characterized with highest yield and pests resistant (Anon., 2005). Egyptian government is going gradually to scale down the dependence on imported wheat by increasing grain yield and productivity (Kherallah *et al*., 1989).

Abdel-Aal *et al*., 2007 reported that the importance of wheat is mainly due to its nutritional value and the fact that its seed can be ground to flour, semolina, which are the main component of bread and other bakery products. Wheat products are an important source of natural antioxidants and vitamins, such as tocopherols and carotenoids. Lutein is the predominant carotenoid in wheat, while other carotenoids such as β-carotene occur only in small amounts. In addition to carotenoids, wheat is a useful dietary source of vitamin E, consisting of four tocopherols and tocotrinol homologues (α- β-, γ-, and σ-), collectively known as tocochromanols. Vitamin E compounds are among the most bioactive antioxidants, natural, lipophilic, contributing to the protection of proteins and fats, and therefore indispensable to human health (Schneider, 2005).

Wheat milling has two important goals; one is removing the bran and the other into is to ground the endosperm to small and fine granules. This process may be to reduce wheat nutritional value, accordingly, (Mugford, 1993; Shouk, 1996 and Czerny and Schieberle, 2002) They studied the possibility of using whole grain wheat (100% extraction) in different products to take advantage of its brans and germs, which contain many health and nutrient components, to maximize the flour harvest and reduce the gap between production and consumption. Differences usually occurring in wheat flour products depend on wheat varieties (hard or soft wheat), flour milling rate and size of wheat grains. On the other hand, the whole meal consists of a complete product obtained from wheat milling. Bread can only be legally described as whole meal bread if the flour used is accurate flour, and no other flour is added. The production of whole-grain bread, produced from whole grains (100%), should reduce the cost of making bread. (Hussein *et al*., 2010).

Wheat flour is one of the main traditional ingredients in the bread industry because of the portion of gluten, which is responsible for the elasticity of the dough by causing the extension and the carbon dioxide produced by the yeast during fermentation (Mepba, *et al*., 2007). The baking process gives the product (partially baked bread) with crumbs but without crunchy and colored crust. Then the bread can be kept chilled or frozen. Baking causes evaporation of water from the surface layers, thus developing the cortex, Maillard reaction responsible for coloring and release of flavors occurs during this phase (Le Bail *et al*., 2005, Farahnaky and Majzoobi, 2008).

The Mixolab is a relatively new technique, accepted as the ICC standard method No. 173 (ICC 2006), which making it possible to evaluate the properties of physical dough such as dough stability or weakness, and starch properties in a single measurement (Kahraman *et al.* 2008). It is enabled by excessive mixing and heating controlled kneading to 90 ° C and subsequent cooling to 50 ° C. Mixolab records real-time torque (in nm) produced by the dough between two razors. The Mixolab curve is divided into five phases, characterized by five points (C1-C5) and other parameters resulting from differences between individual points. Based on the results published so far by Mixolab, the compatibility is high with standard rheological analysis (eg, farinograph, extensograph, or amylograph). Therefore, we can expect a possible prediction of bread making the wheat quality common to these standards (Tulbek and Hall , 2006), (Cato and Mills 2008)., (Kahraman *et al*., 2008) and (Ozturk *et al*., 2008), Mixolab can predict cookies and quality baking cakes of different various wheat flour, respectively (Bonet *et al.* 2006). It also Mixolab can determine the effectiveness of transglutaminase for the composition of heteropolymers of wheat and wheat exogenous proteins (Pena *et al*., 2006). Development time of the dough and its stability and parameters have recorded high relations with the strength parameters of the dough from the vesicles when the whole grains are thoroughly tested. However, there are a limited number of studies on the application of mixolab to evaluate the bread-making quality of wheat varieties.

In this study, Mixolab was used with baking test to evaluate the quality attributes of the different types of new wheat bread cropped in south of Egypt (Toshka), and bread making potential of this wheat flours. Mixolab was selected for this study because during the rheological tests, the dough can be heated to 90 ° C, then refrigeration if desired. This function makes Mixolab unique, by allowing through a single test to obtain information on water absorption capacity and stability kneading, as well as gelatin temperature, amylase activity and starch retrogradation. Thus this information can be used in order to better understand the ability to make bread from flour.

MATERIALS AND METHODS

Materials:-

A new genotype of wheat (lines in F4) and Giza 168 (Table 1) were obtained during winter 2015/2016 from Toshka station, Desert Research Center, Aswan Governorate, Egypt.

Table 1. Origin of genotypes used

No.	Parent	Origin
Sample 1 (Line 1)	ICARDA 2	ICARDA(Syria)
	ICARDA 5	ICARDA
Sample 2 (Line 2)	ICARDA 1	ICARDA
	Gemmeza 7	Egypt
Sample 3 (Line 3)	ICARDA 4	ICARDA
	Gemmeza 7	Egypt
Giza 168		Egypt

Methods:

Preparation of wheat

The wheat is cleaned to remove soil particles, broken and foreign seeds. The wheat genotype was modified to 14% of moisture content for 24 hours, then milling (QuadrumatJounior) flour mill (100% whole mill extract) and sieve for 72% flour.

Analytical methods:

Gross chemical analysis

The flour samples were analyzed from three hereditary patterns of wheat Giza 168 for moisture and protein (% N × 5.7), ash, fat and fiber according to the methods described in A.O.A.C (2010). Total carbohydrates were calculated by the difference (100-(protein + fat + ash) on the dry weight.

Physical properties:

Falling number (FN), wet gluten (WG), and gluten index (GI) were determined for all samples according to standard methods of AACC (2010).

Rheological analysis

Mixolab:

The mixing and paste of wheat flour and mixing of the dough was evaluated using Mixolab(Chopin Technologies, Marcellin Berthelot Z.I. Du Val De Seine 92390 Villeneuve La Garenne, France), which measured the torque (expressed in Nm) produced by passing the dough between the two kneading arms, allowing to study their rheological properties. For the tests, 75 g of flour was placed in a Mixolab bowl and mixed with the amount of water needed to obtain 70-77% (v / w, flour basis) water absorption. The Mixolab data model provides information about protein stability subjected to mechanical and thermal constraints, both gelatinization and polishing of starch. These parameters included the initial maximum consistency (Nm) (C1) (Huang *et al*. 2010), and the minimum torque (nm) developed by the passing dough subject to mechanical and thermal constraints(C2), maximum torque produced during the heating stage (C3), minimum torque during the heating period (nm) (C4), and the torque (nm) proved after cooling at 50 °C (C5). During the assay curve slopes were related to the flour features: speed of the protein network weakness due to heating (alfa); gelatinization rate (beta) and cooking stability rate (gamma) (Rosell and Collar 2009).

Bread-making

The bread was made according to the internal protocol of flour (300 g), yeast (12 g), fat (3 g), sugar (4.5 g) and salt (5.1 g). The dough was kneaded with the addition of water according to the retention capacity of the flour. The dough is high in the thermostat for 45 minutes at 30 ° C and then was divided into four parts on the shape of the ball and left in heat for 50 minutes. Then, put the pieces in the oven at 240 ° C for 14 minutes (AACC 2010).

Bread characteristics

The characteristics of the baking or bread were evaluated from the weight of the specified loaf, the size of the loaf and a certain size, 30 minutes after removal from the oven. The size of the loaf was determined by the displacement of the rapeseed; a certain size was obtained by dividing the size of the loaf by the weight of the corresponding loaf (AACC 2010) and (El-Demery, 2011).

Sensory Evaluation

The loaf was cooled for 1-2 hours at room temperature in a sealed plastic bag. The bread was then sliced into 2 x 3 x 5 cm slices using a knife. The sensory evaluation was conducted by 15 faculty members of graduate students and staff of the Faculty of Agriculture and Natural Resources, Aswan University. Samples were randomly assigned to each member. Team members evaluate each loaf of color, taste, smell, texture and acceptance in general. The hedonic scale was used from 9 points where 1 = dislike extremely to 9 = like extremely (See *et al*. 2007).

Statistical analysis

The results were analyzed in statistical analyzes of SAS Statistical Analysis System (1999). Duncan's was used at a level of 5% of importance for comparing methods as for Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Approximate chemical composition of whole wheat bread meal:

Table (2) shows the proximate chemical composition of the various new wheat varieties of bread. The results obtained showed no significant differences (P <0.05) between all wheat varieties of different bread in different moisture content compared to control (Giza 168). The sample (3) was characterized by its high protein content. (13.47%) and control (Giza 168) by 12.98% followed by sample (1) 12.77% and sample (2) 12.7%; respectively. Fat in all wheat bread hid slightly in Giza 168, and samples (1, 2, 3) to 1.66, 1.84, 1.65 and 1.65%; respectively. Samples (1, 2, 3) showed no significant content (P <0.05) in ash (2.70, 2.88, 2.80%); respectively, compared to control (2.39%). The fiber content of the sample (3) increased significantly to the highest level (52.68%) and fell to the lowest level (47.91%) in the sample (2). Finally, the carbohydrate content calculated by the difference and the results showed that there was no significant difference (P <0.05) between control and sample (1, 2) but the sample (3) recorded the lowest level (82.08%).

These results are treated with those obtained by Mepba *et al*. (2007), Malomo *et al*. (2011), Akubor and Ishiwu (2013), Blessing (2014), and Amir *et al*. (2015).

Table 2. The Total chemical composition of new bread wheat varieties (Dry weight)

Samples	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate*
Control (Giza 168)	5.51^{a}	12.98^{b}	1.66^{a}	2.39^{b}	49.63^{c}	82.97^{a}
1	5.48^{a}	12.77^{b}	1.84^{a}	2.70^{a}	51.61^{b}	82.69^{a}
2	5.71^{a}	12.7^{b}	1.65^{a}	2.88^{a}	47.91^{d}	82.77^{a}
3	5.7^{a}	13.47^{a}	1.65^{a}	2.80^{a}	52.68^{a}	82.08^{b}

***Calculated by difference.**
***The different letters on the same column explain statistically significant differences (P<0.05) between means.**
***sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3 (ICARDA 4, Gemmeza 7)**

Gluten content is one of the most important factors responsible for the quality and strength of baking for wheat flour. Gluten and fall were measured to determine the technological quality of wheat varieties. The data in Table (3) showed that the highest content of wet gluten was significant in whole bread wheat lines. Farooq *et al.* (2001) noted a significant effect of the varieties and lines on the chemical properties of wheat. Differences in the number of wetlands and wet gluten from different varieties of wheat are reflected in difference in moisture content and protein (Corbellini *et al*; 1999). There are many genetic and non-genetic factors that may modify the characteristics of wheat grains and flour such as environmental conditions, storage, sites, soil and fertilizer use (Anjum and Walker, 2000., and Butt *et al*; 2001)

Table 3. The gluten, gluten index, and the Falling number of flour (72% extraction) of new wheat varieties of bread.

Samples	Gluten	Gluten index	Falling number
Control (Giza 168)	40.2^{b}	66.2^{c}	349^{c}
1	32.6^{d}	86.5^{a}	401^{a}
2	36.2^{c}	80.1^{b}	398^{b}
3	40.6^{a}	64.8^{d}	398^{b}

***The different letters on the same column explain statistically significant differences (P<0.05) between means.**
***sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3 (ICARDA 4, Gemmeza 7).**

Dough rheological behavior:

The behavior of the rheological dough was measured by Mixolab by increasing the temperature first and then reducing it. The following effects were observed: higher minimum torque (C2), higher maximum torque (C3), higher minimum torque during the heating period (C4) and lower starch gelatin Control (Table 4).

Bread is developed during the technological process by a Mixolab machine, from dough making to starch retrogradation. These torque actions are exposed when baking double dough mixing and temperature restriction Collar *et al*., (2007). The dynamic rheological parameters of the dough are used to predict the bread-making quality of the wheat. Poor quality wheat crusts are usually less flexible and more viscous than quality wheat (Bordes, *et al*., 2008), The Mixolab curve of regions (1) and (2) was mainly characterized by protein binding, and those of regions (3), (4) and (5) described the behavior of starch (starch gelatinization, gelling and retrogradation).

(C1) was an indication of water absorption in the dough. The results showed no significant difference (P <0.05) between all the different new wheat varieties in C1 compared with control (Giza 168).

When the samples were compared (control, 1, 2, and 3), the least stability was obtained for the dough (7.5 min) in the flour sample (1), while the highest stability of the dough was obtained (8.21min) in the control sample flour. Then the sample (3) recorded (7.92 minutes) of the dough stability, may be due to α-amylase content, according to Banu *et al*. (2011),An increased dose of α-amylase reduces the stability of the dough, while different doses of hemicellulases and xylanasesdo not make significant changes in dough stability.

The mean for C2had the low values and signifying a poor quality for protein. The combined effect of the mechanical shear stress and the temperature constraint induced a decrease in the torque due to the beginning of the protein destabilization and unfolding (Collar *et al*., 2007), Rosell *et al*. (2007). Sample flour (3)had a good protein quality, the value for C2 0.432 Nm as comparing with control. In the “Mixolab applications handbook. Rheological and Enzymatic Analysis” Rosell *et al*. (2007), the optimum value for C2 it is considered 0.5 Nm.

The flour sample (2) had recorded the lowest value of the βslope (0.122 Nm/min), on the other hand the control sample had recorded the highest value of the βslope (0.234 Nm/min) followed by sample (3) recorded (0.184 Nm/min), which gives indications about starch gelatinization. Haros *et al*. (2006), Collar *et al*. (2007), Rosell *et al*. (2007) and Banu *et al*. (2010) said that the flour with high enzymatic activity has low absolute value of the βslope.

C4 indicating the stability of the starch gel formed is lower for samples with high α-amylases activity (Table 4). Banu *et al*. (2011) told that C4 significantly correlates with the parameters of the βslope, so we found sample (control) have the highest value of C4 (0.845 Nm), while sample number (2) have the lowest value of C4 (0.521 Nm).

C5 gives indications about starch retrogradation (Haros *et al*.,2006; Collar *et al*., 2007; Rosell *et al*., 2007; Kahraman *et al*., 2008), from a result we found that control flour recorded the highest value of C5 flowed by sample flour (3) then sample flour (1) as follow (1.168, 1.162, 0.946 Nm); respectively.

Sensory evaluation:

Table (5) shows the effect of wheat varieties on sensory properties of bread. The obtained results illustrated that, bread made from sample (3) recorded highest scores for all quality features of substitution (color, taste, odor, textures, and overall acceptability) as follow (8, 8, 8.5, 8.27, and 8.84) respectively. This indicated that the consumer preferred bread from sample (3) this is may be due to the high content of protein and fiber. Furthermore, color seemed to be more important standard for overall acceptability of the bakery product by the consumer, (El-Demery, 2011). Bloukas *et al*., (1999) stated that development of food products with interesting colors has been a major target in the food industries. On the other hand we found that low significant (p<0.05) difference about bread made from control, sample (1), and sample (2) in (color, taste, odor, textures, and overall acceptability).

Table 4. Mixolab test of flour (extraction 72%) of new bread wheat varieties.

Samples	Time (min)	C1 Torque (Nm)	Stability Time (min)	C2 (Nm)	C3 (Nm)	C4 (Nm)	C5 (Nm)	Alfa (Nm/min)	Beta (Nm/min)	Gamma (Nm/min)
Control (Giza 168)	3.53[a]	1.122[b]	8.21[a]	0.486[a]	1.149[a]	0.845[a]	1.168[a]	-0.054[a]	0.234[a]	-0.034[a]
1	3.25[b]	1.139[a]	7.5[d]	0.403[c]	0.995[c]	0.632[c]	0.946[b]	-0.068[a]	0.138[c]	-0.050[a]
2	2.88[c]	1.116[b]	7.83[c]	0.399[d]	0.864[d]	0.521[d]	0.855[c]	-0.058[a]	0.122[d]	-0.046[a]
3	3.33[b]	1.068[c]	7.92[b]	0.432[b]	1.038[b]	0.741[b]	1.162[a]	-0.054[a]	0.184[b]	-0.028[a]

***The different letters on the same column explain statistically significant differences (P <0.05) between means.**
***sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3 (ICARDA 4, Gemmeza 7).**

Table 5. Sensory evaluationof bread wheat varieties.

Sample	Color	Taste	Odor (Aroma)	Textures	Overall acceptability
Control (Giza 168)	7.54[b]	7.27[d]	7.03[b]	7.63[b]	7.58[c]
1	7.44[c]	7.71[b]	8.24[a]	7.36[c]	7.59[a]
2	7.18[d]	7.51[c]	7.90[b]	7.47[c]	7.87[b]
3	8[a]	8[a]	8.5[a]	8.27[a]	8.84[c]

***The different letters on the same column explain statistically significant differences (P <0.05) between means.**
Values are the Means ± SD and n=15 for each group.
***sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3 (ICARDA 4, Gemmeza 7).**

Control

Sample (1)

Sample (2)

Sample (3)

Bread characteristics:

The volume, weight and specific volume (Table 6) of the loaves ranged from 90 to 110 cm^3, 41.64 to 55.56 g and 1.98 to 2.19 cm^3/g; respectively. The results showed that there were no significant results (P>0.05) were noticed in loaf volumes, loaf weights and specific volumes of loaf bread made from control flour and loaf bread made from samples (1, 2, 3) flours.

The content of moisture in breads was essential factor affecting loaf volume. Gallagher *et al*., 2003 said that increasing water level in the composition by 10 and 20% increased the loaf volumes in bread

The Gluten portion is responsible for the elasticity of the dough by causing it to expand and catch the carbon dioxide generated by yeast during fermentation process. When gluten coagulates under the effect of heat during baking, it serves as the framing of the loaf, which becomes comparatively rigid and does not breakdown. The percentage of wheat flour required to complete a certain effect in composite flours depends significantly on the quality and quantity of wheat gluten and the nature of the product interested, (Mepba *et al*. 2007).

Loaf weight of sample (1) recorded the lowest weight as comparing with all sample (41.64 g) this may be is attributed to low gluten content which has a direct contribution to the viscoelastic properties of dough (Okaka, 2005).On the other hand the highest loaf weight recorded by sample (3) (55.56 g) as comparing with control this may linked to the high content of gluten and fiber which increased the water absorption capacity of the dough

Table 6. The physical properties of wheat bread loaves

Sample	Loaf volume (cm^3)	Loaf weight (g)	Specific volume (cm^3/g)
Control (Giza 168)	100[c]	45.47[c]	2.19[a]
1	90[d]	41.64[d]	2.16[a]
2	105[b]	49.20[b]	2.13[a]
3	110[a]	55.56[a]	1.98[b]

***The different letters on the same column explain statistically significant differences (P <0.05) between means.**
***sample 1(ICARDA 2, ICARDA 5), sample 2 (ICARDA 1, Gemmeza 7) and sample 3 (ICARDA 4, Gemmeza 7).**

CONCLUSION

In terms of physical, chemical, rheological and sensory properties, the bread made from sample 3

(ICARDA 4, Gemmeza7) was the most acceptable and was not significantly different in terms of acceptability of control simulation (Giza 168).

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تقدير الخواص الفيزيائية والكيميائية والريولوجية والتكنولوجية لأصناف جديدة من القمح مزروعة فى منطقة توشكى – أسوان – مصر بإستخدام جهاز Mixolab

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أجريت هذه الدراسة لتقدير جودة ثلاث أصناف جديدة من القمح تم زراعتها بمنطقة توشكى بمحافظة أسوان – مصر كما يلى: عينة رقم 1 (ICARDA 2, ICARDA 5) ، عينة رقم 2 (ICARDA 1, Gemmeza 7) ، عينة رقم 3 (ICARDA 4, Gemmeza 7) ومقارنة هذه الأصناف مع صنف (جيزة 168). تم تقدير الخواص الفيزيائية والكيميائية والخواص الريولوجية وخواص العجين لكل من الدقيق الناتج من هذه الأصناف وكذلك الخبز الناتج من الدقيق. تم استخدام جهاز Mixolab لتقدير الخواص الفيزيائية والريولوجية للدقيق والعجين الناتج من هذه الأصناف والربط ما بين النتائج المتحصل عليها من جهاز Mixolab والتقديرات الأخرى للحبوب والدقيق الناتج من الأصناف المختلفة مثل (الرطوبة ، البروتين، الدهن، الرماد ، الألياف ، الكربوهيدرات). أيضا تم تقدير رقم السقوط والمحتوى من الجلوتين ووجدت اختلافات معنوية بين مختلف الأصناف مقارنة بصنف جيزة 168. أخيرا تم تقدير الخواص الفيزيائية للخبز الناتج من الدقيق عن طريق تقدير وزن الرغيف ، حجم الرغيف الحجم النوعى للرغيف. كذلك تم تقدير الخواص الحسية للمنتج (الخبز) عن طريق مجموعة من المحكمين. وقد أشارت النتائج المتحصل عليها أن العينة رقم 3 (ICARDA 4, Gemmeza 7) كانت من أكثر الأصناف قبولا ولم تختلف إختلافا معنويا فى معظم التقديرات بالمقارنة مع صنف (جيزة 168).