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Evaluation of Some New Durum Wheat Genotypes in Egypt

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THE AIM of this study is to study the quality of three different new varieties of durum wheat, variety 1(ACSAD 65, Syria), variety 2 (ACSAD 1105, Syria) and variety 3 (ACSAD 1229, Syria), the research material for the investigation came from the field experiments of Toshka Station, Desert Research Center in the south of Egypt comparing with the control (Bani Sweif 1), The scope of the investigation included the evaluation of the chemical indicators of the flour quality (moisture, protein, and ash), and the physical characteristics (gluten content, falling number, and yellow pigment) as well as the rheological characteristics of the dough by farinograph (water absorption, dough development time, dough stability, and mixing tolerance index) and Amylograph (beginning of gelatinization, gelatinization temperature, and maximum gelatinization of starch). The findings indicated that variety 1 (ACSAD 65) which recorded the best results in all terms (protein content in semolina, gluten content, and falling number), Moreover rheological properties which in relation to pasta quality such as (water absorption, dough development time, dough Stability, and gelatinization) indicate a good technological quality of flour when comparing with local control (Bani Sweif 1).

Keywords: Durum wheat, Farinograph, Amylograph, Flours, Falling number, Gluten index and Chemical evaluation.

Introduction

Products of cereals are considered a big part in human diet, which provides proteins, carbohydrates, fats, dietary fibre, B-group vitamins and minerals. Moreover, the whole grain is used to make foods (Okarter and Liu, 2010), (Sarwar et al., 2013).

Wheat semolina is usually used to make pasta products, but recently more other cereals have been used to partially replace it. Also, in pre-cooked pasta products we can use wheat flour, but due to the low protein ratio, we can fortify the products to improve the functional characteristics and quality if the right manufacturing conditions are applied (Chillo et al., 2008 and Kalnina, et al., 2015).

We can attribute that durum wheat importance to numerous uses for human consumption such as (bread, macaroni industry) due to high protein and gluten contents (Rachon et al., 2002 and Makowska et al., 2008).

Dick and Matsuo (1988) and Fuad & Prabhasankar (2010) reported that a high protein content of durum semolina makes it the main source in macaroni industry, because it produces a hard translucent product that remains firm after cooking tn addition to the high content of yellow carotenoid pigments in semolina. By mixing water with semolina or durum flour we can make paste products which can be formed into various shapes and eaten or dried for later consumption.

The quality of food products and predicting the processing behavior is effective by dough rheological properties characterization (Song and Zheng, 2007). Determining rheological properties of dough, we can expect the behavior of the resulting dough when submitted to mechanical energy (Bloksma, 1990). The main factor responsible for the elastic and viscous properties of the dough is gliadin and glutenin which are the two primary species of grain proteins, which form a glutinous network in the dough (Koehler, et al., 2010).

Kalnina, et al. (2015) mentioned that the results of the Farinograph refer to the characteristic of

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dough mixing which is attributable to wheat starch, wheat gluten, lipid and moisture ratio, also amount and activity of α-amylase.

Starch properties in a dough determined by Amylograph are ascribed to grain. Amylose and amylopectin are the main starch granules component. Amylopectin structurally is responsible for the crystalline organization of cereals granule starch. Gelatinization, retrogradation, and pasting properties of starch are affected by chain length of amylopectin (Jeon, et al., 2010 and Alcazar-alay & Meireles., 2015).

Gelatinization of starch is an operation performed to fall apart the links between molecules of starch by water and heat, let the hydrogen bonding sites (the hydroxyl hydrogen and oxygen) to attract more water (Sobkowska, 2001 and Tako et al., 2014). Cooking quality of pasta depended on starch (Delcour et al., 2000). Water absorbance, and gel consistency of the gluten matrix during cooking were affected by starch (Edwards et al., 1999 and Tako et al., 2014).

The aim of this study was to evaluate the quality of some new durum wheat genotypes from southern Egypt (Toshka).

Materials and Methods

Materials

Three genotypes (Table 1) of durum wheat (Lines) and control (Bani Sweif 1) were grown in Toshka Station, Desert Research Center, Aswan Governorate, Egypt during the winter seasons of 2015/2016.

TABLE 1. Pedigree of genotypes used

Genotypes	Entry	Origin
Variety 1	ACSAD 65	ACSAD, Syria
Variety 2	ACSAD 1105	ACSAD, Syria
Variety 3	ACSAD 1229	ACSAD, Syria
Control	Bani Sweif 1	Egypt

Methods

Preparation of wheat samples

The wheat is cleaned to remove unwanted stuff. The durum wheat cultivars were tempered to 17.5% moisture content for 24 hr then milled on a durum Buhler experimental mill (Egyptian Baking Technology Center) fitted with two laboratory scale purifiers. Milling was performed according to the standard procedure of AACC (2010) approved method 26-20.

Chemical and physical analyses of durum wheat

Chemical analyses of durum wheat

The durum flour samples and semolina were analyzed for moisture, protein (% N × 5.7), and ash according to the methods described in A.O.A.C (2010) on the dry weight.

Falling number (FN), wet gluten (WG), dry gluten (DG), and yellow pigment were determined for all samples according to standard AACC (2010) methods.

Physical analyses of durum wheat

Farinograph analysis was performed using AACC Approved Method 54-21.02. This method measures and records the resistance of dough to mixing. It is used to evaluate the absorption of flours and to determine stability and other characteristics of dough during mixing. Results were expressed in terms of 6 parameters: (1) water absorption, which is the amount of water required to bring the dough to 500 FU; (2) dough development time, which is the time from water addition to the first sign of dough weakening in the range of maximum consistency; (3) stability, which is the difference in time between the points where the top of the curve reach and leave a constant torque line tangent to the middle curve at the point of maximum consistency; (4) mixing tolerance index, which corresponds to the decrease in Farinograph units (FU) between the top of the curve at maximum consistency and the top of the curve four minutes after maximum consistency was reached, AACC (2010).

For analysis of starch gelatinization properties Amylograph-E (Brabender GmbH&Co.KG., Germany) was used according to the international standard method (AACC standard 22-10; ICC No. 126/1). The acquired diagram was evaluated for the gelatinization maximum and the gelatinization temperature (ICC Standard 126/1, 1992).

Statistical analysis

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

Results and Discussions

Chemical composition of new durum wheat varieties and semolina

Results presented in Table 2 showed the chemical composition of different varieties of durum wheat and fine semolina on dry weight basis. From these data it could be noticed that moisture content of whole durum wheat ranged from 5.27 to 6.53%, we found a significant (P <0.05) increase in moisture content in semolina from 13.00 to 14.27%. The results obtained showed no significant differences (P <0.05) between all wheat varieties in different moisture content compared with the control (Bani Sweif 1). On the other hand variety (2) was characterized by its high protein content (16.58%) , variety (3) by 16.19% followed by the control (Bani Sweif 1) 15.85% and variety (1) 15.54%, respectively, in whole durum wheat, while the percentage of protein had a slight decrease in semolina recording 15.62% in variety (1), 14.58% in variety (2), then 13.71% in varity (3), and 12.14% in the control (Bani Sweif 1), respectively. Mariani et al. (1995) reported that the content of protein is significantly (P <0.05) affected by the environment while protein quality appeared to be influenced more by genotype. Finally, the results of ash content showed no significant difference (P <0.05) between the control and varieties (1, 2, 3). In this study ash content of varieties (1, 2, 3) was slightly higher (0.68, 0.89, and 0.79%, respectively) than the control (0.52%). Generally, these higher values in ash still are within the range of first grade semolina according to Cubadda (1988) who classified semolina with ash content <0.9% as first grade semolina.

These results are treated with those obtained by Boyacioglu and d'appolonia (1994), Alamri et al. (2009), Torbica et al. (2011), Khorshid et al. (2011), and Parate et al. (2016).

Properties of the durum wheat semolina varieties flour

Gluten content is a primary important factor responsible for the quality and wheat flour strength. Gluten was measured to assay the quality of wheat varieties. In pasta making gluten must be tenacious enough to regain the gelatinized starch granules pasta cooking. In addition, water absorption of pasta dough ranged from 31-35% compared to bread dough of 60% (Liu et al., 1996). The data in Table 3 showed that the highest content of wet gluten was recorded by variety (2) flowed by variety (3) then variety (1) as (31.40, 30.63, and 27.66, respectively) comparing with the control (33.26%). Differences in the number of 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 & Walker, 2000., and Butt et al; 2001). Dry gluten contents of the varieties also varied between genotypes and showed some significant variations between genotypes, the highest content of dry gluten wasrecorded by the control (12.83%), flowed by variety (1), then variety (3), and variety (2) as follows (11.40, 10.43, and 8.03%, respectively).

The assay of falling number is an indicator of the activity of alpha amylase in the semolina. From the results in Table 3 we found no significant differences (P <0.05) between all durum wheat semolina varieties comparing with the control but we found that all varieties recorded a higher value in falling number (low activity of alpha-amylase) which ranged from (567.33 to 545.67), durum wheat grown in dry climatic condition, usually has extremely high falling number. Also, the higher falling number values for durum wheat flours may be due to the quality of the starch in varieties according to Posner et al. (2006).

Yellow pigment in semolina and pasta is a traditional rather than functional mark of quality. In general there is no significant difference between all new durum wheat semolina varieties in yellow pigment levels comparing with the control, the values ranged from 7.89 to 7.23 (Table 3). Therefore manufacturers should look for durum wheat, with high carotiniod pigment content, low poly phenols oxidase activity, and possibly, low lipoxygenase activity. However, they must also take into account the influence of high temperature drying on pasta characteristics and the complex interaction between drying condition, (temperature, and pasta water content) and semolina characteristics (Kruger et al., 1998).

TABLE 2. Chemical composition of new durum wheat varieties and semolina (Dry weight) %

varieties	Whole durum wheat			Fine semolina		
	Moisture	Protein	Ash	Moisture	Protein	Ash
Control	5.80[b]	15.85[a]	2.17[a]	13.20[a]	12.14[b]	0.52[a]
variety 1	5.27[b]	15.54[a]	2.17[a]	13.00[a]	15.62[a]	0.68[ab]
variety 2	5.80[b]	16.58[a]	2.16[a]	14.27[a]	14.58[a]	0.89[a]
variety 3	6.53[a]	16.19[a]	2.04[a]	13.43[a]	13.71[ab]	0.79[ab]

* The different letters on the same column explain statistically significant differences ($P < 0.05$) between means.

TABLE 3. Wet gluten, dry gluten, falling number and yellow pigment of new durum wheat semolina varieties.

Varieties	Wet gluten %	Dry gluten %	Falling number	Yellow pigment
Control	33.26[a]	12.83[a]	552.67[a]	7.89[a]
variety 1	31.40[b]	11.40[a]	567.33[a]	7.43[a]
variety 2	27.66[c]	8.03[b]	545.67[a]	7.35[a]
variety 3	30.63[b]	10.43[ab]	549.33[a]	7.23[a]

* The different letters on the same column explain statistically significant differences ($P < 0.05$) between means.

Physical properties of new durum wheat semolina varieties

Farinograph

The obtained results of Farinograph describe the properties of dough-mixing which refer to the wheat gluten, starch, lipid and moisture contents in addition to the activity of α- amylase. The main factor playing a role in elastic and viscous properties of the dough is gliadin and glutenin which are the two primary types of grain proteins, which play a role to form a continuous spatial network in the dough. Wheat flour dough strengthes due to glutenin. But the responsible for minimizing the solidity and increasing the extensibility of the gluten phase is gliadin molecules (Koehler et al., 2010). Also, farinograph measured water absorption of dough is the most important parameter, which indicates the amount of water required to develop the standard dough of 500 farinograph units (FU) at the peak of the curve. We found the ability to absorption and retention more water as compared with weak flours just in stronger wheat flours (Mis, 2005). Protein content in flour affects water absorption, during milling the quantity of starch damaged and the presence of non-starch carbohydrates (Finney et al., 1987).

In the current study it was detected, that water absorption of the analyzed flour samples increased with the quantity of protein such as variety (1) recorded the highest value of water absorption (68.90) and the value of protein (15.62%). Whereas, the control sample recorded the lowest value of water absorption (58.66) and the value of protein (12.14%).

Other study observed that there was an increase in water absorption if the quantity of the added whole flour increased. Also, increasing the ratio of bran in the dough formulation usually leads to increment in water absorption of dough due to the higher levels of pentosans in bran (Sanz-Penella et al., 2008) and whole grain bran flour can interfere with water migration, increasing water retention within the pasta (Villeneuve and Gelinas, 2007).

The time of dough development (peak time) is a significance of quality of protein, in addition stronger flours naturally require more time of dough development than do weaker flours. Therefore, a comparison of peak times indicates the relative strength of different flours (Faridi, 1990) so we found from the results that variety (1) had the highest value of dough development time (4.76 min) comparing with the control which recorded the lowest value (2.90 min) while variety (2 and 3) had (4.17 and 3.90 min), respectively. Also, we can't deny that the difference degree in starch damaged is a principal factor to affect the rate of hydration (Kunerth and D'Appolonia, 1985).

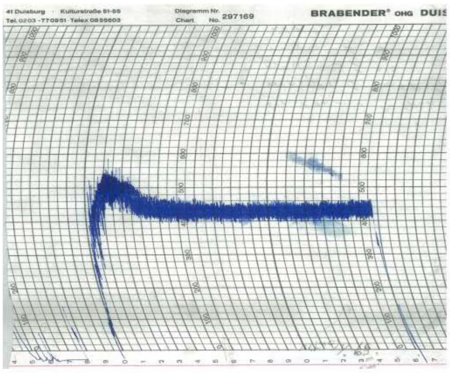
Dough stability indicates the time when the dough maintains maximum consistency and is a good indication of dough strength. Good quality dough has a stability of 4–12 min (Kulhomaki and Salovaara, 1985). In the present experiments stability time of the control dough sample was 4.77 min. while the highest time was recorded by variety (1) 6.30 min. then variety (2) and (3) 5.00 min. The stability time is an indication of the strength of flour, a higher value signifys a stronger dough. Similar results were obtained by Zhang et al. (2014). The Quality of flour processing is affected by quantity and quality of gluten. Gluten has viscoelastic properties while gliadin and glutenin fractions have viscous and elastic properties, respectively. Dough properties and relevance for end products amongst the cultivars are not only due to variation in protein content (Zhu and Khan, 2002).

The mixing tolerance index ranged from 69.33 to 46.66 brabender units (BU). The highest mixing tolerance index of 69.33 was found in the control wheat flour. The lowest mixing tolerance index was observed in variety (1) 46.66, according to Gupta et al. (1992) who reported that the strong gluten cultivars showed significantly higher water absorption, longer dough development time and stability and lower mixing tolerance index than those of the weak gluten cultivars.

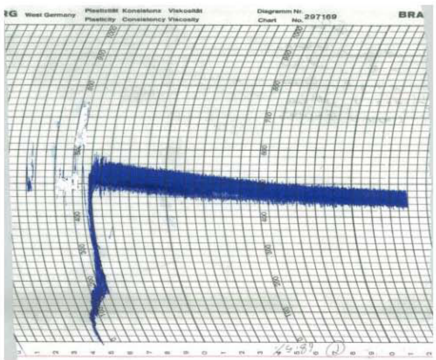
TABLE 4. Farinograph data of new durum wheat semolina varieties

Varieties	Water absorption	Dough development time (min)	Stability (min)	Mixing Tolerance Index (BU)
Control	58.66[c]	2.90[b]	4.77[b]	69.33[a]
variety 1	68.90[a]	4.76[a]	6.30[a]	46.66[c]
variety 2	66.66[a]	4.17[a]	5.00[ab]	58.66[b]
variety 3	63.33[b]	3.80[b]	5.00[ab]	66.66[a]

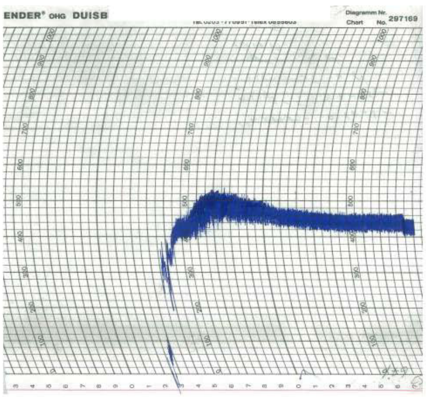
* The different letters on the same column explain statistically significant differences (P <0.05) between means.



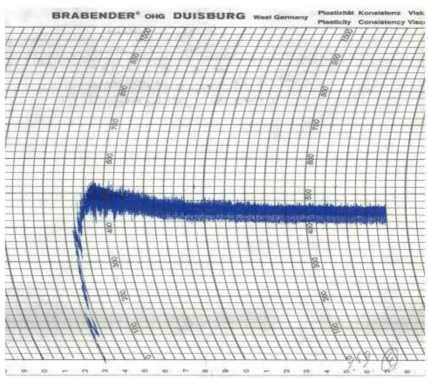
Control



Variety 1



Variety 2



Variety 3

Amylograph

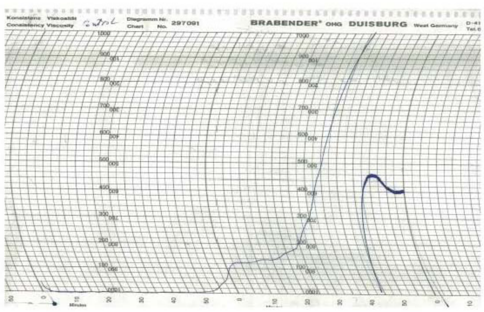
The quality of pasta basically depended on the raw materials in pasta production based on ratio of protein content, and starch properties (Cubadda et al., 2007 and Delcour et al., 2000). Starch is important to determine the pasta cooking quality (Delcour et al., 2000). During pasta cooking, protein existing network restricts the diffusion of water and limits the swelling of starch granules in the central zone of pasta. The extrusion process causes damage to the protein matrix; the resulting pasta is compact and a continuous protein network (Stefano and Marco, 2009). To produce good pasta with high quality parameters, we must use the right manufacturing conditions especially starch gelatinization temperature (extrusion temperature). Therefore, the determination of starch gelatinization temperature of new durum wheat semolina varieties (Table 5). was recommendable

The data in Table 5 show no significant difference ($p<0.05$) among all durum wheat semolina varieties and the control in gelatinization temperature where it ranged from (91.33 to 90.16 ºC). The higher gelatinization temperature illustrates a higher thermal stability in the future processing according to (Marti et al., 2010). Gelatinization temperature of wheat starch ranged from 52 to 85 °C and the heating processing of the dough to 80–90 °C in the precence of an amount moisture adequate to make starch swelling and gelatinization (Thomas and Atwell, 1999). The obtained results demonstrate that a higher maximum gelatinization (BU) (1800) was for variety (1), and the lower – for variety (3) (1290).

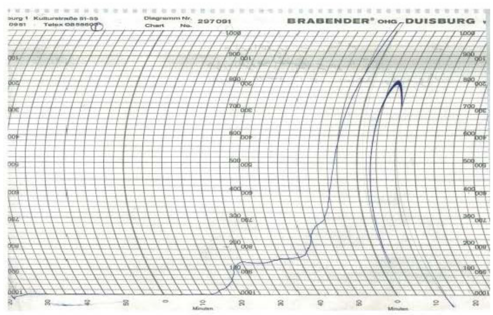
TABLE 5. Amylograph data of new durum wheat semolina varieties

Varieties	Beginning of gelatinization ºC	Gelatinization ºC	Maximum gelatinization (BU)
Control	59.66^{b}	90.33^{a}	1449.00^{c}
variety 1	59.66^{b}	90.16^{a}	1800.00^{a}
variety 2	62.66^{ab}	90.16^{a}	1621.33^{b}
variety 3	70.16^{a}	91.33^{a}	1290.00^{d}

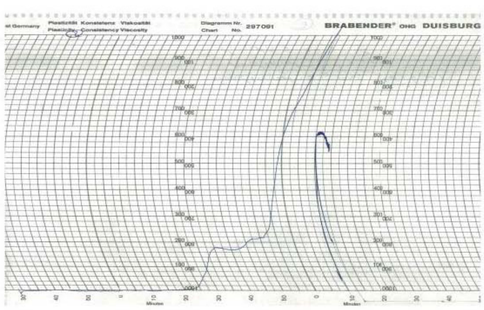
* The different letters on the same column explain statistically significant differences ($P<0.05$) between means.



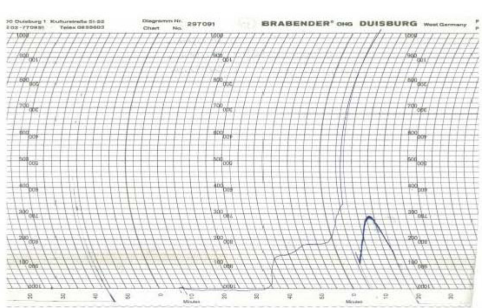
Control



Variety 1



Variety 2



Variety 3

Conclusion

We can conclude that, variety 1 (ACSAD 65) had the best results in (protein, gluten content, and falling number), in addition to the physical properties which in relation to pasta quality comparing with local control (Bani Sweif 1)

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تقييم بعض السلالات الجديدة من قمح الديورم فى مصر

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أجريت هذه الدراسة لتقدير جودة ثلاث سلالات جديدة من قمح الديورم تم زراعتها بمنطقة توشكى بمحافظة أسوان – مصر كما يلى: عينة سلالة رقم ١ (ACSAD 65, Syria) ، سلالة رقم ٢ (ACSAD 1105, Syria) ، سلالة رقم ٣ (ACSAD 1229, Syria) ومقارنة هذه الأصناف مع صنف (بنى سويف ١).

تم تقدير الخواص الفيزيائية والكيميائية والخواص الريولوجية للعجين لكل من الدقيق الناتج من هذه السلالات. تم استخدام جهاز الفارينوجراف (امتصاص الماء ، مدة التخمر، ثبات العجينة) والأميلوجراف (جلتنة النشا ، درجة حرارة الجلتنة) لتقدير الخواص الفيزيائية والريولوجية للدقيق والعجين الناتج من هذه السلالات والربط ما بين النتائج المتحصل عليها من هذه الأجهزة والتقديرات الأخرى للدقيق الناتج من الأصناف المختلفة مثل (الرطوبة ، البروتين، الرماد). أيضا تم تقدير رقم السقوط والمحتوى من الجلوتين ووجدت اختلافات معنوية بين مختلف الأصناف مقارنة بصنف بنى سويف ١.

وقد أشارت النتائج المتحصل عليها أن السلالة رقم ١ (ACSAD 65, Syria) كانت من أفضل السلالات فى التقديرات ولم تختلف إختلافا معنويا فى معظم التقديرات بالمقارنة مع صنف (بنى سويف ١).