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Quality profile of the most commonly grown wheat varieties in Jordan

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Abstract

Deir alla-6, Um Qais, Haurani, Cham-1 and ACSAD-65 are the most commonly cultivated five wheat varieties in Jordan. Overall quality profile of these wheat varieties was evaluated based on grain, flour and rheological characteristics. The aim of this research was to determine the quality characteristics of the Jordanian wheat that may provide some directions to the breeders to improve the quality of wheat grown in this area. According to results from these analyses, the wheat varieties were classified as durum to hard wheat. Test weights for tested kernels ranged between 64.2 and 64.3 lb/bu. The average grain protein content was 12.32%. ACSAD-65 had the highest gluten index value (75.2). Ash contents were more than 0.88% for all the varieties. Mixing Tolerance Index values ranged from 40 to 80 (BU). Grain, flour and rheological parameters support the conclusion that Jordanian wheat has relatively poor to moderate gluten quality. Resistance and extensibility results in the tested samples showed that flours can be used to produce good quality Arabic flat bread, which requires the extensibility during bread making process. Miller should blend Jordanian wheat with other imported-high-quality-gluten wheat varieties to get appropriate flour characteristics for each end-product. More breeding programs must be applied for Jordanian wheat with desired end-product quality.

Key words: Wheat, flour, quality parameters, rheological properties.

Introduction

Wheat (*Triticum* spp.) is a cereal that is cultivated worldwide. It is the most important human food grain. According to the available data for the last 30 years, there were many wheat varieties cultivated in Jordan. Some of these cultivars disappeared due to several factors, such as climatic conditions (notably drought grain yield) and pest resistance (for example F8, Ammon, Raba, Veery, Stork S and others). The most commonly grown varieties in the last two years include Horany, Sham-1, ACSAD-65, Deir-alla and Um Qais. These varieties are classified either hard or durum wheat and considered more than 97% of the wheat cultivated in Jordan. National Centre for Agricultural Research and Technology Transfer (NCARTT) looks foreword for breeding of wheat varieties planted in Jordan and neighboring countries to improve the characteristics of wheat and other cereals and their resistance to climatic conditions, especially drought [1,2].

Previously, Amr studied effects of genotype, growing location and season on the quality characteristics of Jordanian wheat cultivars ACSAD 65, Deir-alla , Horany, F8, and Stork S. Compared to other durum or bread wheat varieties, Jordanian wheat was low in the protein and gluten content [2]. Also, water absorption values were high and rheological properties were poor. Both ACSAD 65 and Stork S had relatively better rheological properties compared to other varieties [2]. With the extensive breeding studies, their protein and gluten content were improved. Ereifej and Shibli studied the rheological (farinograph and extensograph) and bread-making quality of Jordanian wheat [5]. The results showed significant differences in many characteristics among the wheat grown in Jordan (Horani-27, ACSAD- 65, Amra, Deir Alla-6, Deir-Alla-2, Veery, Korifla, Lacesh, Rabi-S, and Sham-1) and all the durum wheat cultivars produced desirable characteristics for bread making. Amra, Veery, and Lacesh were rated excellent for bread making while the others, including Horani-27, were rated good [5].

Kernel morphology is an important parameter for manufacturing different food products requiring specific grain characteristics. Size and shape are emerged as important breeding objectives. Wheat milling quality is a complex property that involves interaction between grain morphology, separability of bran from endosperm and endosperm fracture [13]. Color of kernel also is an important parameter among wheat classified as red to light or amber (white). White kernel color offers potential for improved milling performance products predominance.

Grain protein composition depends primarily on genotype; it is significantly affected by environmental factors and their interactions [6]. Wheat flour is classified for use in baking on the basis of its texture (soft vs. hard) and chemical properties (primarily protein). It has been recognized that the grain lot mixtures of hard and soft wheat could affect processing quality and end-use performance [8]. Intrinsic quality characteristics determine the milling and bread-making or the end-use performance of wheat. These characteristics include gluten content and quality, falling number, flour yield, ash content, flour color, the amount of damaged starch in flour, bread-loaf volume, grain, texture and color. Hard winter wheat varieties with exceptional intrinsic qualities possess the genetic potential to produce large, uniform kernels with high protein content and good milling and baking performance under favorable growing conditions [3].

Functional properties of wheat flour depend on the quality of raw material and on technological process. With the aim to assure a satisfactory behavior within different production lines, wheat

flours should have special qualities. The bread-baking potential of wheat is typically assessed on the basis of flour protein quantity, through the use of physical dough mixing and recording instruments and through experimental bread-baking procedures. Good bread flours have strong gluten which is indicated by high protein quantity, long peak time, high peak height and long or less negative tolerance values. A combination of short peak time, high peak height and very negative tolerance is a characteristic of weak gluten flour. Weak gluten flours can also have short peak time, low peak height and less negative tolerance. That type of flour could have good cookie baking qualities if it was soft with low protein quantity. Cookie flour is characterized by low water absorption, fine particle-size and low protein content as compared with bread flour milled from hard wheat [9].

Jordan is one of the countries, which are exporting wheat. Imported wheat includes durum, hard and soft wheat varieties. Hard and soft wheat are used for bread and cookie baking, respectively. The objective of this work was to determine the quality parameters of the most commonly grown wheat varieties in Jordan, and to study the chemical and rheological properties of flour and dough of these varieties which evaluate the previous breeding applications and may give the breeders any indication for more improvements in the quality of Jordanian wheat.

Materials and Methods

Grain samples: Wheat samples of five varieties, Deir alla-6, Um Qais, Haurani, Cham-1 and ACSAD-65, from 2006 crop were provided by NCARTT and used to carry out this study. The samples were divided into three subsamples and applied for all tests.

Determination of grain quality: Moisture of grains was determined by AACC 44-15A method. Protein of grains was determined by AACC 46-13 Micro-Kjeldahl method. Test weight of grains was determined according AACC 55-10 method. Determination of 1000-kernel weight was based on three measurements of 100-kernel weight. Ash was determined by AACC 08-3 method expressed on a 14% moisture basis. Kernel size distribution was determined by sifting the grains with a RoTap sifter using a Tyler No. 7 screen (2.82 mm) and a Tyler No.9 screen (2.00 mm). Kernels retained on the No. 7 screen are classified as "Large." Kernels passing through the No. 7 screen and retained on the No. 9 screen are "Medium." Kernels passing through the No. 9 screen are "Small" [1].

Determination of flour quality: Grain samples were cleaned and tempered according to AACC Method 26-10A. Grains were milled on a Brabender Quadrumat mill using the Brabender procedure. Extraction rates were ~ 70%. Moisture of flour was determined by AACC 44-15A method. Ash was determined by AACC 08-3 method. Protein of flour was determined by AACC 46-13 Micro-Kjeldahl method. Wet, dry and gluten index were determined by Glutomatic Method ICC 137 [1,10].

Rheological analyses: Measurements of water absorption %, peak time, dough stability and mixing tolerance index MTI were done by using a Farinograph (Brabender OHG, Duisburg, Germany) according to AACC 54-21 method, constant flour weight procedure. Dough extensibility, maximum resistance to an extension, area of extensogram and the ratio were determined using an extensograph (Brabender OHG, Duisburg, Germany) according to AACC 54-10 method [1].

Statistical analyses: Data analyses were performed using SAS software [14] and LSD test [15] for significant differences at $P \leq 0.05$ among the wheat varieties.

Results and Discussion

Grain quality: Fig.1 illustrates the tested weight for the analyzed kernels which ranged between 64.2 and 64.3 lb/bu. 'Deir alla-6' had the lowest test weight, which was significantly different from the other varieties at $P \leq 0.05$. On the other hand, the 1000-kernel weight values were 42.8, 36.8, 43.8, 37.7 and 36.8 for 'Deir alla-6', 'Um Qais', 'Haurani', 'Cham-1' and 'ACSAD-65' grains, respectively.

Kernel size distribution (Fig. 2) shows greater large kernels percentage for 'ACSAD-65' and 'Deir alla-6' (53.1 and 50.6%) than 'Um Qais', 'Haurani' and 'Cham-1', and the small kernel size not exceed more than 2.2 g for 'Um-Qais' kernels. These results of kernel tests may be affected by the climate conditions during harvesting the grains.

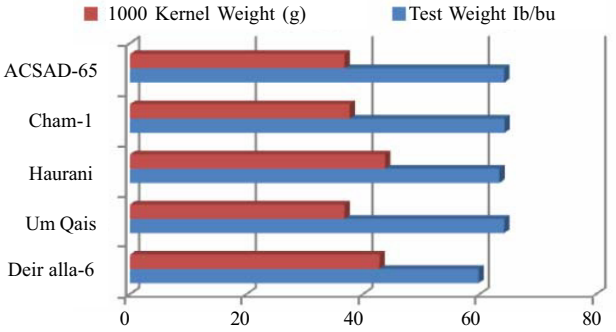

Figure 1. Tested weight and 1000-kernel weight values of wheat varieties.

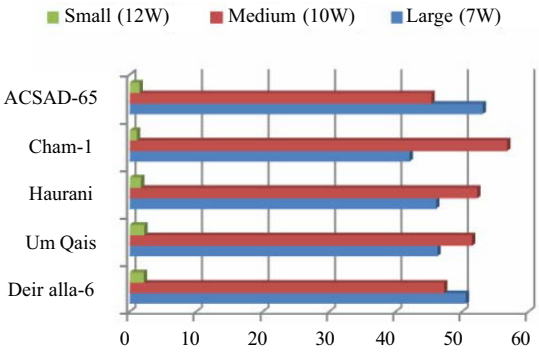

Figure 2. Kernel size distribution values of wheat varieties.

As shown in Fig. 3, both 'Deir alla-6' and 'Cham-1' have around 12% protein content while 'Haurani', 'ACSAD-65' and 'Um Qais' contain 12.6, 12.5 and 12.4 grains, respectively. The results of protein may classify these varieties as hard or durum wheat [7]. Grain protein depends primarily on genotype and it is significantly affected by environmental factors and their interactions [6]. 'Um

Qais' has the lowest moisture content (10.5%) followed by 'Haurani' (10.8%) and 'Cham-1' (10.9%) while the highest moisture content was in 'ACSAD-65' (11.3%). Also these results might be affected by the climate conditions during harvesting the grains, which is known as dry and high temperatures. In general ash percentage was found relatively higher than that of other hard and durum wheat cultivars from other countries. 'Haurani' has the highest ash content 1.76% while other varieties had an average ash content of 1.4%. Higher ash content found in hard and durum wheat grains seems to be one of the factors that control flour color.

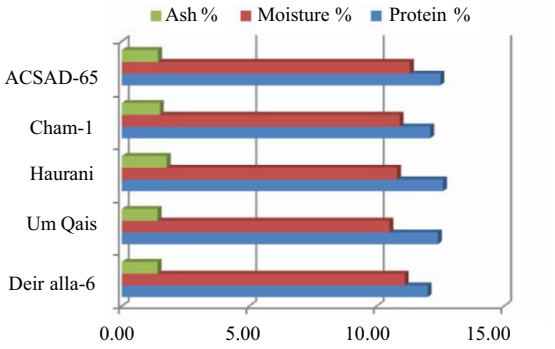

Figure 3. Ash, moisture and protein content of wheat grains.

Flour quality: The quality parameters of wheat flour of the five tested samples are illustrated in Figs 4 and 5. Flour moisture contents were 13.4, 12.7, 13.1, 13.0 and 14.2% for 'Deir alla-6', 'Um Qais', 'Haurani', 'Cham-1' and 'ACSAD-65' flours, respectively. Conditioning of grains during milling process may cause a rise in moisture content. It was found that all wheat flours contained high percentages of ash compared to wheat flour standards [4]. The results were between 0.88% (for 'Deir alla-6' flour) and 1.11% (for 'Haurani' wheat flour).

'ACSAD-65' wheat flour contained 10.5% protein followed by 10.4% for 'Haurani' wheat flour. 'Deir alla-6', 'Um Qais' and 'Cham-1' have protein content around 9.5% with no significant differences at $P \leq 0.05$. These percentages are considered medium protein contents, which may have effect on the gluten quantity and quality as well as on the rheological properties of dough. This effect is illustrated in Fig. 5 in wet, dry and gluten index results. Based on these results, all of tested wheat flours have poor to moderate gluten quality. 'Deir alla-6' has the lowest gluten index of 55.1 in the tested flour samples while the other gluten index values for 'Um Qais', 'Haurani', 'Cham-1'and 'ACSAD-65' were 71.1, 69.7, 69.7, 67.4 and 75.2, respectively and in agreement with results of Amr [2].

Gluten quantity and quality are affected by environmental conditions during growing of wheat, such as nitrogen fertilization, soil fertility, temperature and rainfall [11]. Gluten index is an excellent parameter for evaluation of gluten network in dough as will as on volume of bread. However, flat bread requires gluten quality with enhanced the extensibility during dough molding [7].

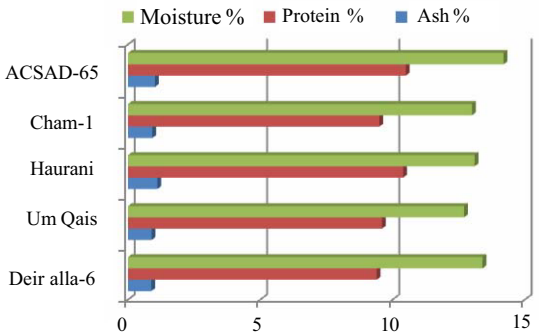

Figure 4. Ash, moisture and protein content of wheat flours.

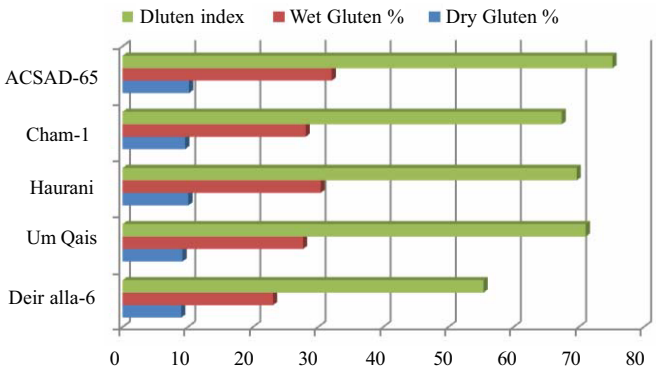

Figure 5. Gluten quantity and quality of wheat flours.

Rheological analyses: Some of farinograph parameters are summarized in Fig. 6. Water absorption is the amount of water that flour can absorb until the dough consistency reaches 500 BU (Brabender Units). Water absorption values were 64.5, 62, 65.7, 63.5 and 66.7% for flours from 'Deir alla-6', 'Um Qais', 'Haurani', 'Cham-1' and 'ACSAD-65', respectively. The time needed for the curve to reach the peak or maximum dough consistency, which indicates the relative strength of the flour, ranged between two minutes in 'Deir alla-6' flour dough to three minutes in 'Haurani' flour dough.

The stability of the dough is the interval time that remains at maximum consistency, and is a very important number in relation to the type of fermentation and mechanical stress, to which dough can be subjected. The stability values were low for the all tested flours. 'ACSAD-65' flour dough had the highest stability for six minutes, which is considered more stable (with a significant difference at $P \leq 0.05$) than that of the other varieties. The second

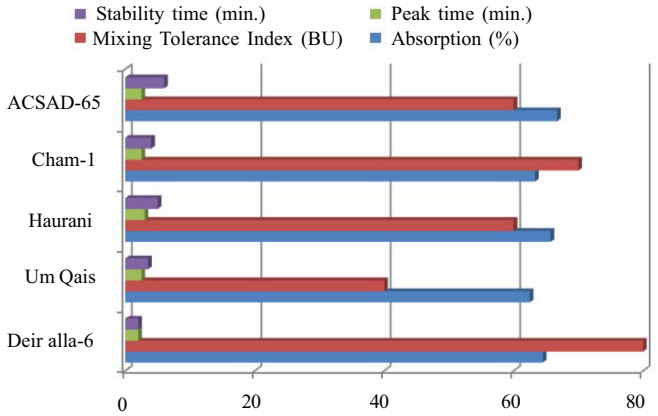

Figure 6. Some of farinograph parameters of wheat flours.

one was 'Haurani' flour dough, which remained five minutes. 'Um Qais' and 'Cham-1' flour dough remained for 3.5 and 4 minutes, respectively. 'Deir alla-6' flour dough had the lowest stability by having two minutes. The mixing tolerance index (MTI) for all tested samples was higher than for other hard and durum wheat flours in other references, which indicates to the poor gluten quantity and quality in these varieties. Both 'Haurani' and 'ACSAD-65' flours have 60 (BU) while 'Deir alla-6' 80 (BU), 'Cham-1' 70 (BU) and 'Um Qais' had the lowest value of 40 (BU).

A combination of the resistance and extensibility results from the tested samples of Jordanian wheat dough properties are shown in Fig. 7. Extensibility of the dough is the measurement of its elasticity, which ranged from 150 mm in 'Deir alla-6' dough to 162 mm in 'Haurani' dough. No significant difference at $P \leq 0.05$ between 'Um Qais' and 'Deir alla-6' dough extensibility was detected. 'Haurani', 'Cham-1' and 'ACSAD-65' flour dough extensibility average was 161 mm with no significant difference at $P \leq 0.05$ between these cultivars. 'Deir alla-6' had lowest resistance to extension (241 BU) compared to the other tested varieties 'Um Qais', 'Cham-1', 'Haurani' and 'ACSAD-65' dough that had 310, 320, 360 and 380 BU, respectively. Both resistance and extensibility of dough data confirm the above protein, gluten and farinograph analysis results obtained in this study. Area below the extensogram curve (at 45 min) for 'ACSAD-65' dough was the best of all tested samples (77 cm) followed by 76 cm for 'Haurani' dough and 72 cm for 'Cham-1' dough without significant difference at $P \leq 0.05$ between the three varieties. Ratio between extensibility and resistance of dough indicates the medium strength of dough. The ratio value of 2.36 obtained for 'ACSAD-65' dough was higher than 1.6 for 'Deir alla-6' dough

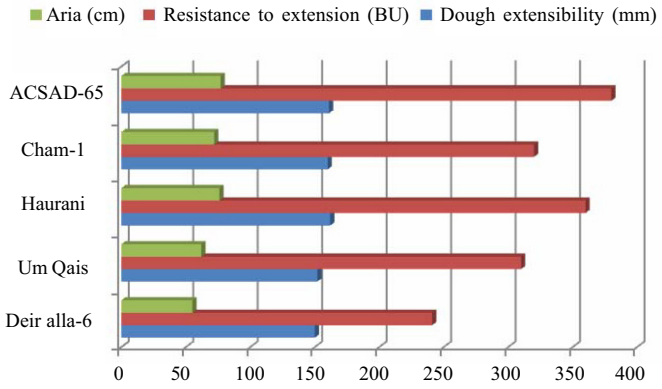

Figure 7. Some of extensograph parameters of wheat flours.

Conclusions

Deir alla-6, Um Qais, Haurani, Cham-1 and ACSAD-65 are the most commonly cultivated wheat varieties in Jordan. Their grain, flour and rheological parameters were analyzed in this study. Based on flour and rheological tests, grains can be considered as durum or hard wheat. The average grain protein content was good with poor to moderate gluten quality. Rheological measurements verified the results obtained from grain and flour analysis that may give a bad gas retention results. In terms of resistance and extensibility results, tested samples were assumed to be good for production of Arabic flat bread, which requires the extensibility during bread making process. Miller should blend Jordanian wheat with other imported varieties to get appropriate flour characteristics for each product. More breeding must be implementing in the cultivated wheat to improve the quality profile, which determines the end-use applications of the Jordanian wheat.

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