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BIOCHEMICAL AND TECHNOLOGICAL CHARACTERIZATION OF PAKISTANI SPRING WHEATS

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Five different spring wheat varieties grown in Pakistan were selected for their biochemical and technological properties. The physical characteristics such as thousand kernel weight and test weight differed significantly among the wheat varieties. The chemical parameters such as moisture content, ash content, crude protein, and Pelshenke value, differed significantly for straight grade flour (SGF) among different wheat varieties. Significantly the highest wet gluten (38.83%) was found in SGF of Iqbal 2000 while the lowest (28.47%) wet gluten content was found in SGF of Kohinoor 83. The dry gluten content ranged from 10.49 to 13.60% between SGF of different wheat varieties. The Pelshenke value ranged from 51.04 to 150.12 minutes in SGF of different wheat varieties. The mineral contents like, calcium, iron, zinc and copper significantly differed among the wheat varieties.

The electrophoretic patterns showed the variation in regions of molecular weight of glutenin subunits with differences in their intensities in different wheat varieties. The highest numbers of HMW-GS polypeptide bands were identified in wheat varieties Iqbal-2000 (102.9 kDa, 98.8 kDa, 87.1 kDa and 80.8 kDa). The low molecular weight glutenin subunits (LMW-GS) represented approximately 60% of the total wheat glutenin fractions of different wheat varieties, and their molecular weight ranged from 32.9 kDa to 67.0 kDa. The wheat variety Iqbal-2000 showed the presence of LMW-GS of ~42 kDa which play only a major role in determining the good bread making quality characteristics. The sensoric attributes of breads varied significantly among different wheat varieties. The highest scores for different parameters were assigned to breads prepared from flour of C-273 and Iqbal 2000 while significantly the lowest were given to the breads prepared from wheat variety Punjab 96. The information obtained in this study can be useful for millers and bakers for the selection of suitable variety for their intended uses.

Keywords: Straight grade flour, characterization, SDS-PAGE of glutenin subunits, sensory attributes

INTRODUCTION

The wheat is a staple food of Pakistani peoples and contributes more than 60% to the total requirements for the calories and proteins in average daily life. In Pakistan major cultivated area is devoted to wheat. Wheat is a cheaper source of calories, protein, and fiber in human nutrition. In Pakistan wheat was grown on an area of 8.49 million hectares which produced 23.52 million tonnes of grains (GOP, 2008).

In the world about 65% of wheat grain is used directly as human's food, 21% as a feed for animals, 8% as a seed, and the remaining 6% goes for other industrial applications. In Pakistan about 80% of the total wheat produced is used for the production of unleavened flat bread locally known as "chapatti" and its culinary variations like "tandoori roti", "naans", "prathas" and "poories". However, 20% of the rest is used for other bakery products such as breads, cookies, cakes and pastries etc.

The quality of wheat is generally assessed on the basis of different physical, chemical and biochemical properties. The products prepared from wheat grains require different quality characteristics. The wheat flour's ability to be processed into different food products is mainly determined by the contents and quality of gluten proteins (Weegels *et al*., 1996). The mature wheat grains contain 8% to 20% protein. The gluten proteins constitute up to 80% to 85% of total flour proteins and are responsible for imparting elasticity and extensibility properties to the dough essential for functionality of wheat flours (Shewry *et al*., 1999). The main constituents of the gluten are gliadins and glutenins. The unique elastic and cohesive properties of wheat dough are mainly due to glutenin and which determines the end use quality of the baked products. Two major classes of glutenin subunits have been identified in wheat endosperm, the high molecular weight (HMW) glutenins (80 -130 kDa) and the low molecular weight (LMW) glutenins (10-70 kDa) (Bietz and Walls, 1980). High molecular weight glutenins (HMW-GS) subunits make the dough elastic whereas LMW-GS play an important role with respect to dough resistance and extensibility (Cornish *et al.,* 2001).

MATERIALS AND METHODS

Collection of wheat samples

Five wheat varieties were collected from Wheat Research Institute, Faisalabad grown during the crop year 2005-06. The wheat varieties were evaluated for various parameters described here under.

Physical Tests

Thousand kernel weight

Thousand kernel weights were recorded in grams/1000 kernel. Representative sample (50g) of each wheat variety was drawn randomly and thousand-kernel weight was recorded by counting and weighing the clean, unbroken and sound kernels.

Test weight

The test weight of each wheat variety was measured according to the procedure given in AACC (2000) method No.55-10.

Milling

Straight grade flour

Two kg grains of each wheat variety was tempered to 16.0 % moisture level and was allowed to stand to equilibrate the moisture content in the wheat grains for 24 hrs at room temperature. The quantity of water required to temper the wheat grains for each variety was calculated according to the expression given in AACC (2000) method No. 26-95. The tempered wheat grains were milled through a Brabender Quadrumate Senior Mill (C.W. Brabender Instruments, Inc.) The straight grade flour was prepared by blending the two flour fractions i.e. break flour and reduction flour.

Chemical analysis

The whole meal wheat flour and straight grade flour of each wheat variety were tested for chemical characteristics as described below.

Moisture content

The moisture content was determined in each flour sample according to the procedure of AACC (2000) method No. 44-15.

Crude protein

The Kjeldhal's method as described in AACC (2000) method 46-10 was used to determine nitrogen content in each sample and crude protein percentage was calculated by multiplying the nitrogen percent with a conversion factor 5.7.

Ash content

The ash content in each flour sample was determined as a total inorganic matter by following the procedure given in AACC (2000) method No. 08-01.

Pelshenke value

The whole wheat meal flour of each wheat variety was tested for Pelshenke value according to AACC (2000) method No 56-50.

Wet and dry gluten

Wet and dry gluten contents in different flour samples were estimated by using hand washing method as detailed in AACC (2000) method 38-10.

Mineral content

The flour samples of each wheat variety were tested for mineral contents i.e. Ca, Fe, Cu, Zn and Mn by using Atomic Absorption Spectrophotometer (A Analyst 100, Agilent, Norvalk, C.T., USA). As described in AOAC (1984) method No. 3.014-016.

Protein fractionation

The protein fractions i.e. high molecular weight (HMW) and low molecular weight (LMW) glutenin proteins from flour samples of each wheat variety were fractionated, using a modified sequential extraction standard methods developed by Curioni *et al.(* 2000).

Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE)

Each flour sample was run for SDS-PAGE analysis according to the basic method described by Laemmli (1970) and as modified by Singh and Shepherd (1985). The dried protein pellets were solubilized in 250 ul of a sample buffer and then used for analysis.

Preparation of bread

The bread was prepared according to the AACC (2000) straight dough method 10-10B. The ingredients were mixed for 5 minutes in a Hobart A-200 Mixer to form dough and allowed to ferment at 30°C and 75% R.H. for 180 minutes. First and second punches were made after 120 and 150 minutes, respectively. The dough was molded and panned into 100 g test pans, and final proofing was done for 45 minutes at 95 °F (35°C) and 85% R.H. The bread was baked at 232°C for 25 minutes.

The sensory scores for external and internal characteristics were recorded for each loaf by a panel of trained judges according to the bread score method developed by the American Institute of Baking and reported by Matz (1960).

Statistical analysis

The data obtained for each parameter was analyzed through Statistical Package Co-Stat-2003 (Cohort v-6.1). The analysis of variance was applied to determine

the level of significance. Moreover, Duncan multiple range test (DMRt) was applied to explore the significant ranges in different cultivars for their various quality attributes.

RESULTS AND DISCUSSION

Physical characteristics of wheat varieties

Thousand kernel weight and test weight

Significantly the highest 1000 kernel weight (40.00 g) was exhibited by the grains of wheat variety Uqab 2000 followed by Punjab 96 (35.87 g), while significantly the lowest 1000 kernel weight (28.99 g) was found in the grains of wheat variety Kohinoor-83 (Table 1). The wheat varieties C-273 and Iqbal 2000 were found statistically at par with respect to their 1000 kernel weight as recorded 34.29, 34.76g, respectively for these wheat varieties.

The results pertaining to 1000 kernel weight in the present study are in line with the earlier findings of Ahmad (2001) and Randhawa *et al*., (2002) who found ranges from 28.00 to 50.00 g for 1000 kernel weight of different wheat varieties grown in Pakistan. The 1000 kernel weight is a useful tool for the assessment of the potential milling yield. The kernel size contributes directly towards the improvement of grain yield as well as milling yield. The present study suggests that all the wheat varieties possessing better grain weight offering great potential for better milling yield and wide variation in grain weight can be exploited by the wheat breeders to improve this trait in the new genotypes.

The results in Table 1 indicated significantly the highest test weight of wheat variety C-273 (78.00 kg/hl) followed by Iqbal 2000 (76.90 kg/ hl). The grains of Kohinoor 83 yielded significantly the lowest test weight (66.47 kg/hl). The wheat varieties C-273 and Iqbal 2000 exhibited test weight more than 75 kg/hl. The wheat variety Kohinoor 83gave test weight less than 70 kg/hl.

The test weight is considered to be one of the most important criterions in all wheat grading systems (Posner and Hibbas, 1999) and the test weight is generally employed as a rough indicator of the flour yield during roller flour milling. The results of the present study are in consistency with the earlier findings of the researchers Zahoor (2003), Anjum *et al*. (2002) and Randhawa *et al.,* (2002) who reported some variations from 68.30 to 81.00 kg/hl in different Pakistani wheat varieties. Martin *et al.* (2001) found test weight from 66.20 to 80.20 kg/ hl in 130 hard red spring wheat recombinant inbred lines grown at different locations of USA. The differences in the test weight reported by U.S researchers may be attributed to the difference in climatic conditions, cropping practices and genetic makeup of the varieties.

Chemical analysis

Moisture content

The results showed that the moisture content in straight grade flour differed among wheat varieties. The moisture content ranged from 12.92 to 13.42 % in straight grade flours among different wheat varieties. It is also obvious from the results (Table 1) that significantly the highest moisture content (13.42%) was found in the SGF of wheat variety Punjab 96 while wheat variety C-273 yielded the lowest moisture content (12.92%) in SGF. The wheat varieties Iqbal 2000 and Uqab 2000 were statistically identical with respect to the moisture contents in SGF. The moisture content in SGF of wheat varieties obtained in the present study fall within the limits reported by Whiteley (1970) who found variation in SGF from 11 to 15 % depending upon the storage conditions and hygroscopic nature of wheat starch. The variation in the moisture content of different wheat varieties might be attributed to genetic factor and climatic factors. The present findings are in consistent with the findings of different workers (Slaughter *et al*., 1992) and (Mahmood, 2004) who told that moisture content is dependent both on genetic make up of varieties and climatic factors and agronomic conditions experienced during growth period.

Table 1. Physico-chemical characteristics of different spring wheat cultivars

Varieties	Thousand K. wt (g)	Test Weight (kg/hL)	Moisture (%)	Crude Protein (%)	Crude Ash (%)	Pelshenke Value (min)	Wet Gluten (%)	Dry Gluten (%)
C-273	34.29±1.57	78.00±3.57	12.92±0.22	10.50±0.18	0.47±0.01	150.12±2.60	37.10±0.64	13.60±0.22
Iqbal-2000	34.76±0.60	76.90±1.33	13.01±0.60	11.60±0.53	0.55±0.03	98.15±4.50	38.83±1.78	12.90±0.46
Kohinoor-83	28.99±0.50	66.47±1.15	13.25±0.70	10.23±0.54	0.51±0.04	51.04±2.70	28.47±1.51	10.49±0.63
Punj-96	35.87±1.64	73.00±3.35	13.42±0.88	10.25±0.67	0.41±0.04	55.80±3.66	38.31±2.51	12.77±0.74
Uqab-2000	40.00±1.83	74.00±3.39	13.09±0.35	11.45±0.30	0.55±0.02	68.09±1.80	35.18±0.93	11.73±0.28

Crude protein content

The results given in Table 1 also indicated that the crude protein content ranged from 10.23 to 11.60 % in straight grade wheat flours among different wheat

varieties. The results revealed that the highest protein content (11.60%) was found in the SGF of Iqbal 2000 and the lowest protein content (10.23%) was observed in SGF of wheat variety Kohinoor 83. The wheat varieties Kohinoor 83 and Punjab 96 possess statistically similar contents of protein. The results of the present study are in consistent with the results reported by Anjum *et al.* (2005) who reported variation in protein content from 9.68 to 13.45 % among Pakistani wheat varieties. The results are also supported by the studies of Randhawa *et al., (*2002), Ahmad (2001) and Mahmood (2004) who found variation from 9.71% to 15.42% in protein content of different wheats. The protein content is an important criterion for assessing wheat quality. The differences in protein content among different wheat varieties could be related to the studies of Kent and Evers, (1994), Gupta *et al.*(1993)*,* who stated that quantity of protein depends on genotype, environment and the growing conditions.

Ash content

It is obvious form the results given in Table 1 that the ash contents in SGF ranged from 0.41 to 0.55%, respectively among different wheat varieties. It is also evident that significantly the highest ash content (0.55%) was found in the SGF of Iqbal 2000 and Uqab 2000. Significantly the lowest ash content (0.41%) was yielded by SGF of wheat variety Punjab 96. The ash content is also one of the best indicators of flour yield; hence the wheats with lower content of ash may have more endosperm and ultimately yield good flour extraction (William *et al*., 1986). The differences observed in the ash content in the present study among wheat varieties may be ascribed to differences in wheat genotypes and environmental conditions. The ash content in SGF of different Pakistani wheat varieties has been found to vary from 0.37 to 0.58 % (Afzal, 2004).

Wet and dry gluten

The wet gluten ranged significantly from 28.47 to 38.83 % in SGF of different wheat varieties. Significantly the highest wet gluten (38.83 %) was found in SGF of variety Iqbal 2000 followed by Punjab 96 (38.31%). However, significantly the lowest (28.47%) wet gluten content was found in SGF of Kohinoor 83. The results are also in consistent with the findings of Miralbes (2003) who found variation from 15.6 to 39.3 % in wet gluten of different wheat varieties. The variation in wet gluten among the wheat varieties found in the present study may be attributed to the differences in genotypes and the environmental conditions like temperature and rainfall as reported by Wrigley *et al*. (1982). The dry gluten content in SGF of different wheat varieties ranged from 10.49 to 13.60%. The highest dry gluten content (13.60%) was found in the SGF of C-273 followed by Iqbal 2000 (12.90%) while the lowest dry gluten content (10.49%) was recorded in SGF of wheat variety Kohinoor 83. The wheat varieties Punjab 96 and Iqbal 2000 were found to be statistically at par regarding dry gluten contents in SGF. The gluten content of the protein determines the flour quality and has significant impact on bread making quality (Kent and Evers, 1994). The gluten content of different Pakistani wheat varieties has been found similar to those who observed differences among different wheat varieties ranging from 7-17% (Randhawa *et al.,* 2002; Lin *et al.,* 2003; Pasha *et al.,* 2007). The wheat varieties Iqbal 2000 and C-273 possessing higher wet and dry gluten content may have better potential for bread making and should be used to explicit their potential in the development of new varieties by the wheat scientists.

Pelshenke value

The Pelshenke value ranged from 51.04 to 150.12 minutes in SGF of different wheat varieties (Table 1). The Pelshenke value was found significantly the highest in the SGF of C-273 (150.12 minutes) followed by Iqbal 2000 (98.15 minutes). The Pelshenke value (51.04 minutes) was measured significantly lowest in SGF wheat variety Kohinoor 83 (Table 1). The Pelshenke test is one of the most important tests used by the wheat scientists to evaluate their breeding material for the assessment of gluten strength. The results regarding Pelshenke value obtained in the present study are in close agreement with the earlier findings of Randhawa *et al.,* (2002) who found Pelshenke values varying from 108-185 minutes among different Pakistani wheat varieties. The wheat variety C-273 may have strong gluten proteins and should be used for exploit this trait in new genotypes.

Mineral contents

The results in Table 2 indicates that significantly the highest zinc content (2.10 mg/100g) was measured in the SGF of Iqbal 2000 while the lowest zinc content (0.90 mg/100g) was observed in SGF of Punjab 96. The results of the present study regarding zinc content of different wheat varieties are in line to the earlier findings of Wahab (2003) who reported that zinc content ranged from 31.35 to 33.52 ppm in wheat varieties cultivated in Sarhad province. The studies of Anjum *et al.* (2002) also support the present results as the concentration of zinc was found by them ranged 9.0 to 81ppm in some Pakistani spring wheat varieties. However, slight variation between the results of

present and earlier studies might be due to differences in genetic makeup of wheat varieties and agro climatic factors experienced by the varieties tested in different studies.

Table 2. Mineral contents of SGF of different spring wheat cultivars

Varieties	Zinc (mg/100g)	Iron (mg/100g)	Copper (mg/100g)	Calcium (mg/100g)
C-273	1.10±0.02	2.36±0.04	0.25±0.00	30.81±0.53
Iqbal-2000	2.10±0.10	2.90±0.13	0.15±0.01	25.06±1.15
Kohinoor-83	1.24±0.07	2.25±0.12	0.17±0.01	23.15±1.22
Punj-96	0.90±0.06	2.78±0.18	0.20±0.01	26.15±1.71
Uqab-2000	1.32±0.03	2.23±0.06	0.17±0.00	22.94±0.61

It is also obvious from the results (Table 2) that significantly the highest iron content was found in SGF of Iqbal 2000 (2.90 mg/100g) followed by Punjab 96 (2.78 mg/100g) ,C-273 (2.36 mg/100g) and Kohinoor 83 (2.25 mg/100g). The iron content was found significantly lowest (2.23 mg/100g) in SGF of wheat variety Uqab 2000. The iron content did not differ significantly in SGF of wheat varieties Kohinoor 83 and Uqab 2000. The wheat flour containing higher amount of iron content is beneficial to the population suffering with anemia which may help to alleviate iron deficiency anemia (IDA). Iron deficiency anemia reduces a person's ability to perform physically demanding tasks and anemic labourers have demonstrated productivity (Basta *et al*., 1990). The results of the present study (Table 2) with respect to iron content fall within the ranges reported by MacGrath (1995) who found iron content ranging from 12.07 to 73.62 ppm in UK wheat samples. Ragaee *et al*. (2006) have also reported iron content 13.20 ppm in hard wheats and 13.9 ppm in soft wheats. The results in this study are also supported by the work done by Pasha (2006), Anjum (2002) and Wahab (2005) who reported significant differences in iron content among wheat varieties. Iron deficiency anemia is one of the identified micronutrient deficient in all over the world including Pakistan. The most vulnerable segment of the population suffering from IDA is children below 5 years, pregnant and lactating women. Therefore the wheat varieties possessing higher content of iron such as C-273, Iqbal 2000 and Punjab 96 should be explored for consumption which can help to reduce the deficiency of this micronutrient in our country.

The copper content in SGF of different wheat varieties varied significantly from 0.15 to 0.25 mg/100g. The highest copper content in SGF of wheat varieties C-273 (0.25 mg/100g) followed by Punjab 96 (0.20 mg/100g), Kohinoor 83 and Uqab 2000 (0.17 mg/100g) The lowest copper content (0.15 mg/100g) was found in wheat variety Iqbal 2000. Copper is an essential nutrient for the maintenance of normal hemoglobin status and it is also a part of many enzyme systems. The results of present study are in close agreement with the findings of earlier studies of Anjum *et al.* (2002) who held that copper content in whole wheat flour of some Pakistani wheats ranged from 10.00 to 17.50 ppm. Wahab (2003) found variation from 9.72 to 11.01 ppm in copper content of different Pakistani wheats. Lopez *et al*. (2003) reported 1.2 ppm copper content in whole wheat flour. Similarly Pasha (2006) found significant variation in copper content among different Pakistani wheat varieties. Significant variation in the wheat varieties tested in the present study indicated that wheat varieties containing higher concentration in SGF such as C-273, Punjab 96 and Uqab 2000 should be used as a source of high copper content in the biofortification programmes to be taken up for the improvement of copper content in new varieties.

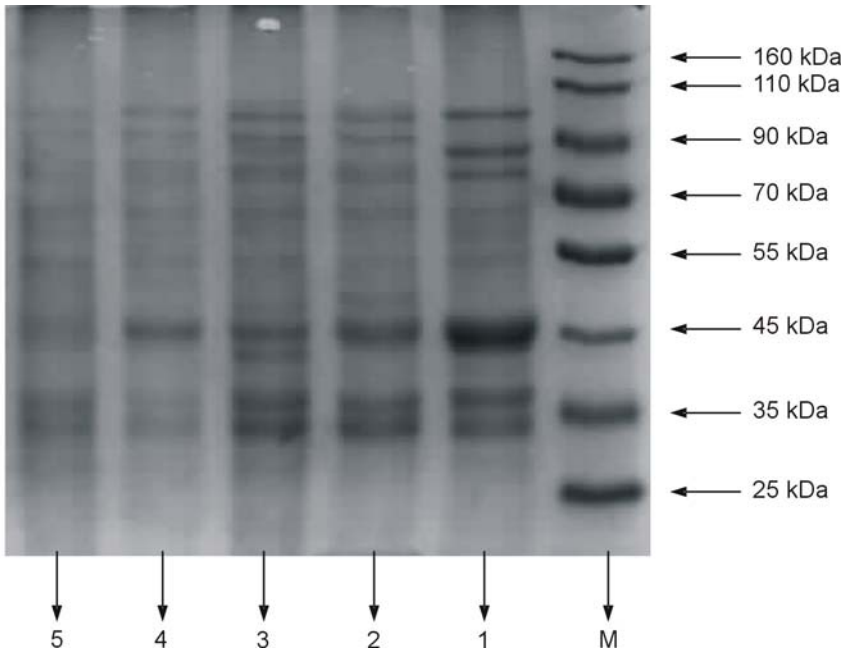
The results further showed that the calcium content varied from 23.15 to 30.81 mg/100g in SGF of different wheat varieties. Significantly the highest calcium content was recorded in SGF of wheat variety C-273 (30.81 mg/100g) followed by Punjab 96 (26.15 mg/100g), Iqbal 2000 (25.06 mg/100g) and Kohinoor 83 (23.15 mg/100g) and the lowest calcium content (22.94 mg/100g) was found in the SGF of Uqab 2000. The results regarding the calcium content in straight grade wheat flours are supported by the findings of Ragaee *et al*. (2006) who reported 159.50 mg/kg calcium content in hard wheats and 202.2 mg/kg in soft wheats. Lopez *et al*. (2003) have reported 348.0 mg/kg calcium content in whole wheat flour. Hussain (1985) reported that whole wheat flour contained 430 mg/kg calcium. Wahab (2003) and Pasha (2006) also found calcium content in the same ranges as observed in the present studies. The slight differences in the results may be attributed to the differences in genetic make up of varieties and climatic as well as agronomic conditions of the varieties tested in different studies.

The wheat possessing higher concentration of these micronutrients should be explored for commercial

exploitation in biofortification programmes to alleviate the micronutrient deficiencies prevailing in our country.

SDS-PAGE characterization

The high molecular weight glutenin subunits (HMW-GS) and low molecular weight glutenin subunits (LMW-GS) fractions in different wheat varieties were determined through SDS-polyacrylamide gel electrophoresis (PAGE) and the results interpreted from electrophoretograms are shown in Figure 1 as well as in Table 3. Two major classes of glutenin polypeptides have been identified in different wheat varieties which were designated as HMW-GS and LMW-GS. It is evident from the electrophorogram that more number of polypeptides were present in the region falling under low molecular weight glutenin subunits. The electrophorogram showed the presence of two electrophoretic bands in the region of 33kDa and 36kDa in all the tested wheat varieties. One polypeptide of LMW-GS in the region around 45kDa was also present in all wheat varieties. The electrophorogram also indicated the presence of electrophoretic band around the region 54kDa with exception of Kohinoor 83 in all other wheat varieties. With respect to high molecular weight glutenin subunits (HMW-GS), the polypeptides were present in the



M = Marker, 1 = C-273, 2 = Iqbal-2000, 3 = Kohinoor-83, 4 = Uqab-2000, 5 = Punjab-96

Fig. 1. Presence of HMW-GS and LMW-GS in different wheat varieties by SDS-PAGE

Table 3. Presence of HMW-GS and LMW-GS in different spring wheat cultivars

Band #	C-273		Iqbal-2000		Kohinoor-83		Uqab-2000		Punjab-96	
	M. wt. (kDa)	Intensity	M. wt. (kDa)	Intensity	M. wt. (kDa)	Intensity	M. wt (kDa)	Intensity	M. wt. (kDa)	Intensity
1	99.7	Dark	102.9	Dark	101.1	Dark	100.1	Light	102.2	Light
2	91.6	Dark	98.8	Dark	93.3	Dark	92.0	Light	93.4	Light
3	80.9	Dark	87.1	Dark	80.2	Dark	79.9	Light	76.6	Light
4	66.3	Light	80.8	Dark	74.6	Light	66.6	Light	67.0	Light
5	53.9	Light	65.9	Light	65.6	Light	52.4	Light	53.9	Light
6	45.1	Dark	54.8	Light	48.1	Dark	45.7	Dark	51.8	Dark
7	36.2	Dark	44.9	Dark	44.4	Dark	35.4	Dark	45.0	Dark
8	33.4	Light	42.1	Dark	35.3	Dark	32.9	Dark	36.1	Dark
9			35.8	Dark	32.9	Dark			33.0	Light
10			32.7	Dark						

region around 80kDa in all wheat varieties except wheat varieties Punjab-96. The electrophoretic bands in the region of 90kDa – 92kDa were also identified in all the wheat varieties except Iqbal 2000. It is obvious from the electrophoretic patterns that there was a variation in regions of molecular weight of glutenin subunits with differences in their intensities in different wheat varieties. The highest numbers of HMW-GS polypeptide bands were identified in wheat varieties Iqbal-2000 (102.9 kDa, 98.8 kDa, 87.1 kDa and 80.8 kDa). It is well known that HMW-GS strongly contributes to the rheological properties of dough. The presence of particular subunits has also been associated with superior bread making quality. The reason of this relationship is still unclear but may have importance due to cysteine aminoacid which affects the degree of cross linking and to the structural regularity, thus affecting the elasticity of the molecule (Shewry *et al*., 1992). The low molecular weight glutenin subunits (LMW-GS) represented approximately 60% (Bietz and Wall, 1973; Zhang *et al.*, 2004) of the total wheat glutenin fractions of different wheat varieties, and their molecular weight ranged from 32.3 kDa to 67.4 kDa (Bietz and Wall, 1973). The LMW-GS in wheat varieties ranged from C-273 (33.4 kDa to 66.3 kDa), Iqbal-2000 (32.7 kDa to 65.9 kDa), Kohinoor-83 (32.9 kDa to 65.6 kDa) Uqbab-2000 (32.9 kDa to 66.6 kDa), Punjab-96 (33.0 kDa to 67.0 kDa). The variation observed in electrophoretic bands with respect to LMW-GS in the present study is in concordance with the findings of Gianibelli *et al.,* (2001) who also reported range of low molecular weight glutenin subunits (LMW-GS) from 10 kDa to 70 kDa. The LMW-GS may have a pronounced effect in determining the physical dough properties of flour during bread making (Gupta and McRitchie, 1994). The wheat varieties Punjab-96 and Iqbal-2000 contained more bands of LMW-GS which may have good physical dough properties of flour during bread making as reported by Gupta and McRitchie, 1994. In the present study the wheat variety Iqbal-2000 showed the presence of LMW-GS of ~42 kDa which play only a major role in determining the quality characteristics. LMW-GS ~42 kDa was also isolated and studied by Masci *et al.,* (1998) who reported that this ~42 kDa subunit as a linear chain extender (Lew *et al.,* 1992) capable of enhancing chain length during glutenin polymer formation. Masci *et al.* (2000) also described the presence of LMW-GS 42 kDa indicating the good quality of bread wheat. In the present study the wheat variety mentioned above has shown presence of this LMW-GS 42 kDa which indicates that these wheat varieties might possess good quality of bread.

Sensory characteristics of bread

The results indicated a significant variation in loaf volume scores of breads as a function of varietals differences. The highest scores (7.35) were assigned to loaf volume of breads prepared from flour of C-273 followed by Iqbal 2000 (7.33), Uqab 2000 (7.20). Significantly the lowest scores (7.00) for loaf volume were given by the panelist to the breads prepared from wheat varieties Kohinoor 83 and Punjab 96.

The scores assigned to mastication of breads prepared from SGF of different varieties ranged from 6.44 to 7.84 scores (Table 4). The wheat varieties C- 273 got significantly the highest scores whereas the wheat varieties Punjab 96 and Uqab 2000 were ranked at bottom by judges for mastication of bread. Significantly the highest scores were assigned to texture of breads prepared from C-273 and Iqbal 2000. The results in Table 4 further indicated that the breads prepared from wheat variety C-273 got the maximum scores (11.40) whereas minimum scores (10.40) for taste were assigned to breads prepared from wheat variety Punjab 96. The highest scores for aroma were given to bread prepared from wheat varieties C-273 and Iqbal 2000 by judges.

Table 4. Sensory characteristics of bread prepared from straight grade flour of different spring wheat cultivars

Varieties	Mastic.	Texture	Taste	Aroma	Loaf V
C-273	7.84±0.49	11.48±0.71	11.40±0.71	7.60±0.47	7.35±0.46
Iqbal-2000	6.80±0.48	11.16±0.78	11.61±0.81	7.60±0.53	7.33±0.51
Kohinoor-83	7.02±0.30	10.84±0.46	10.84±0.46	6.50±0.28	7.00±0.30
Punj-96	6.44±0.41	10.60±0.68	10.40±0.67	7.00±0.45	7.00±0.45
Uqab-2000	6.48±0.16	10.56±0.26	10.84±0.27	6.80±0.17	7.20±0.18

The differences in the scores assigned to different attributes in present study may be ascribed to the differences in chemical composition of wheat varieties especially the crude protein, wet and dry gluten content. The results of the present study are also supported by the earlier findings of Stewart (1977), Preston *et al.* (1992), Zahoor (2003) and Butt (1997) who reported that sensory attributes of breads are significantly affected by wheat varieties. They concluded that genetic factors, damaged starch and alpha amylase activity of flours may have significant effect on sensory attributes of breads prepared for different wheat cultivars. Therefore the differences in bread quality attributes may mainly be due to differences in genetic make up. In the present study

existence of significant variation in sensory parameters of breads prepared from different wheat varieties suggested that wheat varieties possessing higher scores such as C-273and Iqbal 2000 (which also contains 42 kDa protein which is the indication of good bread making quality) should be used by the bakers. In bread purposes this information is useful to the wheat scientists to exploit the potential of these good bread quality wheats in their future breeding programmes.

CONCLUSION

In conclusion, thousand kernel weight, test weight and other chemical characteristics like crude protein, ash, wet and dry gluten and Pelshenke value differed significantly among the wheat varieties. The wheat possessing higher concentration of these micronutrients should be explored for commercial exploitation in biofortification programmes to alleviate the micronutrient deficiencies prevailing in our country. The wheat variety Iqbal 2000 has shown presence of this LMW-GS 42 kDa which indicates that this wheat variety might possess good quality of bread. Significant variation existed among the wheat varieties with respect to bread making quality and wheat varieties recommended in the present study on the basis of possessing high scores should be used by the bakers for bread production. The specified varieties have characterized with special reference to their low molecular weight glutenin sub-units and previously no work has been done on LMW-GS of Pakistani wheat varieties. Further varieties should be characterized with LMW-GS.

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