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Quality Evaluation of Different Wheat Varieties for the Production of Unleavened Flat Bread (Chapatti)

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Abstract: Seven wheat varieties i.e. Inqulab 91, Bhakkar 2002, AS 2002, Shafaq 2006, Sehar 2006, Auqab 2000 and GA 2002 collected from different locations of Punjab were subjected to physicochemical, rheological and sensory analysis to determine their suitability for chapatti preparation during 2006-2008. The quality parameters studied were test weight, 1000 kernel weight, foreign matter, broken/shrunken, damaged grains, moisture, ash, protein, wet and dry gluten, falling number and farinographic properties. Chapattis were prepared from whole-wheat flours and evaluated for colour, taste, flavor, texture, chewing ability, folding ability and overall acceptability. Shafaq 2006 had the maximum test weight (81 kg/hl) thousand kernel weight (41.50 g) and minimum non-edible foreign matter (0.24%), moisture (9.11%) and protein (11.53%) Auqab 2000 had the highest other damaged grains (0.79%), lowest falling number (374) and tolerance index (25 BU) whereas Sehar-2006 had the highest protein (12.78%), wet gluten (29.59%), dry gluten (10.20%), dough development time (5.50 min) and lowest edible foreign matter (0.37%), broken/shrunken grains (0.70%) and softening of dough (43.33 BU). Chapattis prepared from AS 2002 were ranked highest and more acceptable than others. The comparison of studied quality parameters of wheat varieties with Pakistan standard specifications revealed good quality wheat.

Key words: Wheat varieties, physicochemical, farinographic properties, sensory evaluation, chapatti

INTRODUCTION

Wheat is the most important cereal crop and staple food of about two billion people around the world. In Pakistan, bread wheat (*Triticum aestivum* L.) has remained the crux of self-sufficiency program. As a consequence of Green Revolution, Pakistan was the first country in Asia to achieve self-sufficiency in wheat (Hussain and Qamar, 2007). Pakistan wheat falls in the category of medium hard to medium soft group on the basis of particle size index values (Ahmad *et al*., 2001). Grain yield and quality of a crop variety is the end result of interactions between the variety and the environment in which it is grown (Kent and Evers, 1994).

Wheat quality depends upon the genetic factors but environmental conditions, growth locations; agronomic practices prevailing during different wheat growth stages greatly alter the wheat quality attributes. Generally wheat quality refers to its suitability for a particular end-use based on physical, chemical and nutritional properties of wheat grain. Protein content is a key quality factor that determines the suitability of wheat for a particular type of product as it affects other factors including mixing tolerance, loaf volume and water absorption capacity (Shah *et al*., 2008). Both protein quantity and quality are considered important in estimating the potential of flour for its end use quality (Farooq *et al*., 2001).

In Pakistan, due to concerted research efforts made by scientists national average grain yield has been elevated from 920 kg/ha in 1947-48-2451 kg/ha in 2007-08 (GOP, 2009). However, crop improvement programs are more bulk oriented than catering for quality needs of various end-users. The wheat varieties developed are general purpose and put to all uses i.e. chapatti, bread, confectionery, noodles and spaghetti etc. It is estimated that almost 90% of the total wheat produced is used for chapatti production. The sensory qualities of chapatti are affected by wheat variety composition, method of milling, storage conditions, rheological properties, kneading techniques, baking method and temperature (Siddique, 1989). Punjab wheat is grown over wide agro climatic range and is expected to exhibit yield and quality differences (Chaudhry *et al*., 1995). Hence the need is justified to evaluate physicochemical characteristics of different wheat varieties grown in Punjab and to assess their suitability for end use especially chapatti.

MATERIALS AND METHODS

Collection of raw material: Two hundred and seventy wheat samples were collected randomly from nine regions of Punjab for three consecutive crops, 2006, 2007 and 2008. Each year 90 samples were collected randomly. Samples were drawn directly from farmers field. Wheat samples were packed airtight in polyethylene bags and taken to Food Quality and Nutrition Program (FQNP) Lab. National Agricultural Research Centre (NARC). Out of 270 samples, 214 wheat samples of certified varieties were selected for the study. Representative samples of different varieties from every regions were prepared for physico-chemical analysis. For Farinographic studies and chapatti

preparation, individual variety samples were further combined to make a composite sample of each variety per year. Physico-chemical, farinographic analysis of composite samples and sensory evaluation of prepared chapatti were done in triplicate each year.

Physical characteristics of wheat: Wheat samples were uniformly divided through Boerner Divider and analyzed for physical quality characteristics such as thousand kernel weight, test weight, foreign matter, broken/shrunken grains and damaged grains according to standard procedures as described in AACC (2000). Thousand kernel weight was taken on Sartorius analytical balance after counting wheat kernels on Seedburo seed counter, whereas, test weight was determined with Schopper Chondrometer and expressed as kilogram per hectoliter (kg/hl). All matter that passed through a 0.064 inch x 3/8-inch oblong hole sieve was calculated as broken/ shrunken grains. Edible foreign matter included grains of barley and oats; non-edible foreign matter consisted of dirt, dust, stones and straw and weed seeds; were hand picked and weighed. Damaged kernels included those damaged by insect, fungus/black tipped, heat, frost, immature grains were hand picked and weighed. Samples were milled to whole-wheat flour using Perten Laboratory Mill 3100 with 0.8 mm sieve and then mixed thoroughly.

Chemical/general characteristics of whole-wheat flour: The whole-wheat flour obtained from the wheat varieties was subjected to determine its chemical/general characteristics such as moisture, ash, crude protein (N x 5.7), wet and dry gluten and falling number according to standard procedures of AACC (2000). Perten Glutomatic was used to determine wet and dry gluten whereas Falling Number system (Perten 1500) was used for the determination of alpha amylase activity in wheat flour.

Farinographic studies: Rheological behaviour of composite wheat flour samples was evaluated by running flour samples through Brabender Farinograph equipped with a bowl of 50 g capacity. The dough characteristics such as water absorption, dough development time, dough stability, tolerance index and softening of dough were determined according to standard procedure of AACC (2000).

Preparation of unleavened flat bread (Chapatti): Chapattis were prepared on thermostatically controlled hot plate by following the method of Rao *et al.* (1986).

Sensory evaluation: Sensory evaluation of chapattis was carried out by a panel of judges for colour, taste, flavour, texture, chewing ability and folding ability. Samples were presented in succession and panelists were asked to rate evaluation variables according to 9-point Hedonic scale as described by Land and Shepherd (1988).

Statistical analysis: The data obtained for each parameter was subjected to statistical analysis using Statistica 6.0 software according to methods described by Steel *et al.* (1996).

RESULTS AND DISCUSSION

Seven wheat varieties collected from different regions of Punjab were evaluated for physicochemical and rheological characteristics and compared with the specifications for wheat physical quality Pakistan Standards (1996) established by Pakistan standard and quality control authority (Table 1).

Table 1: Requirements for wheat

Quality grade	PAK-I	PAK-II	PAK-III
Factors	---------- Values applicable ----------		
Moisture (%)	Upto 9.0	9.0-10.0	10.0-12.0
Test weight (kg/hl)	76.0	74.1-75.9	70.0-74.0
Foreign matter (%)	Upto 0.5	0.5-1.0	1.0-2.0
Broken and shriveled (%)	Upto 2.0	2.0-3.0	3.0-5.0
Other food grains (%)	Upto 1.5	1.5-3.0	3.0-5.0
Damaged grains (%)	0-0.5	0.5-1.0	1.0-2.0

Source: Pakistan Standard and Quality Control Authority (1996)

Physical characteristics: Data regarding physical parameters of wheat grains revealed that Shafaq-2006 variety had the highest test weight (81 kg/hl) while Inqulab 91 samples possessed the lowest test weight (77 kg/hl) (Table 2). The comparison of different varieties mean test weight with wheat standards (Table 1) showed that all wheat grains were of premium quality i.e. Pak-I. Test weight is considered as one of the important tool in wheat grading system (Pasha, 2006). It is imperative in the grain trade because most grains are sold at a certain test weight. A sample with a higher test weight may get a good price and vice versa. As regards thousand kernel weight, highest value (41.50 g) was recorded in Shafaq 2006 wheat followed by GA 2002 (40.50 g). Thousand kernel weight as well as test weight is useful index for potential milling yield. The differences observed in test weight and thousand kernel weight among wheat varieties may be due to the differences in the genetic make up of the varieties. However, these differences may be partly attributed due to different growing and environmental conditions prevailed during growing periods (Randhawa *et al.*, 2002). Results are comparable with the earlier findings of Ahmad *et al.* (2001) who reported thousand kernel weight ranges from 28.81-49.01 for different wheat varieties grown in Pakistan.

In case of foreign matter, wheat grains of GA 2002 had the highest (1.07%) and Shafaq 2006 had the lowest (0.24%) non-edible foreign matter. When compared with

Table 2: Physical characteristics of wheat grains (2006-08)

	Parameters							
					Foreign matter			
	Test weight (kg/hl)		Thousand Kernel Weight (g)		Non-edible (%)		Edible (%)	
Varieties	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Inqulab 91	73-80	77.00±1.89	34.70-43	37.00±2.53	0.17-1.45	0.85±0.30	0.13-2.06	1.14±0.56
Bhakkar 2002	74.5-81	78.00±1.63	35.30-41	39.00±2.08	0.13-1.38	0.98±0.25	0.03-1.86	0.95±0.45
AS 2002	74-80	77.30±2.02	35-42.50	37.50±2.27	0.19-1.52	0.77±0.36	0.18-2.17	1.03±0.80
Shafaq 2006	77.5-83	81.00±2.21	38-44	41.50±2.25	0.10-0.81	0.24±0.16	0.08-1.72	0.78±0.21
Sehar 2006	76-80.5	79.00±1.35	36-41	38.00±1.71	0.08-0.64	0.35±0.20	0.00-0.64	0.37±0.14
Auqab 2000	75-79.5	77.50±1.28	34-40	38.30±1.50	0.15-1.63	0.65±0.47	0.04-0.97	0.54±0.63
GA 2002	77-81	79.40±1.36	37-42	40.50±2.17	0.18-1.95	1.07±0.55	0.20-1.41	1.09±0.39

	Parameters					
	Broken /shrunken grains (%)		Insect damaged grains (%)		Other damaged grains (%)	
Varieties	Range	Mean	Range	Mean	Range	Mean
Inqulab 91	0.24-1.85	1.25±0.43	0.09-1.42	0.81±0.32	0.15-1.19	0.51±0.17
Bhakkar 2002	0.31-2.14	1.36±0.50	0.15-1.45	0.62±0.27	0.28-1.07	0.70±0.25
AS 2002	0.34-1.49	1.13±0.32	0.10-0.78	0.42±0.30	0.17-1.24	0.56±0.19
Shafaq 2006	0.21-1.53	0.91±0.46	0.13-1.16	0.51±0.20	0.20-1.32	0.65±0.18
Sehar 2006	0.30-1.15	0.70±0.24	0.08-1.11	0.60±0.24	0.12-1.13	0.62±0.15
Auqab 2000	0.18-1.52	1.05±0.27	0.12-1.57	0.49±0.23	0.37-1.49	0.79±0.20
GA 2002	0.41-2.44	1.54±0.63	0.24-1.31	0.67±0.21	0.23-1.38	0.74±0.24

wheat specifications (Table 1) it was observed that wheat samples Sehar 2006 and Shafaq 2006 were of Pak-I grade, Inqulab 91, Bhakkar 2002 and Auqab 2000 Pak II whereas GA 2002 samples were of Pak III grade. Inqulab-91 wheat samples possessed the highest (1.14%) and Sehar-2006 had the lowest (0.37%) edible foreign matter. The comparison of edible foreign matter (other food grains) with Pakistan wheat standards (Table 1) revealed Pak-I grade wheat samples. The differences in foreign matter may be due to varied climatic conditions of different locations, harvesting and threshing operations as well as planting time (Anjum *et al*., 2003). Highest broken/shrunken grains was observed in GA 2002 (1.54%) followed by Bhakkar-2002 (1.36%) samples whereas, Sehar-2006 wheat recorded the lowest value (0.70%). Wheat samples mean comparison with wheat standards (Table 1) confirms Pak-I grade wheat. In case of damaged grains, AS 2002 had the lowest (0.42%) and Inqulab-91 had the highest (0.81%)insect damaged grains, whereas Inqulab 91 had the lowest (0.51%) and Auqab-2000 variety had the highest (0.79%) other damaged grains (fungus/black tipped, heat damaged, immature grains etc). When grand mean of total damaged grains (insect and other damaged grains) of all wheat varieties was compared with wheat standards (Table 1), it was observed that wheat samples in terms of damaged grains were of Pak- II grade. The fungi causing black-tip disease are known to be more active if rains occur during harvest (Rees *et al*., 1984). Hence, it may be a cause of slightly higher other damaged grains.

Chemical/general characteristics: It is evident from the data on chemical characteristics of whole-wheat flour that mean moisture content of different varieties ranged from 9.11% (Shafaq 2006) to 9.79% (GA 2002) (Table 3). It indicated low moisture wheat samples suitable for storage and would be less prone to microbial attack. Moisture content is dependent on genetic makeup of wheat varieties and is largely influenced by agronomic and climatic conditions (Mahmood, 2004). Ash content of all wheat varieties was found quite close to each other. However, highest ash content was observed in Inqulab 91 (1.70%) while lowest ash was recorded in GA 2002 (1.52%) samples. The ash content of flour is related to the amount of bran in the flour and therefore to flour yield.

As regards protein content, Sehar-2006 had the highest protein (12.78%) followed by Inqulab-91 (12.34%), while GA 2002 (11.19%) wheat had the lowest protein content. The protein content is an important criterion while considering the wheat quality. It is a key factor in determining the suitability of wheat for different products. In many areas of the world it is fundamental criterion for establishing the economic value of wheat. Protein content is an inherent characteristic but the quantity of protein depends on the growing conditions (Kent and Evers, 1994). Variation in protein content among wheat varieties is due to differences in their genetic makeup as well as differences in environmental and production conditions prevailed during growth stages (Randhawa, 2001).

Highest wet and dry gluten content was observed in Sehar 2006 (29.59% and 10.20%) whereas lowest value was observed in GA 2002 (26.06% and 8.42%) samples. The differences in gluten content among different samples may be ascribed to the variation in genetic makeup of wheat varieties, climatic conditions

Table 3: Chemical/general characteristics of whole wheat flour (2006-08)

	Parameters					
	Moisture (%)		Ash (%)		Protein (%)	
Varieties	Range	Mean	Range	Mean	Range	Mean
Inqulab 91	8.98-9.95	9.71±0.31	1.39-1.82	1.70±0.13	11.43-13.19	12.34±0.24
Bhakkar 2002	8.83-10.04	9.64±0.35	1.37-1.77	1.58±0.15	11.10-13.04	11.82±0.27
AS 2002	9.01-9.81	9.46±0.26	1.43-1.74	1.54±0.12	11.35-13.16	12.13±0.21
Shafaq 2006	8.87-9.61	9.11±0.29	1.49-1.73	1.60±0.08	11.06-12.37	11.53±0.25
Sehar 2006	8.96-9.72	9.25±0.21	1.52-1.81	1.65±0.10	11.94-13.49	12.78±0.20
Auqab 2000	9.15-10.09	9.57±0.18	1.41-1.70	1.57±0.11	11.31-12.84	11.97±0.32
GA 2002	9.20-10.24	9.79±0.23	1.34-1.61	1.52±0.06	10.81-11.75	11.19±0.48
	Parameters					
	Wet gluten (%)		Dry gluten (%)		Falling number (No.)	
Varieties	Range	Mean	Range	Mean	Range	Mean
Inqulab 91	25.00-33.70	29.15±2.53	8.75-12.01	9.98±1.57	305-510	397±37.60
Bhakkar 2002	24.56-32.15	27.37±3.12	8.12-10.56	9.15±1.31	321-487	425±49.56
AS 2002	24.10-31.79	27.62±2.39	8.41-11.38	9.67±1.42	294-475	408±32.73
Shafaq 2006	23.75-28.98	26.73±1.77	7.73-10.02	9.08±1.13	347-459	392±26.44
Sehar 2006	26.56-33.42	29.59±1.98	8.97-11.64	10.20±1.19	318-484	401±20.85
Auqab 2000	24.83-30.67	27.10±2.15	8.59-10.70	9.33±0.86	329-421	374±18.97
GA 2002	23.16-28.31	26.06±1.64	7.64-9.79	8.42±0.58	334-459	416±29.38

and differences in cultural practices and growth locations (Randhawa *et al*., 2002). Highest protein content of flour is not necessarily indicative of its strongest gluten strength i.e. quantity as well as quality of protein both are important for the evaluation of their end product suitability.

In case of falling number, Bhakkar 2002 had the highest mean falling number (425) and conversely lower alpha amylase activity while Auqab 2000 had lowest mean falling number (374) and therefore higher amylase activity. Alpha amylase activity depends on weather conditions, especially precipitation and mineral fertilizer (Gyiri and Sipos, 2006). Results were in confirmation with the investigations of Pasha (2006) who reported falling number ranged from 243-648 in fifty different wheat varieties during 2004-05.

Farinographic studies: Farinographic studies were conducted to determine the rheological properties of whole-wheat flour (Table 4). Highest water absorption (63.07%) was observed in Inqulab 91 followed by Sehar 2006 (62.33%) while GA 2002 had the lowest water absorption (58.62%). DMR test for water absorption reveals that all wheat flour samples were significantly different from each other except Bhakkar 2002 and AS 2002 which had non-significant differences. Water absorption is considered to be an important characteristic of wheat. Stronger wheat flours have the ability to absorb and retain more water as compared to weak flours. Higher water absorption is required for good chapatti characteristics which remain soft for a longer time (Simon, 1987).

As regards Dough Development Time (DDT), Sehar 2006 had the highest value (5.50 min) whereas Bhakkar 2002 had the lowest time (3.27 min). Higher dough development time reflects strong flour while its lower value is an indication of weak flour. Dough stability of different wheat varieties flour varied from 7.57 min (GA 2002) to 11.62 min (AS 2002). All wheat flours were significantly different from each other (Table 4). It is an indicator of flour strength. Dough stability beyond 10 min may be more suitable to the baker as it can withstand mixing for longer period (Anjum and Walker, 2000).

In case of Tolerance Index (TI), highest value (90 BU) was observed in GA 2002 followed by Shafaq 2006 (71.67 BU) and was significantly different from other flour samples (Table 4). Generally, higher the tolerance index value, weaker is the flour. For softening of dough (SD), Sehar 2006 had the lowest value (43.33 BU), which indicates strong flour since flours that have lower SD are stronger and the ones having higher SD values are weaker. The difference between Shafaq 2006 and GA 2002 was non-significant but were significantly different from other wheat varieties (Table 4).

Differences in farinographic characteristics among different wheat varieties may be due to variations in protein quantity and quality (Rehman *et al*., 2001). Farinographic results of different wheat varieties were comparable to the earlier findings of Huma (2004).

Sensory evaluation: Chapattis prepared from different wheat varieties flour were subjected to sensory evaluation for colour, taste, flavour, texture, chewing ability and folding ability each year in triplicate and their three years mean scores were calculated (Table 5). Highest mean score for colour (7.80) was obtained by Shafaq 2006 whereas Inqulab 91 got the lowest score (6.20). The low score of Inqulab 91 may be due to high ash content, which affect the colour of chapatti since consumers prefer creamy colour and not dark brown

Table 4: Farinographic characteristics of different wheat varieties (2006-08)

Varieties	WA (%)	DDT (min)	DS (min)	TI (BU)	SD (BU)
Inqulab 91	63.07^{a}	4.92^{bc}	10.50^{c}	36.67^{cd}	58.33^{bcd}
Bhakkar 2002	60.90^{d}	3.27^{e}	8.23^{e}	43.33^{c}	70.00^{b}
AS 2002	61.13^{d}	4.50^{c}	11.62^{a}	40.00^{c}	66.67^{bc}
Shafaq 2006	60.20^{e}	3.85^{d}	6.00^{g}	71.67^{b}	110.00^{a}
Sehar 2006	62.33^{b}	5.50^{a}	10.07^{d}	31.67^{cd}	43.33^{d}
Auqab 2000	61.78^{c}	5.13^{ab}	10.93^{b}	25.00^{d}	50.00^{cd}
GA 2002	58.62^{f}	3.67^{de}	7.57^{f}	90.00^{a}	121.67^{a}

WA = Water Absorption, DDT = Dough Development Time, DS = Dough Stability, TI = Tolerance Index, SD = Softening of Dough

Table 5: Sensory attributes of chapattis prepared from different wheat varieties (2006-08)

Wheat varieties	Colour	Taste	Flavour	Texture	Chewing ability	Folding ability	Overall score
Inqulab 91	6.20^{d}	6.93^{b}	7.13^{b}	6.60^{b}	6.07^{cd}	5.80^{b}	6.45^{de}
Bhakkar 2002	7.13^{bc}	6.47^{c}	6.73^{c}	5.47^{d}	5.80^{de}	5.27^{c}	6.14^{f}
AS 2002	7.67^{a}	7.33^{ab}	7.80^{a}	7.00^{ab}	7.20^{a}	6.73^{a}	7.29^{a}
Shafaq 2006	7.80^{a}	7.47^{a}	7.40^{b}	6.87^{ab}	6.73^{b}	6.13^{b}	7.07^{b}
Sehar 2006	7.47^{ab}	7.20^{ab}	7.13^{b}	7.20^{a}	6.27^{c}	6.00^{b}	6.88^{c}
Auqab 2000	6.80^{c}	7.07^{ab}	6.47^{c}	7.33^{a}	6.00^{cd}	5.87^{b}	6.59^{d}
GA 2002	7.33^{ab}	7.00^{ab}	6.60^{c}	6.07^{c}	5.53^{e}	5.67^{bc}	6.37^{e}

*Means followed by same letters do not differ significantly ($p<0.05$)

chapatti. In case of taste, Shafaq 2006 was at the top (7.47) followed by AS 2002 (7.33) and found to be least (6.47) for Bhakkar 2002. Maximum flavor score (7.80) was attained by AS 2002 while Auqab 2000 received the minimum score (6.47). The differences in colour, taste and flavour of all the chapattis were attributed to the differences in hardness/softness of wheat grains and other factors like wheat varieties and milling characteristics of wheat (Farooq *et al*., 2001). For texture, highest mean score (7.33) was obtained by Auqab 2000 followed by Sehar 2006 (7.20). As regards chewing ability, AS 2002 got the maximum score (7.20) and GA 2002 obtained the minimum score (5.53). A wheaty aroma and taste is desirable with a non-sticky, soft chewing feel in mouth (Dhaliwal *et al*., 1996). Bhakkar 2002 obtained the least score (5.27) for folding ability whereas AS 2002 received the highest score (6.73). With respect to overall acceptability of chapattis, highest score (7.29) was obtained by AS 2002 and thus regarded as more acceptable than other flour chapattis while lowest score (6.14) was obtained by Bhakkar 2002 thus considered least acceptable.

Conclusion: It was concluded that physic-chemical and rheological characteristics of wheat varieties affect the quality of the end product. Overall, quality of wheat varieties was good and comparable to International standards. Wheat variety AS 2002 was ranked highest and most suitable for chapatti preparation.

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