Pakistan J. Agric. Res. Vol 22 No1-2, 2009.

PHYSICOCHEMICAL QUALITY ASSESSMENT OF WHEAT GROWN IN DIFFERENT REGIONS OF PUNJAB

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ABSTRACT: Two hundred and seventy wheat grain samples were collected from nine different regions of Punjab and analyzed for physicochemical characteristics during 2006 to 2008. The quality parameters studied were test weight, 1000 kernel weight, foreign matter (non-edible and edible), broken/shrunken grains, damaged grains, moisture, ash, protein (N x 5.7), wet and dry gluten, falling number, and minerals (copper, manganese, iron, zinc). It was observed that wheat samples varied considerably within each region and also between regions. Attock region samples had highest test weight (80.50 kg hl $^{-1}$), protein (11.80 %) and lowest non-edible foreign matter (0.45%) and broken/shrunken grains (0.88 %). Highest wet and dry gluten (27.44 % and 9.29 %) while other damaged grains were observed lowest (0.47 %) in Lahore region samples. Test weight was positively correlated with kernel weight (0.66) and negatively with protein (-0.83) and gluten content (-0.75). Gluten content had a positive correlation (0.97) with protein content. The comparison of studied quality parameters with Pakistan standard specifications revealed good quality wheat.

Key Words: Wheat; Quality; Physicochemical Properties; Pakistan.

INTRODUCTION

Wheat (*Triticum aestivum*) is one of the important cereal crop produced and consumed around the world. Pakistan is the 8th largest wheat producer, contributing about 3.17% of the world wheat production from 3.72% of the wheat growing area. (Shuaib et al., 2007). It is the cheapest and principal source of energy and protein for the inhabitants of Pakistan. Wheat holds a distinct position in Pakistani diet contributing more than 60% of the total protein & calorie requirements and about 80% of total dietary intake (Bostan and Naeem, 2002). It provides more nourishment than any other food grains (Johnson et al., 1978). In Pakistan, the most commonly consumed and least expensive product of wheat is unleavened flat bread locally known as *chapatti.* Furthermore, wheat is used for various other bakery products like bread, cookies, cakes, buns, pastries etc. (Mahmood et al., 2004).

It is grown in all provinces of Pakistan yet Punjab contributes 75% of total wheat grain production at national level (GoP, 2003). Pakistan has been a food deficit country for long because of high population growth rate compared to wheat production. Hence crop improvement programs have always been more yield- oriented and less attention has been paid to the quality of grain produced. The wheat varieties developed are general purpose and put to all uses. The wheat breeders in Pakistan presently are paying more attention to evolve new varieties possessing an improved yield potential coupled with superior quality. The productivity of wheat is related to protein and starch content, its micronutrient composition and other physicochemical characteristics. The wheat quality depends on soil composition, environmental factors including temperature, rainfall, humidity etc. (Zeb et al., 2006). The environmental factors not only affect the grain yield and protein harvest but also the nutritional quality of the produce (Ullah et al., 1980). Pakistani wheat varieties are grown over a wide agro-climatic range and as such are expected to exhibit yield and quality differences (Chaudhry et al., 1995). The present study analyzed the physicochemical and rheological characteristics of wheat growing in different regions of Punjab.

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MATERIALS AND METHODS

Two hundred and seventy wheat samples of different varieties were collected from nine regions of Punjab for three consecutive crops of 2006, 2007 and 2008. Samples were drawn directly from farmers field. Wheat samples were packed airtight in polyethylene bags and taken to Food Quality and Nutrition Programme (FQNP) Lab., National Agricultural Research Centre (NARC), Islamabad. Each year 90 samples of wheat were collected from different regions and analyzed (10 samples/ region), thus a total of 270 samples were physico-chemically analyzed in triplicate during 2006-08.

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^{-1}). All matter that passed through a 0.064 x 3/8 inch oblong hole sieve was calculated as broken/shrunken grains. Edible foreign matter (other food grains) included grains of barley and oats; non-edible foreign matter consisted of dirt, dust, stones, straw and weed seeds. They were hand picked and weighed. Damaged kernels included those damaged by insect, fungus/black tipped, heat, frost and 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 mixed thoroughly.

Chemical characteristics of whole-wheat flour were determined 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. Trace elements were analyzed using a Varian SpectrAA 220FS Atomic Absorption Spectrometer. The samples were prepared according to the standard methods of AOAC (2005).

The data obtained for each parameter was subjected to statistical analysis according to methods described by Steel et al. (1996).

RESULTS AND DISCUSSION

Wheat grains collected from different regions of Punjab were analyzed for physicochemical parameters and compared with the specifications for wheat physical quality established by Pakistan standard and quality control authority (Table 1).

Table 1. Standards values applicable for wheat

Quality Grade	PAK-I	PAK-II	PAK-III
Factors	**Values Applicable**		
Moisture (%)	≤ 9.0	9.0-10.0	10.0-12.0
Test weight (kg hl^{-1})	76.0	74.1-75.9	70.0-74.0
Foreign matter(%)	≤ 0.5	0.5-1.0	1.0-2.0
Broken and shriveled(%)	≤ 2.0	2.0-3.0	3.0-5.0
Other food grains(%)	≤ 1.5	1.5-3.0	3.0-5.0
Damaged grains(%)	0-0.5	0.5-1.0	1.0-2.0

Physical Characteristics

Data regarding physical characteristics of wheat grains reveals the highest test weight (80.5 kg hl^{-1}) in Attock region wheat whereas Multan region samples possessed the lowest test weight (76 kg hl^{-1}) (Table 2). The comparison of grand mean test weight (78.40 kg hl^{-1}) with wheat standards (Table 1) shows that wheat grains were of premium quality i.e., Pak-I. Test weight is considered as one of the important tool in wheat grading system. It is imperative in the grain trade because most grains are sold at a certain test weight. For thousand kernel weight highest value (41 g) was recorded in Sargodha region wheat followed

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

Region	Test weight (kg hl^{-1})		Thousand kernel Weight (g)		Foreign matter: Non-edible (%)		Foreign matter: Edible (%)		Broken/ shrunken grains(%)		Insect damaged grains(%)		Other damaged grains(%)	
	Range	Mean*	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Multan	73-82	76.00 ±2.40	31.60-40	36.60 ±3.72	0.21-1.57	0.77 ±0.32	0.06-1.83	0.80 ±0.40	0.23-2.54	1.42 ±0.77	0.18-2.20	0.65 ±0.41	0.30-1.75	0.74 ±0.43
Muzafar-garh	74-80	78.00 ±1.70	31-40	36.10 ±2.70	0.05-1.38	0.63 ±0.24	0.00-2.11	1.15 ±0.62	0.14-1.62	0.94 ±0.46	0.11-1.86	0.42 ±0.37	0.17-1.62	0.70 ±0.41
Bahawal pur	72-80	77.00 ±2.36	32-44	38.00 ±3.38	0.12-1.62	0.70 ±0.27	0.04-1.38	0.84 ±0.36	0.22-2.24	1.19 ±0.48	0.00-1.98	0.45 ±0.28	0.28-1.57	0.56 ±0.29
Vehari	72-82	77.50 ±2.10	33-45.20	38.40 ±3.70	0.19-1.71	0.89 ±0.49	0.02-1.97	0.95 ±0.49	0.10-2.40	1.31 ±0.67	0.17-2.15	0.71 ±0.48	0.24-1.38	0.61 ±0.37
Lahore	74-81	78.80 ±1.77	32-42	39.10 ±2.95	0.10-1.60	0.55 ±0.51	0.10-2.06	0.87 ±0.51	0.13-2.07	1.03 ±0.62	0.00-2.06	0.59 ±0.43	0.18-1.26	0.47 ±0.23
Gujran-wala	73-81	79.30 ±1.83	32.50-43	39.50 ±2.50	0.08-1.83	0.73 ±0.58	0.00-1.57	0.49 ±0.33	0.19-2.16	1.51 ±0.56	0.09-1.77	0.51 ±0.32	0.50-2.56	0.83 ±0.41
Sargodha	75-81	79.00 ±1.65	36-44	41.00 ±2.30	0.16-1.49	0.49 ±0.23	0.00-2.15	0.72 ±0.56	0.12-2.05	1.12 ±0.61	0.04-1.61	0.53 ±0.30	0.20-1.29	0.51 ±0.27
Attock	76-83	80.50 ±1.78	32.80-42	40.00 ±2.40	0.11-1.18	0.45 ±0.21	0.00-2.78	0.64 ±0.42	0.04-1.72	0.88 ±0.52	0.11-1.50	0.57 ±0.39	0.15-1.45	0.53 ±0.38
Gujar Khan	73-81	79.50 ±1.69	36.50-42	40.50 ±1.95	0.27-1.91	0.81 ±0.45	0.11-2.45	1.19 ±0.78	0.06-2.01	0.97 ±0.57	0.00-1.80	0.62 ±0.37	0.14-1.59	0.58 ±0.32
Grand Mean**		**78.40 ±1.40**		**38.80 ±1.68**		**0.67 ±0.15**		**0.85 ±0.23**		**1.15 ±0.22**		**0.56 ±0.09**		**0.61 ±0.11**

**Mean of 30 values ** Mean of 270 values*

by Gujar Khan region (40.50 g). It was observed that thousand kernel weight was positively correlated (r = 0.66) with test weight (Table 4). Thousand-kernel weight as well as test weight are useful index for potential milling yield. Thousand kernel weight and size are not only genetically controlled but also affected by growing and environmental conditions (William, 1986). In the present study, differences in thousand kernel weight may be attributed to the different locations and environmental conditions.

There is a range of variation in foreign matter, broken/shrunken and damaged grains values within and among the regions. Wheat grains of Vehari region had the highest (0.89 %) and Attock region had the lowest (0.45 %) non-edible foreign matter. Grand mean of non-edible foreign matter (0.67 %) compared with wheat specifications (Table 1) shows that non-edible foreign matter of sampled wheat was of Pak-II grade. As regards edible foreign matter, samples of Gujranwala region possessed the lowest (0.49 %) and Gujar Khan region had the highest (1.19 %) value. 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). The comparison of grand mean of edible foreign matter (0.85 %) with Pakistan wheat standards (Table 1) reveals that edible foreign matter (other food grains) content was according to Pak-I grade wheat. Highest broken/shrunken grains was observed in Gujranwala region (1.51 %) followed by Multan region (1.42 %) samples whereas, Attock region wheat had the lowest value (0.88 %). Grand mean of broken/shrunken grains (1.15 %) compared with wheat standards (Table 1) confirms Pak-I grade wheat. Muzaffargarh region had the lowest (0.42 %) and Vehari region had the highest (0.71%) insect damaged grains, whereas Lahore region wheat had the lowest (0.47 %) and Gujranwala region wheat samples had the highest (0.83 %) other damaged grains (fungus/black tipped, heat damaged, immature grains etc). When

Table 3. Chemical characteristics of whole wheat flour (2006-08)

Region	Moisture(%)		Ash(%)		Protein(%)		Wet Gluten(%)		Dry Gluten(%)		Falling Number (No.)	
	Range	Mean*	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Multan	8.83-10.15	9.65 ±0.61	1.49-1.78	1.62 ±0.08	10.37-12.74	11.80 ±0.60	20.70-33.23	27.32 ±3.44	6.54-11.49	9.21 ±1.53	304-481	399 ±48.80
Muzafar-garh	8.78-10.19	9.49 ±0.74	1.39-1.76	1.60 ±0.12	10.13-12.59	11.51 ±0.77	19.64-34.15	26.63 ±4.12	6.40-11.74	9.10 ±1.78	347-508	406 +37.56
Bahawal-pur	8.65-9.91	9.08 ±0.41	1.40-1.84	1.65 ±0.14	10.02-12.61	11.72 ±0.75	20.58-34.80	27.17 ±3.29	6.88-11.91	8.84 ±1.19	362-495	428 ±44.39
Vehari	8.84-10.52	9.62 ±0.63	1.44-1.82	1.63 ±0.12	10.34-12.85	11.58 ±0.57	19.95-31.62	26.79 ±3.37	6.71-11.62	9.16 ±1.37	345-524	435 ±53.54
Lahore	9.01-10.46	9.87 ±0.54	1.46-1.84	1.66 ±0.10	10.14-12.13	11.67 ±0.46	21.17-32.67	27.44 ±2.78	7.03-11.50	9.29 ±0.95	315-467	377 ±25.41
Gujran-wala	8.89-10.57	9.59 ±0.67	1.56-1.80	1.67 ±0.07	9.98-12.18	11.44 ±0.61	19.59-32.56	26.41 ±3.63	6.39-11.38	9.23 ±1.46	338-492	431 ±29.25
Sargodha	9.11-10.34	9.57 ±0.23	1.37-1.80	1.57 ±0.13	10.42-12.15	11.37 ±0.55	19.42-29.63	26.25 ±2.71	6.78-10.96	8.91 ±1.08	297-469	394 ±41.23
Attock	9.07-10.03	9.46 +0.27	1.27-1.57	1.38 ±0.09	9.85-12.07	10.94 ±0.66	18.79-31.14	25.60 ±3.75	6.17-11.43	8.86 ±1.64	301-480	385 ±39.36
Gujar Khan	9.13-9.97	9.44 ±0.38	1.29-1.63	1.50 ±0.11	9.64-11.64	11.01 ±0.59	18.58-30.88	25.73 ±3.51	6.24-11.07	9.03 ±0.57	311-451	362 ±32.84
Grand Mean**		**9.53 ±0.21**		**1.59 ±0.09**		**11.45 ±0.30**		**26.59 ±0.66**		**9.07 ±0.17**		**402 ±25.52**

**Mean of 30 values, **Mean of 270 values*

grand mean of total damaged grains (0.56 ±0.61= 1.17 %) were 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 than other damaged grains.

Chemical Characteristics of Whole-wheat Flour

It is evident from the data on chemical characteristics of whole-wheat flour that Bahawalpur region samples had the highest moisture (9.87 %) while Lahore region had the lowest (9.08 %) moisture content (Table 3). Grand mean (9.53 %) indicates that wheat samples could be stored easily due to low moisture and would be less prone to microbial attack. Moisture content of wheat is largely influenced by climatic conditions prevailing during storage (Ahmad et al., 2001). Moisture content determination of wheat is very important in terms of its productivity (Khan and Kulachi, 2002). As regards ash content, Gujranwala region wheat samples had the highest (1.67%) and Attock region (1.35 %) had the lowest ash content. The ash content of flour is related to the amount of bran in the flour and therefore to flour yield. High ash content means poor quality wheat with high percentage of small or shriveled kernels.

Highest protein content was observed in Multan region (11.80%) wheat followed by Bahawalpur region (11.72 %), while Attock region (10.94 %) wheat had the lowest protein content. Protein content of wheat samples was negatively correlated (r = –0.83) with test weight and thousand kernel weight (r = –0.67) (Table 4). Protein content is an inherent characteristic but the quantity of protein depends on the growing conditions (Kent and Evers, 1994). Higher grain weight but lower protein content could be attributed to the differences in weather conditions especially higher rainfall and lower temperature during grain development time (Anjum et al., 1987).

Table 4. Correlation coefficients (r) of wheat collected from Punjab

Quality attributes	Thousand kernel weight	Protein	Wet Gluten	Dry Gluten
Test weight	0.66	-0.83	-0.75	-0.06
Thousand kernel weight		-0.67	-0.61	-0.32
Protein			0.97	0.45
Wet Gluten				0.57

Highest wet and dry gluten content was recorded in Lahore region (27.44 % and 9.09%) whereas lowest value was observed in Attock region (25.60 % and 8.86 %) wheat samples. It is evident that wet and dry gluten were negatively correlated with test weight (r = – 0.75 and –0.06, respectively) and thousand kernel weight (r = –0.61 and –0.32, respectively). However positive correlation of wet and dry gluten with protein (r = 0.97 and 0.45, respectively) was observed (Table 4). Correlation studies confirmed the earlier investigations of Khattak et al. (2005). The differences in gluten content among different region samples may be ascribed to the variation in climatic conditions and cultural practices. 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 (r = 0.97 and 0.45, respectively).

As regards falling number, Gujranwala region samples had the highest falling number (431) and conversely lower alpha amylase activity while Gujar Khan samples had lowest falling number (362) and therefore higher amylase activity. Grand mean (402) indicates that wheat samples had low alpha amylase activity and wheat is free of sprout damage. Higher falling number imparts problems in the crumb and crust of bread (Hoseney, 1994).

Data regarding mineral composition of wheat reveals that the concentration of copper varied considerably with highest value in wheat sample collected from Lahore region (7.41 mg kg $^{-1}$) and the lowest in Gujar Khan region (4.90 mg kg $^{-1}$) wheat samples (Table 5). The iron content ranged from 38.79 to 43.73 mg kg $^{-1}$. Highest iron content was observed in Gujar Khan region (43.73 mg kg $^{-1}$) samples while lowest was in Sargodha (38.79 mg kg $^{-1}$) region samples. The concentration of zinc and manganese varied from 22.79 to 37.37 and from 25.29 to 35.44 mg kg $^{-1}$, respectively. The highest values of Mn and Zn were detected in samples collected from Bahawalpur (35.44 mg kg^{-1}) and Gujaranwala (37.37 mg kg^{-1}) regions respectively. Similar findings were reported by Araujo et al. (2008) in their studies on min-

Table 5. Mineral composition of whole wheat flour (2006-08) (mg kg^{-1})

Region	Copper		Iron		Manganese		Zinc	
	Range	Mean*	Range	Mean	Range	Mean	Range	Mean
Multan	4.90-8.05	6.13 ±0.85	31.40-48.00	40.37 ±3.73	23.74-40.30	34.20 ±3.54	12.68-39.70	25.99 ±5.71
Muzafar-garh	5.10-7.47	5.64 ±0.53	38.50-55.27	43.71 ±2.96	19.98-30.30	25.29 ±2.90	20.08-44.83	31.06 ±4.28
Bahawal-pur	4.70-9.10	6.81 ±0.91	28.87-59.00	37.71 ±5.30	27.60-46.13	35.44 ±3.86	12.44-32.30	22.79 ±2.91
Vehari	5.20-8.52	6.52 ±0.96	37.00-57.86	43.50 ±4.50	24.90-42.95	33.41 ±3.26	22.66-35.75	29.91 ±3.20
Lahore	5.90-10.97	7.41 ±0.91	38.70-45.68	42.23 ±1.77	26.96-38.25	30.32 ±2.04	23.30-51.59	33.95 ±5.79
Gujran-wala	3.20-7.10	5.28 ±0.93	30.00-53.02	40.13 ±6.20	14.20-38.60	27.25 ±3.24	21.60-56.20	37.37 ±8.04
Sargodha	2.70-7.60	5.61 ±1.26	27.00-54.00	38.79 ±7.03	17.90-46.30	29.76 ±6.43	16.60-46.40	31.42 ±8.33
Attock	4.30-7.30	5.04 +0.95	29.96-52.02	39.36 ±5.27	19.30-42.80	30.89 ±2.25	15.80-56.63	29.41 ±10.77
Gujar Khan	2.90-7.39	4.90 ±0.98	36.10-56.90	43.73 ±4.81	17.74-44.51	31.91 ±8.31	20.40-36.50	30.98 ±4.66
Grand Mean**		5.93 ±0.97		41.06 ±2.60		30.71 ±3.52		30.09 ±4.90

**Mean of 30 values, ** Mean of 270 values*

eral composition of wheat flour consumed in Brazil.

It is concluded that quality of Punjab wheat is good and comparable to International standards of Australia and USA. Careful agronomic practices such as seed treatment, weed control, use of balanced fertilizers and improved harvest technology can further boost its quality.

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