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Nutritional composition of Pakistani wheat varieties*

IKHTIAR Khan[1], ALAM Zeb[†‡2]

([1]*Institute of Chemical Sciences, University of Peshawar, Peshawar 25120, Pakistan*)

([2]*Department of Biotechnology, University of Malakand, Chakdara 23020, Pakistan*)

[†]E-mail: Alamzeb01@yahoo.com

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Abstract: Pakistani wheat varieties are grown over a wide agro-climatic range and as such are anticipated to exhibit yield and quality differences. It is therefore necessary to investigate the nutritional status of wheat varieties in terms of biochemical and physiochemical characteristics available for food and nutritional purposes in Pakistan. The result shows that wheat grains of different varieties contain a net protein level of 9.15%~10.27%, 2.15%~2.55% total fats, 1.72%~1.85% dietary fibers, 77.65×10^{-6}~84.25×10^{-6} of potassium and 7.70×10^{-6}~35.90×10^{-6} of sodium ions concentration, 0.24×10^{-6}~0.84×10^{-6} of phosphorus, 1.44%~2.10% ash, 31.108~43.602 g of thousand grain mass (TGM) and 8.38%~9.67% moisture contents. This study is significant in providing an opportunity to explore the available wheat varieties and to further improve their nutritional excellence and also essential for setting nutritional regulations for domestic and export purposes.

Key words: Wheat varieties, Chemical composition, Physiochemical characteristics
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INTRODUCTION

Wheat is one of the most important domesticated crops grown around the world. Bread wheat plays a major role among the few crop species being extensively grown as food sources, and was likely a central point to the beginning of agriculture (Harlan, 1981). Wheat is considered as utmost among the cereals largely due to the fact, that its grain contains protein with unique chemical and physical properties. Besides being a rich source of carbohydrates, wheat contains other valuable components such as protein, minerals (P, Mg, Fe, Cu and Zn) and vitamins like thiamine, riboflavin, niacin and vitamin E. However, wheat proteins are deficient in essential amino acids such as lysine and threonine (Adsule and Kadam, 1986).

Global wheat production is concentrated mainly in Australia, Canada, China, European Union, India, Pakistan, Russia, Turkey, Ukraine and the United States, accounting for over 80% of world wheat production. Pakistan is the 8th largest wheat producer, contributing about 3.17% of the world wheat production from 3.72% of the wheat growing area. Wheat in Pakistan is a leading food grain and occupies a central position in agriculture and its economy (Shuaib *et al*., 2007). The wheat breeders in Pakistan presently are paying more attention to evolve new varieties possessing an improved yield potential coupled with superior quality. However, Pakistan has been a food deficit country for long. The breeding efforts in the past remained focused mainly on increasing the per hectare yield of wheat, thus the potential of grain quality improvement remained unexploited. Production was geared up to local market, which is neither quality conscious nor sufficiently diversified to demand exacting standards. Pakistani wheat varieties are grown over a wide agro-climatic range and as such are expected to exhibit yield and quality differences (Chowdhry *et al*., 1995). It is therefore necessary to investigate the biochemical composition of wheat varieties available for food and

‡ Corresponding author

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nutritional purposes in Pakistan, which would provide an opportunity to explore the available wheat varieties for greater excellence in their nutritional quality.

MATERIALS AND METHODS

Wheat grains of twelve varieties were collected from different ecological regions of Pakistan during August to December 2005. The samples were stored in labeled glass bottle to ensure preserve integrity. The analysis was carried out at the Department of Biotechnology, University of Malakand Pakistan during February to June 2006.

Kjeldahl method was used to determine percent nitrogen (%N) as described by American Association of Cereal Chemists (AACC, 1995). The calculated %N was multiplied by a protein factor of 5.70.

Wheat samples of different varieties were placed in cuvettes (3 cm diameter) sealed with aluminum and plastic foils. The absorbance spectra [log(1/*R*)] were recorded on a near infrared spectrometer model 6500 (NIR System Inc., Silver Springs, MD, USA) equipped with computer. The spectra were obtained with the help of computer software WinISI-II version 1.02 (Foss NIR Systems, Infrasoft International). The values of protein, fats and fiber were calculated directly from the system. Samples of each wheat variety were analyzed twice and the results were stored in computer for statistical analysis.

Physiochemical parameters like moisture, ash, total fat and fiber contents were determined according to the standard AOAC (1990) methods (AOAC methods Nos. 925.10, 923.03, 2003.05 and 993.19 respectively) and by the procedure described recently by Zeb *et al*.(2006). Wet digestion was performed for mineral quantification. The mineral composition (Na^+ and K^+) was determined with the help of flame photometer (Jenway PFP7, Barloworld Scientific, England). The phosphorus content of wheat grain was determined by the reaction of acidified solution of ammonium molybdate containing ascorbic acid and antimony (Chapman and Pratt, 1978). The phosphate in plant sample reacts to form an ammonium molydiphosphate complex, which is reduced to blue color solution by ascorbic acid. The amount of light absorbed by the solution was measured at 660 nm with UV-visible spectrophotometer (Shimadzu UV-1700, Shimadzu, Japan). The sample reading was measured from the standard calibration curve.

Statistical analysis like standard deviation and mean values was carried out for duplicate and triplicate measurements of individual analysis and overall readings of NIRS (near infrared reflectance spectroscopy) and AOAC methods using computer software SPSS 12.0 for windows (released on Sept. 4, 2003, Lead Technologies Inc., USA).

RESULTS AND DISCUSSION

Protein contents

Grain protein percentage is an important component of grain quality. Protein contents measured by standard Kjeldahl method show a higher level than protein contents calculated from NIRS as given in Table 1. However the highest mean value from both methods are (mean±*SD*): (10.27±1.161)%, (10.25±1.061)% and (10.20±1.414)% for varieties Gandam-711, Watan and Bakhtawar-92 respectively. Low values were observed in Saleem-2000 (9.15±0.212)%, and Fakhre-Sarhad (9.57±0.460)%. Generally grain protein contents in wheat varies between 8% and 17%, depending on genetic make-up and on external factors associated with the crop, however the protein contents in wheat measured by NIRS have been shown to be in the range of 10%~19% (Hruschka and Norris, 1982). Thus our values for protein contents on both NIRS and Kjeldahl method are in this range, but mostly on the lower side of the scale.

Results regarding standard Kjeldahl analysis of protein reveals highest level of 11.2% protein in variety Bakhtawar-92, while Tatara, Watan, Bhakkar-01, Wafaq-01, Gandam-2002 and Chudry-97 contain 11.0% protein. The lowest value is present in Saleem-2000 (9.0%). This trend is close to the mean values from both methods. However our value correlates with the recently reported value of 8.6% for variety Inqilab-91 (Hussain *et al*., 2006).

Fats contents

The Fats values are higher for AOAC method than NIRS value (Table 1). Highest total mean fat content are present in Wafaq-01, Bakhtawar-92 with values of (2.55±0.495)%, (2.50±0.424)%, and

(2.45±0.354)% shown by Tatara and Bhakkar-01. The most probable reason for the low level may be the presence of lipase or lipase activity, which is responsible for the hydrolysis of lipids in dormant wheat during storage (Rose and Pike, 2006).

Dietary fiber

Dietary fiber measurement is essential for the assessment of potential therapeutic and preventive effect of fiber intake (Anderson and Bridges, 1988). The values of fiber content for each variety are given in Table 1. The highest mean values of fiber are: (1.85±0.071)%, (1.85±0.212)% for Bhakkar-01, Gandam-2002, and a same value of (1.82±0.106)% is shown by Ghaznawy, Bakhtawar-92 and Saleem-2000 respectively. It has been shown that wheat is among cereals containing lowest level of fiber (Anderson and Bridges, 1988).

Micronutrients composition

Micronutrients compositions especially potassium and sodium are essential cations abundantly present in plants (Mäser *et al*., 2002). Data regarding mineral composition of different Pakistani wheat varieties are presented in Table 2. The highest potassium contents are observed in Chudry-97, Saleem-2000 and Gandam-2002 with value (mean±*SD*) of $84.25\times10^{-6}\pm0.353\times10^{-6}$, $84.15\times10^{-6}\pm2.192\times10^{-6}$ and $83.50\times10^{-6}\pm1.272\times10^{-6}$ respectively. While lowest value is there for variety Ghaznawy with a value of

Table 1 Protein, fats and fiber contents of different Pakistani wheat varieties determined by different methods

Variety name	[a]Protein (%)			[a]Fat (%)			[a]Fiber (%)		
	Kjeldahl[b]	NIRS[c]	Mean±*SD*	AOAC[d]	NIRS	Mean±*SD*	AOAC[d]	NIRS	Mean±*SD*
Tatara	11.0	9.25	10.12±1.237	2.7	2.20	2.45±0.354	1.9	1.65	1.77±0.177
Watan	11.0	9.50	10.25±1.061	2.4	2.25	2.32±0.106	2.0	1.60	1.80±0.283
Gandam-711	10.9	9.25	10.27±1.161	2.2	2.20	2.20±0.000	1.9	1.70	1.80±0.141
Bakhtawar-92	11.2	9.20	10.20±1.414	2.8	2.20	2.50±0.424	1.9	1.75	1.82±0.106
Fakhre-Sarhad	9.9	9.25	9.57±0.460	2.6	2.20	2.40±0.283	1.8	1.75	1.77±0.035
Bhakkar-01	11.0	9.30	10.15±1.202	2.7	2.20	2.45±0.354	1.9	1.80	1.85±0.071
Ghaznawy	10.8	9.10	9.95±1.202	2.2	2.20	2.20±0.000	1.9	1.75	1.82±0.106
Saleem-2000	9.0	9.30	9.15±0.212	2.1	2.20	2.15±0.071	1.9	1.75	1.82±0.106
Wafaq-01	11.0	9.20	10.10±1.271	2.9	2.20	2.55±0.495	1.9	1.70	1.80±0.141
Gandam-2002	11.0	9.20	10.10±1.271	2.5	2.20	2.35±0.212	2.0	1.70	1.85±0.212
Chudry-97	11.0	9.30	10.15±1.202	2.6	2.20	2.40±0.283	1.7	1.80	1.75±0.071
Inqilab-91	10.2	9.40	9.80±0.565	2.4	2.20	2.30±0.141	1.8	1.65	1.72±0.101

[a]Values are expressed as mean±*SD* (*n*=3); [b]Data are determined by Kjeldahl method; [c]Data are determined by near infrared reflectance spectroscopy (NIRS); [d]Data are determined by Association of Official Analytical Chemists (AOAC) method

Table 2 Mineral compositions of different Pakistani wheat varieties

Wheat variety	[a]Na^+ ($\times10^{-6}$)	[a]K^+ ($\times10^{-6}$)	Na^+/K^+	[b]Phosphorus ($\times10^{-6}$)
Tatara	35.90±3.676	77.80±3.111	0.461	0.36
Watan	30.60±3.252	83.10±4.101	0.368	0.84
Gandam-711	30.95±3.040	80.15±3.040	0.386	0.60
Bakhtawar-92	29.40±4.525	81.75±2.474	0.359	0.42
Fakhre-Sarhad	32.05±3.747	81.55±2.757	0.393	0.53
Bhakkar-01	7.70±1.555	78.60±2.262	0.098	0.68
Ghaznawy	31.25±1.060	77.65±2.050	0.402	0.44
Saleem-2000	31.45±3.465	84.15±2.192	0.373	0.84
Wafaq-01	31.25±3.606	81.15±2.050	0.385	0.66
Gandam-2002	33.80±2.828	83.50±1.272	0.404	0.24
Chudry-97	31.20±3.818	84.25±0.353	0.370	0.68
Inqilab-91	31.45±3.323	81.15±1.202	0.387	0.26

[a]Values are expressed as mean±*SD* (*n*=2); [b]Values are mean of duplicate reading (*n*=2)

$77.65\times10^{-6}\pm2.050\times10^{-6}$. The highest sodium value was obtained for Tatara, Gandam-2002 and Fakhre-Sarhad with values of $35.90\times10^{-6}\pm3.676\times10^{-6}$, $33.80\times10^{-6}\pm2.828\times10^{-6}$ and $32.05\times10^{-6}\pm3.747\times10^{-6}$ respectively, while the lowest value was observed in Bhakkar-01 with $7.70\times10^{-6}\pm1.555\times10^{-6}$ of sodium. Regarding Na^+/K^+ ratio, high value variety is Tatara with value of 0.461 and was positioned first. The lowest value was observed in Bhakkar-01 with 0.098. Highest level of phosphorus is present in varieties Watan and Saleem-2000 with a mean value of 0.84×10^{-6}, while Bhakkar-01 and Chudry-97 are placed on the second position having 0.68×10^{-6} of phosphorus. It has been observed that lower phosphorus concentration in higher yielding variety is necessarily associated with success in selection for dry matter yield, where uptake of nutrient is limited (Lipsett, 1964).

Physiochemical characteristics

Physiochemical characteristics like ash, total grain mass and moisture are important parameters in the study of nutritional and agricultural aspect. The value of ash content is given in Table 3. The highest level is present in Gandam-2002, with a value (mean±*SD*) of (2.16±0.3804)% and Watan (2.15±0.3535)%. The lowest level is observed in variety Fakhre-Sarhad with (1.44±0.2100)% ashes. Our values are in some cases higher than already obtained for some other Pakistani wheat varieties (1.3%~1.95%) (Kamal *et al*., 2003). However the variation and negative relationships of ash with yield and all the other parameters may be attributable to the finding that ash is higher in those genotypes, which are more affected by drought during grain filling (Araus *et al*., 1998). Thousand grain mass (TGM) is an important parameter for determining productivity of wheat. TGM of different varieties is accessible in Table 3. Data represent the high mass of Wafaq-01 and Tatara with 43.602 g and 41.484 g respectively. Bhakkar-01, Inqilab-91 and Bakhtawar-92 have less TGM value of 34.025 g, 33.495 g and 31.108 g respectively. Jamil and Khan (2002) reported a TGM value of 36.29 g for Bakhtawar-92, which is 5.182 g higher than our value of 31.108 g. The probable reason for this high value may be the fresh grains they used. The result of TGM for Inqilab-91 is lower than the means value reported by Hussain *et al*.(2006).

Data regarding moisture content are present in Table 3. It is evident from the table that highest level of moisture is present in Wafaq-01, Chudry-97 and Tatara with values of (9.67±2.029)%, (9.64±1.923)% and (9.42±1.527)% respectively. Our value is higher than moisture contents of wheat varieties determined in D.I. Khan, Pakistan (6.06%) (Jamil and Khan, 2002). The main reason for this difference is the large drought area of D.I. Khan. Thus moisture content appears to affect the grain hardness and is important parameter for meal as well (Gaines and Windham, 1998).

Table 3 Physiochemical components of different Pakistani wheat varieties

Wheat variety	[a]Ash (%)	[b]TGM (g)	[a]Moisture (%)
Tatara	1.58±0.1675	41.484	9.42±1.527
Watan	2.15±0.3535	35.724	8.38±2.291
Gandam-711	1.83±0.0919	39.531	8.70±2.128
Bakhtawar-92	2.10±0.4355	31.108	9.27±1.605
Fakhre-Sarhad	1.44±0.2100	36.860	9.08±2.156
Bhakkar-01	1.63±0.3811	34.025	9.36±2.184
Ghaznawy	1.80±0.1541	35.133	9.03±1.796
Saleem-2000	2.04±0.3443	36.071	8.76±1.329
Wafaq-01	1.69±0.2934	43.602	9.67±2.029
Gandam-2002	2.16±0.3804	39.297	9.16±2.602
Chudry-97	1.58±0.3068	40.210	9.64±1.923
Inqilab-91	1.77±0.2708	33.495	9.00±1.838

[a]Values are expressed as mean±*SD* (*n*=2); [b]Thousand grain mass (TGM) values are expressed as mean (*n*=2)

It is concluded from the present study that wheat grains of different varieties in Pakistan contain total protein of 9.15%~10.27%, 2.15%~2.55% total fats, 1.72%~1.85% dietary fibers, 77.65×10^{-6}~84.25×10^{-6} of potassium and 7.70×10^{-6}~35.90×10^{-6} of sodium ions concentration, 0.24×10^{-6}~0.84×10^{-6} of phosphorus, 1.44%~2.10% ash, 31.108~43.602 g of TGM and 8.38%~9.67% moisture contents. This study is important in providing an opportunity to improve the nutritional quality of wheat and for setting up of nutritional and export regulations in Pakistan.

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