Received: 13 July 24 | Revised: 28 Aug 24 | Accepted: 17 Sep 24
DOI: https://doi.org/10.62460/TBPS/2024.052

RESEARCHARTICLE

Trends in Biotechnology and Plant Sciences

Genotypic Variation in Quality Parameters of Bread Wheat (*Triticum aestivum* L.)

Muhammad Ihsan Ali[2], Kiran Dost[1]*, Nimra Gul[1], Zafran khan[1], Imran Khan[5], Rabia Dilshad[1], Rizwana Maqbool[3], Muhammad Kashif[1] and Hira Shair[4]

[1]Department of Plant Breeding and Genetics, University of Agriculture Faisalabad
[2]Department of Seed Science and Technology, University of Agriculture Faisalabad
[3]CAS-AFS Department of Plant Breeding and Genetics, University of Agriculture Faisalabad
[4]Wheat Research Institute, AARI, Faisalabad
[5]Department of Forestry and Range Management, University of Agriculture, Faisalabad.

Correspondence
kdostgondal@gmail.com

Abstract

Wheat is an important cereal crop enriched in minerals, dietary fiber, vitamins, and crude protein used as a staple food in many countries of the world. This experiment was conducted to assess the protein in ten different genotypes of bread wheat. These genotypes were named as Kohistan-97, Chakwal-86, Maxi Pak-65, 36 ESWYT-142, 36 ESWYT-145, Chakwal-50, Aas-2011, Johar-2016, Anaj-2017 and Akbar-2019. This research investigates the genotypic variation in quality parameters of bread wheat (*Triticum aestivum* L.) focusing on key traits including moisture content, crude protein, starch, fiber, wet gluten, dry gluten, gluten index, and fat. A total of ten wheat genotypes were evaluated for their biochemical properties using near-infrared reflectance spectroscopy (NIRS) and traditional methods. Analysis of variance (ANOVA) revealed significant differences among genotypes for all parameters assessed using Statistix 8.1. Tukey's test was applied to compare the mean values of parameters collected from different genotypes. Aas-2011 exhibited the highest crude protein content (13.64%) and Maxi Pak-65 showed the highest moisture content (11.40%). Mean comparisons further highlighted substantial variations, particularly in wet gluten and gluten index, where Akbar-2019 and Aas-2011 displayed the highest values. Correlation analysis demonstrated complex interactions between quality parameters and grain yield, revealing a strong negative correlation between crude protein and yield, while starch content showed a positive correlation with yield. These findings underscore the potential of specific wheat genotypes to enhance nutritional quality and processing attributes. The results of this study contribute valuable insights for breeding programs aimed at improving wheat quality, thereby supporting agricultural sustainability and food security.

KEYWORDS
Wheat, quality parameters, wet gluten, dry gluten, gluten index, NIR.

1 | INTRODUCTION

Wheat is an important staple food with 14% protein content and 20% dietary energy. Some essential nutrients i.e. iron, zinc, manganese, vitamins E and B, and magnesium were present in grains of wheat, and all these nutrients transfer into the products prepared from the grains. All these nutrients are freely available for human consumption. Wheat is the source of 40 % of required nutrients for human in progressive countries that completely rely on wheat products (Velu et al., 2017). There is also a fraction of different proteins i.e. albumins, globulins, gliadins, and glutenins. The gliadins and glutenins are the main subunits of gluten protein that relate to the viscoelastic properties which helps to make dough for bread, noodles, pasta and other food products (Shewry, 2009). Gluten protein is also important to measure the quality of wheat flour. It is considered that the gluten content along with damaged starch is affected by the water absorption ability and type and degree of milling (Kulkarni et al., 1987). It was suggested that some specific products prepared from the grains or flour of wheat cause severe allergies in human beings, the most common examples of intolerance due to use of wheat products is coeliac disease and food and respiratory infections. It was

decided to introduce varieties of wheat with better quality parameters and agrochemical characters that will be beneficial for human beings (Shewry, 2009). Protein is supposed as an important nutrient present in wheat grain that is very essential for human as well as animal diet. Wheat grain is rich source of a number of nutrients i.e. minerals, fiber etc moreover 10-18% of protein also present in wheat. Gluten is consisted of 80% of the total protein present in wheat grain. The protein is present in the form of albumins, globulins, gliadins and glutenins. Out of total fraction of protein 25% is cover by albumins and globulins and 75% of protein is present in the form of glutenins and gliadins (Belderok et al., 2000). The glutenins are taken as the high molecular weight and low molecular weight protein and it is noted that the HMW trigger elasticity of dough. So it is said that gluten is the reason behind so many products made up of wheat flour such as bread, pizza etc (Anjum et al., 2007).

A research was conducted in which they evaluated the ability of near infrared reflectance spectroscopy to estimate the quality of wheat. It was stated that the quality of wheat played very important role in trade and processing. A number of techniques had been used to measure the quality of wheat. Out of all these techniques NIRS proved as the technique that respond to quickly and also covered more number of samples as compared to the other techniques but the accuracy of NIRS for most important quality parameters was needed to investigate. So the purpose of the study was to estimate the performance of near infrared reflectance spectroscopy to determine the sensitive quality parameters with reference to the optimized techniques. Total number of samples that were studied was thirty out of them 11 were wheat varieties and remaining 19 were collected from composites. It was noted that all samples had various values for wet gluten content and test weight on the other hand these samples showed low variability in moisture content. The values for wet gluten, test weight and moisture content by using near infrared reflectance were closed to the values obtained from the optimized techniques. All the information obtained from the near infrared reflectance technique was beneficial for improvement of quality traits in different wheat genotypes (Yousaf et al. 2018).

It was evaluated that some wheat genotypes for their nutritional status sown in dry and wet land in Sindh province. There were total eight varieties used for this experiment. The list of wet land genotypes of wheat was Inqulab, kherman, Sarsabz and TD-1 and dry land genotypes was PK-85, Marvi, Sassi and TK-3. The parameters collected in this research were moisture content, protein content, gluten content, wet gluten, dry gluten, gluten index and starch content. The biochemical parameters were measured by following AACC 2000. The experiment was resulted that there was significant difference among these genotypes in context to the biochemical properties. This study aimed to estimate the variation in quality parameters of ten different genotypes of bread wheat. Correlation analysis of quality parameters of these wheat varieties was also practiced (Panhwar et al., 2014).

The objectives of this research are given as:

- To estimate the gluten protein fractions of different genotypes of bread wheat.
- To estimate the quality parameters of different genotypes of bread wheat.

To estimate the correlation between yield contributing and quality traits of different genotypes of bread wheat.

2 METERIAL AND METHOD

The experiment was conducted in the field area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad to evaluate the yield contributing traits of ten wheat genotypes. The quality parameters i.e. wet gluten, dry gluten, and gluten index of wheat were measured in the Cereal Lab of Wheat Research Institute, Ayub Agriculture Research Institute, Faisalabad. Some other parameters i.e. fat, fiber, and moisture content were measured in the Analytical Lab, Center for Advance Studies, University of Agriculture, Faisalabad. The wheat genotypes evaluated for yield and quality parameters in this experiment were collected Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The list of wheat genotypes is given as; Kohistan-97, Chakwal-86, Maxipak-65, 36 ESWYT-142, 36 ESWYT-145, Aas-2011, Chakwal-50, Johar-2016, Akbar-2019 and Anaj-2017

Quality Parameters

The quality parameters were measured after grinding the grains of all treatments in 100 g flour by using a grinder and further passing the flour from glutamate and NIR analysis in the Cereal Lab of Wheat Research Institute, Faisalabad. Moisture content (%), Fat (%), Fiber (%), Crude protein (%), and Starch (%) were measured by near-infrared spectroscopy (NIR), and other quality parameters such as Falling number (Seconds), Wet gluten, Dry gluten, and Gluten index were measured by using glutamate machine.

Statistical analysis

The obtained data was subjected to analysis of variance (Steel et al. 1997) by using Statistix 8.1. Significant difference among treatments was determined by employing Tukey's test at 5% probability level. Correlation was performed to study the association among quality traits and yield of different genotypes (Pearson 1901).

3 RESULTS

Quality Parameters

The moisture content of 10 genotypes of bread wheat was measured by NIR. It analyzed the obtained values under RCBD analysis of variance. It showed that all genotypes were significantly different in moisture content (Table 1). To compare these genotypes Tukey's test was applied which showed that the genotypes that shared a letter were similar to each other and the genotypes that did not share the letter were different from each other (Table 2). It was showed the maximum value for moisture content observed in genotype Maxi Pak-65 (11.40%) and minimum in Anaj-2017 (11.16%). Data for crude protein of ten genotypes of bread was measured and subjected it to analysis of variance to check variation among the genotypes. The results of analysis of variance showed that the genotypes were significantly different from each other in the reference of crude protein (Table 1). The comparison of crude proteins of 10 wheat genotypes of wheat was also done by Tukey's test that showed that the genotypes share letters were statistically same and the genotypes with various letters were quite different from each other (Table 2). There was a genotype with highest crude protein named as Aas-2011 (13.64 %) and the wheat variety with the lowest crude protein was Kohistan-97 (13.04 %). Fat percentage of ten genotypes of wheat have been measured and subjected to analysis of variance that exhibited that there was no significant difference among the genotypes with reference to the fat percentage (Table 1). Tukey's test represented that the genotypes with same letters have no difference among them in fat percentage (Table 2). The values for fat % have been showed that genotypes such as 36 ESWYT-145 (7.21 %) and Anaj-2017 (5.82 %) have maximum and minimum values respectively.

The fiber % of ten genotypes of wheat has been measured by using near infrared spectroscopy and practiced analysis of variance on it that resulted that the significant variation among all tested genotypes (Table 1). The Tukey's test also applied to compare all these genotypes that resulted that the genotypes with different letters have variation among them (Table 2). It was exposed that Akbar-2019 (5.47 %) have maximum Fiber % and 36 ESWYT-142 (3.73 %). Data for starch percentage of 10 genotypes of bread wheat was measured and subjected to analysis of variance that gave the information that there was no significant difference among all genotypes (Table 1). The wheat variety Maxi Pak-65 (53.17 %) have highest starch % and Aas-2011 (52.26 %) contained minimum starch %. The values for the falling number of all wheat samples were collected and analyzed them by using analysis of variance technique that resulted that all the samples were quite different from each other in the aspect of falling number (Table 1). The comparison test was also applied that exhibited that most of the genotypes have separate letters which was the indication of variation (Table 2). Aas-2011 (572.83 Sec) has highest falling number and 36 ESWYT-145 (474.79 Sec) showed the minimum value. The wet gluten percentage was measured for 10 wheat samples of 10 different genotypes and tested its significance level through analysis of variance that showed the significant results (Table 1). The comparison test used to compare wet gluten of ten genotypes was Tukey's test that resulted that most of the genotypes have various letters that showed the variation among gluten % of all wheat genotypes (Table 2). It was represented that Akbar-2019 (22.95 %) contained the minimum value for wet gluten percentage and Aas-2011 (25.68 %) had the maximum value. The percentage of dry gluten was measured and subjected to analysis of variance to check the variation among 10 wheat samples belong the different genotypes of bread wheat. It was resulted that all varieties were different from each other (Table 1). The mean comparison test was also indicated that the genotypes have been showed change pattern of letters (Table 2). Johar-2016 (5.11 %) contained minimum value for dry gluten and Chakwal-86 (6.64 %) had maximum dry gluten. The gluten index percentage of 10 different genotypes of bread wheat was calculated and analysis of variance was applied on it that showed the significant variation among all wheat samples (Table 1). The Tukey's test was practiced on calculated data that showed that the genotypes with various letters were different from each other and the varieties shared the letters were statistically similar to each other (Table 2). The results of gluten index was showed such as Chakwal-86 (91.36 %) have the minimum gluten index % and Akbar-2019 (100.90 %) had maximum gluten index.

The correlation analysis (Table 3) highlights significant interactions among various quality parameters and yield (GYP) in the context of MC (moisture content), CP (crude protein), ST (starch), FB (fiber), WG (wet gluten), DG (dry gluten), and GI (gluten index). Notably, crude protein (CP) shows a strong negative correlation with yield, suggesting that higher protein levels may reduce yield. In contrast, starch (ST) correlates positively with yield, indicating that increased starch content may enhance yield. Wet gluten (WG) and gluten index (GI) also display significant negative correlations with yield, implying that higher values in these parameters could detract from yield. Other parameters, such as fat content (FT) and fiber (FB), present weaker or non-significant correlations. Overall, these results reveal a complex interplay among quality parameters, particularly emphasizing the trade-offs between protein and starch levels concerning yield.

4 | DISCUSSION

Quality Parameters

An experiment on commercial varieties of wheat concerning the gluten quality and other physicochemical

Table 1: Mean square values from analysis of variance (ANOVA).

SOV	D.F	MC (%)	CP (%)	Fat (%)	Fiber (%)	St (%)	FN (Sec)	WG (%)	DG (%)	GI (%)	GYPP(g)
Replication	2	0.001ns	0.001ns	0.003ns	0.004ns	0.001ns	332.50ns	0.012ns	0.001ns	0.008ns	0.005ns
Genotypes	9	0.053**	1.843**	3.089**	6.034**	1.475**	21377.60**	21.518**	1.929**	184.709**	82.660**
Error	18	0.000	0.000	0.000	0.000	0.000	333.30	0.035	0.000	0.000	0.003
Total	29										

Different values derived from ANOVA indicate significant differences at probability; ** = p ≤ 0.01; * = p ≤ 0.05; ns = Non-significant.
Abberviations: S.O.V: Source of variation, D.F: Degree of freedom, MC: Moisture content, CP: Crude protein, St: Starch, FN: Falling number (Seconds), WG: Wet gluten, DG: Dry gluten, GI: Gluten index, GYPP: Grain yield per plant.

Table 2: Mean comparison of quality traits of wheat genotypes

Genotypes	MC (%)	CP (%)	Fat (%)	Fiber (%)	St (%)	FN (Sec)	WG (%)	DG (%)	GI (%)	GYPP(g)
Kohistan-97	11.50b	12.62g	7.51d	2.22h	53.82c	594.01d	23.68d	6.80e	99.02a	28.94a
Chakwal-86	11.50b	13.12e	7.32f	2.39g	54.00b	405.02e	22.03f	8.77a	76.02d	22.45d
Maxi Pak-65	11.80a	11.70j	7.40e	4.21d	54.40a	459.02d	23.02e	7.10d	99.04a	25.90c
36 ESWYT-142	11.40c	13.70c	6.74h	0.97j	53.02g	487.68cd	27.02b	6.50f	99.02a	17.97f
36 ESWYT-145	11.40c	13.04f	9.30a	4.39c	53.20f	375.01e	23.02e	7.17c	99.03a	17.99f
AAS-2011	11.41c	14.21a	8.27c	5.24a	52.10i	666.01a	29.01a	7.06d	99.03a	16.97g
CHAKWAL-50	11.50b	13.52d	7.16g	1.49i	52.50h	519.02c	26.02c	7.53b	95.02b	14.98h
JOHAR-2016	11.42c	13.80b	8.42b	2.75f	53.80c	471.02cd	27.03b	5.67g	99.03a	21.99e
ANAJ-2017	11.41c	12.40h	5.83j	3.55e	53.60d	503.01cd	22.04f	6.82e	86.03c	27.48b
AKBAR-2019	11.30d	12.31i	6.46i	4.49b	53.50e	508.01cd	21.03g	6.52f	99.02a	28.99a

Table 3: Correlation analysis between quality parameters and yield

	MC	**CP**	**FT**	**FB**	**ST**	**FN**	**WG**	**DG**	**GI**
CP	-0.471ns								
FT	0.039ns	0.394ns							
FB	-0.033ns	-0.244ns	0.283ns						
ST	0.476ns	-0.719*	-0.161ns	-0.035ns					
FN	-0.162ns	0.333ns	-0.177ns	0.073ns	-0.537ns				
WG	-0.105ns	0.837**	0.369ns	-0.184ns	-0.649*	0.570ns			
DG	0.312ns	-0.096ns	-0.034ns	-0.068ns	0.025ns	-0.280ns	-0.324ns		
GI	-0.032ns	0.085ns	0.347ns	0.197ns	-0.267ns	0.361ns	0.424ns	-0.725*	
GYP	0.107ns	-0.770**	-0.465ns	0.207ns	0.724*	-0.007ns	-0.674*	-0.185ns	-0.101ns

traits and found a noticeable variation among all genotypes that affirmed our results of difference in moisture content of different genotypes of bread wheat (Dangi and Khatkar 2017). The physicochemical parameters of wheat and their effect on cookie quality. The results of this experiment obtained from analysis of variance showed the great variation for all chemical traits of various genotypes of wheat that promote our results of significant variation for a crude protein of bread wheat varieties. Fourier transform infrared to identify different wheat genotypes and found that there was a clear variation among all genotypes for fat % that was similar to our results (Amir et al., 2013). The rheological and physicochemical properties of two wheat varieties and observed the non-significant difference between these two genotypes for fiber content that was in favor of our results in which the starch content of all wheat genotypes varied from each other (Iqbal et al., 2015). Research on winter wheat varieties to find the influence of quality parameters of wheat on bread making found a significant difference of all wheat genotypes for all quality parameters such as starch %, crude protein, hardiness of dough, and moisture content, etc. that was in contrast with our results in which starch is noticeably different in all genotypes of bread wheat (Salmanowicz et al., 2012).

Research on the nutritional value of bread wheat in the aspect of the development of bio-fortified wheat varieties. In this experiment, found out that the falling number of all tested genotypes was present in a wide range that assisted our results in which the falling number was significantly different for each genotype (Abdullah et al., 2018). The rheological, physicochemical and functional characteristics of bread wheat and observed and there was clear variation among the genotypes of wheat in the aspect of wet as well as dry gluten. The results of their research assist our results of significant variation among all genotypes (Iqbal et al., 2015). Research in which they practiced the comparison of different wheat varieties of the province of Punjab for its bread-making quality. By this research they found significant variation among all genotypes in reference to wet and dry gluten that supported our results (Amjad et al., 2010). The quantity and quality of gluten are affected by breakage grains of wheat. This experiment resulted as there was a significant difference of gluten index among all checked wheat cultivars that supported our results (Afzal et al., 2012). A correlation study showed that crude protein and wet gluten were negatively correlated with yield and starch was positively correlated

with grain yield (Kaya and Akcura 2014).

Conclusion

Quality assessments indicated notable differences in moisture content, crude protein, wet and dry gluten, gluten index, falling number, and fiber percentage. Overall, the genotypes displayed substantial differences across most traits, underscoring their distinct characteristics. This study highlighted significant differences in quality parameters among various wheat genotypes, emphasizing the importance of selecting appropriate varieties for enhanced nutritional and processing qualities. The analysis revealed that Maxi Pak-65 had the highest moisture content, while Aas-2011 exhibited the highest crude protein levels. The correlation analysis further illustrated complex relationships between traits, notably showing a negative correlation between crude protein and yield, and a positive correlation between starch content and yield. These findings underscore the trade-offs between quality traits and yield potential, providing valuable insights for breeding programs aimed at improving wheat quality and productivity.

REFERENCES

AACC, (2000) Approved methods of the AACC. American Association of Cereal Chemists, St. Paul, MN.

Anjum, F. M., Khan, M. R., Din, A., Saeed, M., Pasha, I., & Arshad, M. U. (2007). Wheat gluten: high molecular weight glutenin subunits—structure, genetics, and relation to dough elasticity. Journal of Food Science, 72(3), R56-R63.

Amjad, M., Safdar, M. N., Mumtaz, A., Naseem, K., Raza, S., & Khalil, S. (2010). Comparison of different wheat varieties grown in Punjab for leavened flat bread (Naan) production. Pakistan Journal of Nutrition, 9(2), 146-150.

Afzal, Q.A., Arif S., Ahmed M., Hasnain A. and Munir M. (2012). Influence of shriveling and breakage of wheat kernels on gluten contents and its quality. Sarhad Journal of Agriculture, 28(2), 297-301.

Amir, R. M., Anjum, F. M., Khan, M. I., Khan, M. R., Pasha, I., & Nadeem, M. (2013). Application of Fourier transform infrared (FTIR) spectroscopy for the identification of wheat varieties. Journal of Food Science and Technology, 50, 1018-1023.

Abdullah, M., Ahmad, J., Javed, A., Hussain, M., Shamim, S., Shair, H., & Gulnaz, S. (2018). Nutritive appraisal of various wheat varieties/lines for developing biofortified wheat (*Triticum Aestivum* L.). Journal Food Process Technology, 9(7), 1-4.

Belderok, B., Mesdag, J., & Donner, D. A. (2000). Bread-making quality of wheat: a century of breeding in Europe. Springer Science & Business Media.

Dangi, P., & Khatkar, B. S. (2017). Physicochemical and gluten quality characteristics of commercial wheat varieties. International Journal of Innovation Research Science Engineering Technology, 6, 13448-13454.

Iqbal, Z., Pasha, I., Abrar, M., Masih, S., & Hanif, M. S. (2015). Physico-chemical, functional and rheological properties of wheat varieties. Journal of Agricultural Research (03681157), 53(2).

Kulkarni, R. G., Ponte, J. G., & Kulp, K. (1987). Significance of gluten content as an index of flour quality. Cereal Chemistry, 64(1), 1-3.

Kaya, Y., & Akcura, M. (2014). Effects of genotype and environment on grain yield and quality traits in bread wheat (*T. aestivum* L.). Food Science and Technology, 34, 386-393.

Pearson, K. (1901). LIII. On lines and planes of closest fit to systems of points in space. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 2(11), 559-572.

Panhwar, A. A., Sheikh, S. A., Mirani, B. N., Channa, M. J., & Khanzada, S. (2014). Studies on the nutritional characteristics of some commercial wheat varieties of dry land and wet land grown in Sindh province. Journal of Pharmacy and Nutrition Sciences, 4(4), 263-267.

Steel, R.G., Torrie, H. and Dickey, D.A. (1997). Principal and Procedure of Statistics: A Biometrical Approach. 3rd edition. McGraw Hill Book Co. New York.

Shewry, P.R. (2009). Wheat. Journal of Experimental Botany, 60(6), 1537-1553.

Salmanowicz, B. P., Adamski, T., Surma, M., Kaczmarek, Z., Karolina, K., Kuczyńska, A., & Obuchowski, W. (2012). The relationship between grain hardness, dough mixing parameters and bread-making quality in winter wheat. International Journal of Molecular Sciences, 13(4), 4186-4201.

Velu, G., Singh, R. P., Huerta, J., & Guzmán, C. (2017). Genetic impact of Rht dwarfing genes on grain micronutrients concentration in wheat. Field Crops Research, 214, 373-377.

Yousaf, S., Khurshid, S., Arif, S., Iqbal, H. M., Akbar, Q. A., Sahar, N., & Rasul, G. (2018). Performance of transmittance near-infrared spectrometry in determining wheat quality. Journal of Innovative Sciences, 4(2), 114-119.