

Diversity in Quality Traits of Indian Wheat Cultivars: Grain, Whole Wheat Flour and Protein Characteristics

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ABSTRACT: Five different Indian wheat cultivars obtained from different locations were evaluated for the grain quality traits and whole wheat characteristics. The physico-chemical data showed that the cultivars studied were quite diverse in terms of wheat quality characteristics. The wheat quality parameters i.e. grain dimensions, thousand kernel weight and grain hardness showed significant differences among the cultivars studied. The diameter of grain was found to have a strong positive relationship with the Hectoliter weight ($r=0.786$). The damaged starch content of whole wheat flour also depicted a highly positive ($r=0.938$) correlation with the Grain hardness. Wide diversity was exhibited by wheat variety HD2932 in protein content as well as quality.

KEYWORDS: Wheat cultivars, Whole wheat flour, location, quality, protein.

I. INTRODUCTION

Wheat varieties cultivated in India are not only large in number but they are also specific to different regions and production conditions (Singh, 2011). The flour functionality is influenced by many factors such as cultivar type, protein content, grain hardness, growing condition and crop season (Nemeth et al., 1994) and thereby impacts the end product quality. The physico-chemical properties are important quality parameters in wheat (Moss, 1973; Pena, 2008), compositional variations in the flours from different wheat cultivars and flour streams from the same cultivar vary in dough rheological and baking properties (Fustier et al., 2007) and governs the processing and quality characteristics of wheat based products.

It is widely known that quality of wheat grain and the end products is cultivar and environment specific (Peña et al., 2002; Williams et al., 2008). Location effect in wheat quality has been realized in many parts of the world as well as in India (Mohan and Gupta, 2011; Rharrabti et al., 2003). Wheat flour when mixed with appropriate quantity of water gives a viscoelastic mass called “dough”, this unique property to wheat flour is mainly conferred by the Gluten. While considering the wheat quality, the protein content and quality which is majorly represented by the gluten proteins is an important criterion of selection of wheat cultivars for specific products. It is influenced by genetic as well as by non-genetic factors.

There are many wheat varieties which are prevalent throughout India and as a result they are exposed to environmental and climatic conditions that can lead to variation in the wheat quality characteristics. Therefore, the present study was devised to understand the variation among the quality traits of same wheat varieties grown at different locations.

II. RELATED WORK

Wheat is a most important cereal in India and is consumed mainly in the form of unleavened flat bread- chapatti (Prabhasankar et al., 2002). Chapatti is usually prepared from whole-wheat flour and the desired quality parameters in

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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chapatti are good pliability, soft texture, light creamish brown colour and wheatish aroma (Haridas Rao et al., 1986). The quality characteristics of chapatti are mainly governed by the quality of wheat used and the processing conditions employed for converting it into flour (Austin and Ram, 1971).

III. MATERIALS AND METHODS

A. MATERIALS

The wheat grains of five wheat cultivars i.e. DBW17, DL788-2, HD2932, HI1544 and MACS2496 were obtained from different agricultural institutes (ARI, Pune; GBPU, Pantnagar; Wheat Research Station, SDAU, Vijaypur, Gujarat; CCSHAU, Hisar), seed farm (Central Seed Farm, Hisar) and IARI regional stations (IARI, Indore). DBW17 was taken from two locations i.e. Haryana and Uttarakhand, DL788-2 was obtained from Indore and Gujarat, HD2932 was from three locations i.e. IARI Indore; CSF, Hisar, Haryana and Vijaypur, Gujarat. Wheat variety HI1544 was from Indore and Vijaypur, Gujarat, while MACS2496 was obtained from ARI, Pune and Vijaypur, Gujarat.

B. Analysis of Wheat Grain Characteristics

The physical characteristics wheat cultivars i.e. grain width/diameter, hardness, weight, and moisture content were determined using Single Kernel Characterization System (SKCS, Model 4100, Perten Instruments, Sweden). Grain length was determined using a digital Vernier caliper and hectoliter weight was obtained by weighing the wheat grain in standard container of 100 mL capacity. All wheat varieties were cleaned and milled in a laboratory mill to obtain whole wheat flour.

C. Analysis of Whole Wheat Flour

Moisture, ash, fat, falling number, and protein ($N \times 5.7$) content of whole wheat flour samples were determined according to standard AACC methods 2000. SDS sedimentation volume of flour was obtained by using the method of Axford et al. (1979). Damaged starch content was analyzed by means of SDmatic (Chopin Technologies, France). Gluten content and gluten index (GI) of the whole wheat flour were examined using Glutomatic (Perten Instruments, Sweden) as per standard ICC method. Mineral composition of whole wheat flour was determined according to the standard AOAC methods. Gluten extensibility of isolated gluten was analysed by Kieffer dough/gluten extensibility rig (A/KIE) using Texture Analyzer. Resistance to extension, g (R) and Extensibility, mm (E) were the two main parameters measured by the gluten extensibility test.

D. Statistical Analysis

Descriptive statistics (Mean, min-max. range, standard deviation) and Pearson correlation coefficients (significance levels at $p < 0.01$ and $p < 0.05$) were computed for data of wheat varieties using the SPSS software version 16.0 (SPSS Inc., USA). All determinations were made in triplicate.

IV. EXPERIMENTAL RESULTS

Table 1 represents the grain quality traits of different wheat cultivars. The wheat grain moisture, length, diameter, hectolitre weight, thousand kernel weight and hardness varied from 8.7 to 15.3%, 6.5 to 7.3 mm, 2.8 to 3.3 mm, 77.2 to 88.3 kg/hL, 31.5 to 50.2 g and 55 to 91.2 N, respectively. In terms of grain quality traits, the same wheat varieties obtained from different locations showed significant differences except wheat cultivar HI 1544 which had comparable thousand kernel weight and wheat cultivar MACS2496 which showed same grain length among the grains from different locations. On the basis of hardness, wheat cultivar DBW17 was found to be softer, while DL788-2 (G) and MACS2496(G) had the harder grains. Grain hardness is an important determinant of the end-product quality in wheat. It is the main classification parameter for global wheat trade. Grain hardness or kernel hardness (GHD) affects parameters such as milling yield, starch damage and baking properties. Further, the data indicated that wheat grains obtained from Indore had lower moisture contents as compared to the other locations, which may typically be attributed to higher temperature and drier climate. It was found that Grain diameter was significantly positively correlated with the Hectoliter weight ($r=0.786$) and Thousand kernel weight ($r=0.953$).

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Table I Wheat Grain Quality Traits

Variety Name*	Moisture (%)	Length (mm)	Diameter (mm)	Hectoliter (kg/hL)	Thousand kernel weight (g)	Hardness (N)
DBW 17 (H)	9.6c	7.0f	3.0c	77.2a	34.8c	55.0a
DBW 17 (U)	12.2e	6.9e	3.1d	82.3e	38.8f	64.9b
DL 788-2 (I)	9.7d	7.1g	3.3f	88.3g	50.2i	77.4e
DL 788-2 (G)	12.4g	7.3i	2.9b	80.4c	35.2d	91.2j
HD 2932 (I)	8.7a	6.7c	3.3f	84.3f	44.6h	71.8d
HD 2932 (H)	12.1e	6.5a	2.9b	80.4c	33.2b	66.4c
HD 2932 (G)	12.3f	6.6b	2.8a	81.0cd	31.5a	84.6g
HI 1544 (I)	8.9b	6.8d	3.2e	84.2f	43.3g	78.2f
HI 1544 (G)	15.3j	7.1g	3.3f	81.6d	43.0g	88.6h
MACS 2496 (P)	14.8i	7.2h	3.0c	80.3c	37.5e	78.1f
MACS 2496 (G)	14.4h	7.2h	2.9b	78.0b	33.8b	90.8i

*The letters in parenthesis represents the location from where wheat cultivar was procured.

**The values followed by different letter in the same column are significantly different at $p < 0.05$

Moisture, fat and ash content of whole wheat flours ranged from 8.10 to 12.1 %, 1.2 to 2.2 % and 1.4 to 1.7 %. Significant difference was observed between these flour characteristics obtained from similar varieties at different locations. However variety DL 788-2 and HD 2932 showed no significant difference between moisture and ash content. Damaged starch (DaS) content varied from 10.3 to 15.9 %. DBW 17 (H) showed the minimum DaS whereas DL 788-2 (G) showed highest. Similar varieties from different locations showed significant differences in DaS values. Whole wheat flour characteristics of different wheat cultivars have been shown in Table 2. Similar to wheat grain moisture, the corresponding whole wheat flour moisture was found to be low or high. Further, it was clear from the data that there is certainly an impact of climatic conditions and other parameters on grain and flour quality characteristics when the same wheat variety is grown at different locations. Correlation analysis (Table 4) revealed that hardness was significantly and positively linked with damage starch ($r=0.938$) which is as expected since the harder are the grains, more is the force needed to crush them into flour and consequently higher is the damaged starch.

Table II Whole Wheat Flour Characteristics

Variety Name*	Moisture (%)	Fat (%)	Ash (%)	Falling No. (s)	Damage Starch (%)	Iron (ppm)	Copper (ppm)	Zinc (ppm)	Manganese (ppm)	Magnesium (ppm)
DBW 17 (H)	8.1a	1.2a	1.5c	317.0a	10.3a	20.1a	1.7a	25.7b	13.8a	512.8a
DBW 17 (U)	12.1e	1.3b	1.7d	429.5b	12.9c	22.8b	3.2c	39.3f	24.0f	1398.3c
DL 788-2 (I)	9.1b	1.9f	1.4b	751.5h	13.1d	41.7h	4.5e	57.4i	28.6i	1666.3e
DL 788-2 (G)	11.1c	1.7e	1.5c	758.5h	15.9f	30.5d	4.3e	18.9a	18.1b	2406.9h
HD 2932 (I)	9.3b	1.8f	1.4b	457.0c	12.6b	32.3e	3.6d	45.8h	23.9g	1570.4d
HD 2932 (H)	10.6c	2.2g	1.5c	448.5c	10.6a	41.3h	2.6b	28.1b	18.5b	2293.7g
HD 2932 (G)	10.8c	1.6d	1.5c	656.5g	15.6f	44.4i	5.6g	19.0a	21.0d	1368.1c
HI 1544 (I)	8.5a	2.2g	1.2a	586.5f	14.5e	31.2d	4.9f	30.0c	23.3e	2791.5i
HI 1544 (G)	11.5cd	1.4c	1.3a	477.5d	16.2g	33.5f	3.0c	35.7e	19.1c	1961.3f
MACS 2496 (P)	12.5e	2.4i	1.7d	427.5b	13.1d	37.9g	6.3h	36.5f	30.0j	2905.3j
MACS 2496 (G)	10.8c	2.3h	1.8e	564.5e	16.0g	27.7c	4.5e	32.0d	25.3h	1293.3b

*The letters in parenthesis represents the location from where wheat cultivar was procured.

**The values followed by different letter in the same column are significantly different at $p < 0.05$

Falling number (FN) determines the level of α -amylase in the flour which increases when the wheat grains are exposed to humid and undesirable climate during storage. Falling number values ranged from 317.0 to 758.0 s. Variety DBW 17 showed the minimum FN whereas DL 788-2 showed the maximum. No significant difference was observed in falling

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number values of similar varieties grown at different location except for DBW 17 which showed slight difference. The mineral composition of the whole wheat flour was also examined. It was evident that whole wheat flour had considerable amount of magnesium i.e. 512 to 2905 ppm, while Cu was present in least amount i.e. 1.7 to 6.3 ppm among the minerals studied (Table 2).

Table III Protein Content and Quality Characteristics of Whole Wheat Flours

Variety Name*	Protein (%)	Wet gluten (%)	Dry Gluten (%)	Gluten Index	Resistance/Extensibility	SDS SV (ml)
DBW 17 (H)	13.2e	19.2a	5.5a	68.3c	2.1f	35.3b
DBW 17 (U)	12.2c	23.2c	6.6c	44.7b	1.4cd	31.8a
DL 788-2 (I)	11.5b	25.3d	7.9e	83.3d	0.4ab	35.0b
DL 788-2 (G)	13.8	30.7f	9.1f	79.6d	0.3a	48.8h
HD 2932 (I)	11.1a	29.2e	9.0f	78.4d	0.5ab	45.3e
HD 2932 (H)	11.7b	20.9b	6.9d	94.8e	3.8g	43.5c
HD 2932 (G)	15.1g	35.6i	11.0h	80.9d	1.5d	48.1g
HI 1544 (I)	11.7b	33.2h	9.6g	42.8b	0.5ab	47.0f
HI 1544 (G)	13.5f	32.7g	9.4g	40.0a	0.5ab	34.8b
MACS 2496 (P)	12.7d	21.1b	6.3b	92.0e	1.7e	42.3c
MACS 2496 (G)	13.4f	30.4f	9.2f	83.0d	1.3c	44.3d

*The letters in parenthesis represents the location from where wheat cultivar was procured.

**The values followed by different letter in the same column are significantly different at p<0.05

Protein content and quality parameters were evaluated in whole wheat flours as depicted in Table 3. The protein content ranged from 11.1 to 15.1%. It was interesting to note that this wide range was exhibited by same variety i.e. HD2932 obtained from different location wherein HD2932(I) showed the least, while HD2932(G) showed the maximum protein content.

Table IV Correlations among the selected Wheat Grain Quality Traits and Whole Wheat Flour Characteristics

Parameters	GL	GD	HLW	TKW	GHD	PRO	DG	SDS	FN	DaS
GL	1.000									
GD	Ns	1.000								
HLW	Ns	0.786**	1.000							
TKW	Ns	0.953**	0.857**	1.000						
GHD	0.468*	Ns	Ns	Ns	1.000					
PRO	Ns	-0.699**	-0.547**	-0.625**	0.464*	1.000				
DG	Ns	Ns	Ns	Ns	0.750**	Ns	1.000			
SDS	Ns	Ns	Ns	Ns	0.465*	Ns	0.569**	1.000		
FN	Ns	Ns	0.466*	Ns	0.680**	Ns	0.628**	Ns	1.000	
DaS	0.425*	Ns	Ns	Ns	0.938**	0.550**	0.794**	Ns	0.602**	1.000

GL- Grain Length (mm), GD- Grain Diameter (mm), HLW- Hectoliter weight (kg/hL), TKW- Thousand kernel weight (g), GHD- Grain Hardness (N), PRO- Protein Content (%), DG- Dry Gluten (%), SDS- SDS Sedimentation value (mL), FN- Falling Number (s), DaS- Damaged Starch (%)

In contrary to the whole wheat flour characteristic, the protein quality parameters showed some insignificant differences among the locations. For instance, The dry gluten content, gluten index and R/E ratio of HI1544(I) and HI1544(G) was comparable. Similarly, for wheat cultivar DL788-2(I) and DL788-2(G), the values of gluten index and R/E were found to be statistically similar. Further, wheat cultivar HD 2932 and MACS 2496 also displayed insignificant variability in the SDS sedimentation volume among the grains obtained from different locations. However, HD2932 also showed maximum variability in terms of R/E ratio among the three locations. Protein also displayed

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significant positive association with the Grain hardness ($r=0.464$) and Damaged starch ($r=0.550$). Variation in protein content might be attributed to environmental and growing conditions as well as genetic makeup of the cultivars (Kaur et al., 2013). Sedimentation tests have been associated with gluten strength and superior bread-making quality (Ayoub et al., 1993). Sedimentation values in SDS solution were reported to be due of swelling of glutenins strand (Eckert et al., 1993). Dough with higher strength of gluten had more swelling in SDS suspension, hence, showed more sedimentation value. SDS Sedimentation value (SDS SV) varied from 31.8 to 48.8 mL among the whole wheat flour obtained from selected wheat varieties. SDS SV obtained from wheat varieties DBW 17(H), DL 788-2 and HI 1544 was comparable.

V. CONCLUSION

The present study indicated a wide variation in the grain quality traits and whole wheat flour characteristics among the same cultivars from different location. Therefore, wheat grain itself becomes a potential source of variability in processing and end use quality of wheat. It is very critical to keep this in view while selecting the same cultivar meant to be used for a specific product to sustain the quality of product.

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