Genetic Variability and Physio-Chemical Attributes in Relation to Quality in Bread Wheat (*Triticum aestivum* L Em. Thell)

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SYNOPSIS

Genetic Variability and Physio-Chemical Attributes in Relation to Quality in Bread Wheat (*Triticum aestivum* L Em. Thell)

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Introduction

Ever since the mankind assumed the civilized life, the contribution of wheat in thwarting both hunger and malnutrition has been cardinally unparalleled. Wheat is the second most important staple food crop next to rice, consumed by over 35% of the world population and providing 20% of the total food calories. It is a mainstay food crop of the world due to its remarkable adoption to a wide range of environments and its role to world economy (Kumar *et al.,* 2011). Wheat occupies about 32% of the total acreage under cereals in the world. The main wheat growing countries include China, India, U.S.A., Russia, France, Canada, Germany, Turkey, Australia and Ukraine. In India, wheat is mainly grown in the states of Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Maharashtra, Karnataka and Gujarat. India produces wheat on an area of 29.90 million ha with production of 94.88 million metric tons and productivity of 3140 kg/ha. In Gujarat, wheat is grown on 1.35 million ha area with total production of 4.1 million metric tons and a productivity of 3.04 metric tons/ha (Anonymous, 2012-13).

Wheat belongs to the genus *Triticum* of the family *Poaceae.* It is believed to have been originated in the golden crescent between Tigris and Euphrates in Middle East Asia (Lupton, 1987). Among the two types of wheat (winter and summer wheat), spring wheat is grown in India mainly in the winter season, though it is grown in spring season too in cooler places like Nilgiri hill of Tamilnadu and Lahul Spiti valley of Himachal Pradesh. Three species of wheat *viz*., bread wheat (*Triticum aestivum* L. Em. Thell), macaroni wheat (*Triticum durum* Desf.) and emmer wheat (*Triticum dicoccum* Schulb) are grown as commercial crop in India, covering 86, 12, and 2% of the total area, respectively. Bread wheat, a hexaploid with chromosome number 2n=42, is cultivated in the all wheat growing areas of the country. The macaroni or durum wheat (tetraploid, 2n=28) is mostly grown in central and southern states, while the emmer wheat (tetraploid, 2n=28) is confined mainly to Karnataka with some punctuated pockets in parts of Porbandar district in Gujarat.

Wheat (*Triticum spp.)* is an incredible cereal by dint of having unique quality of protein, gluten that assigns peculiar functional properties to its dough. India is unique as unlike other parts of the globe about 75 per cent of the ninety odd million metric tons annual produce of wheat is processed in plate mills as whole wheat flour that is used to prepare traditional baked products like chapati and its myriad culinary variants. Chapati is single layered, flat and unleavened bread used as main staple in the diet in overarching South Asian countries. In India, where no clear cut wheat classes are there, good quality of wheat means one that make good chapaties. And of course, good chapaties entail softness, pliability, sweetness and light creamish brown colour devoid of specks that can be torn easily without being extremely brittle or leathery but with slight chewiness and baked wheat aroma (Haridas Rao, 1993).

The uniqueness of wheat flour is that when it is mixed with water, it impregnates unique visco-elastic properties to the dough. This provides special functional properties to dough to make it amenable to processing in to variety of food products such as bread, chapatti, biscuits and pasta. Each product demands unique physical and chemical requirements in wheat grain. Therefore, wheat varieties have been classified in to different classes commercially in global wheat trade as per physical (hardness and bran colour) and chemical attributes (protein contents and quality). In India, no such commercial classes exist. However, it has been univocally reported that the both physical and chemical properties of wheat are inherently genotypic attributes, though they have been found varying over different zones of the country; South Zone and North Hill Zone being the richest and poorest for realizing protein content, respectively. Similar regional differences exist for other quality traits too. There hardly needs any emphasis that wheat grown in Central Zone is considered good quality wheat.

Wheat grain contains starch (60-68%), protein (6-21%), fat (1.5-2.0%), cellulose (2.0-2.5%), minerals (1.8%) and vitamins (Koehler and Wieser 2013). About 80 per cent of wheat protein contains gluten, which in turn comprises of glutenin and gliadin. Both these components are cardinal for imparting functional properties to dough. Glutenin assign extensibility while gliadin provides viscosity to dough. Starch dilutes gluten to appropriate consistency and furnishes maltose by amylase action for fermentation for loaf expansion and loaf structure. Protein quality (glutenin and gliadin) is the inherent characteristic of the genotype while protein content is the manifestation of genotype, environment and their interaction.

The present investigation will be undertaken to delineate bread wheat with the following objectives;

i. To ascertain the nature and magnitude of variability present in wheat with respect to its yield and its component traits

ii. To estimate genotypic and phenotypic correlation between grain yield and its component characters

iii. To determinate the direct and indirect influences of various yield attributing characters through path coefficient analysis.

iv. To comprehend stability of performance of different quality attributes in relation to wheat quality.

Review of literature

Cereals are staple foods for human nutrition and their use into a wide range of products is of great economic importance. Wheat is one of the major cereals across the world and is used mainly for the preparation of bread. Wheat in India is consumed mainly in the form of unleavened flat bread known as chapati. Chapaties constitute an important source of dietary proteins, calories, some of the vitamins and minerals for large section of Indian population.

Effect of damaged starch on the functional quality characteristics of whole wheat flour used for chapati making was reported by Rao *et al.* (1989). They found that damaged starch in the flour was positively correlated to the diastatic activity ($r= 0.884$, $P<0.01$) and chapati water absorption ($r=0.955$, $P< 0.001$) and negatively correlated to the percentage over tailings on a 10 XX sieve ($r=-0.938$, $p<0.001$). The various rheological characteristics of whole wheat flour were also influenced by the damaged starch as indicated by its significant correlation to dough development time ($r=-0.924$, $P<0.001$), extensibility ($r=0.883$, $P<0.01$), resistance to extension ($r=0.899$, $P<0.001$), cohesiveness ($r=0.835$, $P<0.01$), and adhesiveness ($r=0.732$, $P<0.01$). The flour with damaged starch in the range of 14.1-16.5% was considered to be optimum, as it yielded chapaties with better pliability, texture, taste and overall acceptability.

Butt *et al.* (2001) studied highest iron content was observed in wheat bran i.e. 64.6 mg/kg whereas iron content in different treatments of brown flour ranged from 16.8 to 29.2 mg/kg. Chapaties prepared from the respective flour samples were further evaluated for various chemical and sensory attributes. The brown flour prepared by the addition of 10% bran showed better performance and was quite comparable with whole wheat flour regarding the proximate and sensory attributes like color, flavor, texture, taste, folding ability, chewing ability and appearance. Moreover the same sample (T3) had better iron content than whole wheat flour. Chapattis prepared by brown flour with 10% followed by

15% bran were of best quality and quite comparable with chapattis prepared from whole wheat flour.

Manu and Rao (2008) studied that SDS buffer extracted 72–90% of the total flour protein in different varieties and 7–11% protein was extracted from the remaining residues by sonication. The proteins extracted were fractionated by SE-HPLC into large polymeric proteins (>130 kDa), small polymeric proteins (80–130 kDa) and monomeric proteins (10–80 kDa). Total polymeric protein content in the flour protein showed a significant positive correlation with dough hardness ($r=0.71$, $p<0.05$) and positive correlation with chapati texture ($r=0.58$, $p<0.05$). Of the SDS extractable polymeric proteins, large polymeric protein in flour protein had significant positive correlation to dough hardness ($r = 0.89$, $p<0.05$) and chapati cutting force, which reflects the chapati texture ($r=0.70$, $p<0.05$). Protein disulfide content showed positive correlation to dough hardness ($r=0.66$, $p<0.05$) and texture of chapati ($r=0.58$, $p<0.05$) while protein thiol content showed significant negative correlation to chapati texture ($r=0.77$, $p<0.05$). Thus, the results indicate that high proportion of SDS extractable large polymeric protein in flour protein increases the toughness of chapati texture while flours having high thiol content decrease the toughness of chapati.

Seven wheat varieties, 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 was reported by Muhammad Safdar *et al.* (2009). They found that Shafaq 2006 had the maximum test weight (81 kg/hl) thousand kernel weights (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 (25BU) 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, respectively.

A spreadsheet aided fuzzy logic model for predicting chapatti making quality characteristics of wheat varieties was reported by Gangadharappa and Prabhasankar (2011). They found that 19 randomly selected wheat varieties were used for starch damage, farinograph water absorption as input variables and chapatti overall score as output variable were fuzzified by the use of excel spreadsheet and defuzzification was carried out using weighted average method. Fuzzy model was compared with the regression model of measured data for its error levels and ease of application. Standard error of estimate of fuzzy model was smaller (1.825) than measured (2.895) chapati quality score regression model.

Mallick *et al.* (2011) reported that wheat genotypes developed under stress tolerant breeding programme viz. RSP-511, RSP-529, RSP-560, RSP-561, RSP-564 and RSP-566 and national cultivars PBW-343 and PBW-175Sa was analyzed for the nutritional quality parameters. However, the genotype was little behind in chapatti making quality as it showed low Gln (4.75%) and Gld (3.94%) values and sedimentation volume (34.42ml) in comparison to other genotypes. The RSP-561 and PBW-343 genotypes revealed superiority in protein, Gln, sedimentation volume, gluten (Gln+Gld) compositions with values 12.17 and 11.71%, 5.20 and 4.99%, 44.57 and 38.22 ml, 9.97 and 9.38% respectively and also in iron, calcium, zinc having levels 6.89 and 7.11 mg/100g, 50.58 and 50.92 mg/100g, 5.75 and 3.45 mg/100g respectively along with moderate lysine, phytic acid, and antioxidant compositions (2.26 and 2.32%, 0.81 and 0.76g/100g, and 16.69 and 14.95% respectively) and hence were considered as superior genotypes for chapati making quality comprising of high nutritional values in which RSP-561 stood higher rank compared to PBW-343. RSP-566 constituting protein (10.68%), sedimentation volume (40.43), Gluten (Gln 4.85 and Gld 3.64%), iron (6.92), calcium (49.25) zinc (5.00), antioxidant (17.60%) and lowest phytic acid content (0.39mg/100g) followed PBW-343. RSP-560 and PBW-175 which possessed good levels of total protein, sedimentation volume, protein fractions, and lysine ranged medium in essential element levels were featured to have significantly rich chapati making quality but moderate nutritional qualities.

Guar and carboxy methyl cellulose gums on the rheological characteristics for chapati bread was reported by Vafaei and Movahhed (2012). They found that treatment with 0.5% of carboxy methyl cellulose gum (G4) had the highest amount of water absorption and the treatment with 0.5% of guar gum (G2) had the higher rank in terms of dough development time, stability and volumetric time and according to the results of extensograph test the dough samples of the treatment with 0.5% of guar gum (G2) had higher advantage than control samples and other samples in terms of resistance to dough stretching (in each time period) and energy (in times of 45 and 135 min).

Material and Methods

1	Name of the experiment	:	Genetic Variability and Physio-Chemical Attributes in Relation to Quality in Bread Wheat (*Triticum aestivum* L Em. Thell)
2	Location	:	Three i. LPU Research station
3	Season	:	*rabi* 2017
4	Date of sowing	:	Timely
5	Number of Genotype	:	30 + 5 = 35
6	Experimental design	:	RBD (Plot size 2.50 x 0.90 m^2)
7	Number of replication	:	3
8	Spacing	:	22.5cm
9	Agronomic practice	:	As per recommendation
10	Plant protection	:	Need based

Material:

The present investigation would entail thirty diverse genotypes and five checks of bread wheat. Seed material will be acquired from the National Bureau For Plant Genetic Resources.

Observations

Sr No.	Character	Sr No.	Character
1	Grain Yield	7	1000 seed weight
2	Reproductive Phase	8	Grain Hardness
3	Vegetative Phase	9	Dry Gluten
4	Protein content (%)	10	Wet Gluten

5	Sedimentation value (cc)	11	Extensibility
6	Hectoliter weight (kg/l)	12	Baking Strength
		13	P/L Ratio

1. **Grain Yield/Plot (gm)**

   Total grains in each plot would be harvested at maturity and weighed in grams as Grain Yield/Plot.

2. **Vegetative Phase (days)**

   The period in days taken by each genotypes to reach initiation of flowering from date of sowing.

3. **Reproductive Phase (days)**

   The period in days taken by each genotype to reach maturity from initiation of flowering.

4. **Protein Content (%)**

   Protein content in each genotype would be estimated as per NIR technique

5. **Sedimentation Value (cc)**

   Sedimentation value for each genotype would be estimated as per NIR technique

6. **Hectoliter Weight (kg/l)**

   The hectoliter weight would be estimated as kg/hectoliter by hectoliter weight kit

7. **1000 seed weight (gm)**

   Representative random samples of 1000-grains would be counted and weighed in grams.

8. Plant height (cm)

At the physiological maturity, the height of individual tagged/sampled plant will be measured in centimeters from the ground level to the tip of terminal spikelet (excluding the awn) of the main shoot.

9. Number of effective tillers

At the physiological maturity, the total number of spike bearing tillers in each plant will be recorded.

10. Spike length (cm)

Length of main spike (cm) will be measured from the base to the tip of the terminal spikelet, excluding the awn.

11. Number of grains per spike

The number of grains per spike will be counted from main spike after the harvesting of plant.

12. Harvest index

Harvest index will be calculated as,

$$\text{Harvest Index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

13. Grain Hardness

Grain hardness would be measured in Single Kernel Characterization System

14. Dry Gluten

Would be estimated using glutomatic system

15. Wet Gluten

Would be estimated using glutomatic system

16. Extensibility

Would be estimated using Alveo Consistograph test.

17. Baking Strength

Would be estimated using Alveo Consistograph test.

18. P/L Ratio

Would be estimated using Alveo Consistograph test.

Statistical Analysis

Analysis of variance, correlations, paths will be estimated as per standard methods. The stability of performance of quality attributes will be estimated as per Eberhart and Russell (1966).

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