

Evaluation of wheat genotypes for farinographic characteristics in relation to their *chapati*-making properties

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Abstract

A set of 34 wheat genotypes were evaluated over two seasons for *chapati* making properties and Farinographic characteristics. The genotypes used in the study included tall Indian landraces, released varieties known to have good quality, genetic stocks possessing one or other quality components and high yielding commercial varieties. The results indicated that superior *chapati* quality wheats scored low for almost all the farinographic characteristics thus negative correlation as observed in one or the other season. Consistent trends were not observed possibly due to change in set constituents and differential environments.

Key Words: Wheat, *chapati* making, farinograph, water absorption, correlation

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Introduction

Wheat is the leading cereal grain produced, consumed and traded in the world. The cultivation of wheat is thought to have begun several thousand years before the birth of Christ; and bread, leavened and unleavened, has been a staple food for humans throughout recorded history. In the Indian sub-continent and parts thereof, wheat is generally consumed as unleavened, single-layered flat bread, commonly known as '*chapati*'. Just as bread is a staple food item in the western world, *chapati* prepared from whole wheat meal (locally known as *atta*) is the staple diet of a sizable population of Indian sub-continent. The quality of wheat, as far as *chapati* is concerned, is relative. The concept of good *chapati* varies from region to region, as also on the preparation. However, a soft and pliable texture, creamish colour, pleasing flavour and sweet taste along with good puffing are recognized as desirable quality attributes of good *chapatis* everywhere. Since there are large differences in grain quality requirements for major baked food types such as bread, pastries, noodles, and cookies etc., the grain quality required to produce a flat bread, like Indian *chapati* is different from that required to make a pan type bread. The technological interventions for processing of wheat flour depend mainly on the rheological properties of the dough used to prepare the *chapatis*. Sinha and Singh (1974) studied the rheological characteristics of 25 varieties from the four wheat growing states on the farinograph and categorized those for different purposes. Studies on the rheological aspects of improved wheat varieties were conducted by Austin and Hanslas (1983). The authors observed that for *chapati* making, medium-strong dough is the ideal choice. The present study was taken up with the aim to understand

the rheological characteristics of wheat dough and their correlation with *chapati*-making properties. Genotypes known to have good *chapati*-making characteristics are known to be grown under different production conditions. Since the growing environment plays an important role for the expression of multigenic traits such as *chapati* quality, studies in one environment with the genotypes known to have good quality will be helpful in understanding this trait and its association with end use quality.

Materials and methods

The field experiments for the present research were carried out in the experimental area of the Department of Plant Breeding and Genetics, Punjab Agricultural University (PAU), Ludhiana during the crop seasons 2005-2006 and 2006-2007 and the laboratory analysis of the wheat samples for Farinograph and *chapati*-making tests were done in the Wheat Section of the Department of Plant Breeding and Genetics, PAU, Ludhiana. Following set of wheat genotypes including tall Indian landraces, released varieties and some genetic stocks known to excel in one or more aspects of *chapati* quality were used.

- a) *Tall wheats known for chapati quality:* 8A, 9D, C 306, C 273, C 591, C 518, WG 357
- b) *High yielding wheats:* PBW 343, PBW 502, PBW 509, PBW 533, PBW 550, DBW 16
- c) *Good chapati quality wheat varieties:* PBW 154, PBW 175, PBW 226, Lok 1, HD 2793
- d) *Trait specific genetic stocks:* Pusa 5-3 (High protein and Lysine), DI 105 (C 591 + rht 3), DI 9 (C 306 + rht 1), WH 423 (High protein), WH 595 (High protein), WH 712 (High sedimentation value), K 0123 (High

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protein), KYZ K2K-13 (High protein), WH 800 (High protein & sedimentation value), WH 1003 (High sedimentation value)

e) *Other advanced lines available:* PBW 531, PBW 534, PBW 554, HI 1418, HI 1479

f) *High protein winter wheat stock:* Glupro

Farinographic studies: Constant flour weight method of AACC (1990) was followed using Brabender farinograph having stainless steel mixer bowl of 50 g capacity. The water sufficient to center the curve at 500 B.U line was added from the burette and the mixing continued for 15 min. The curves were interpreted for the following parameters.

- i) *Farinographic water absorption (FWA):* The quantity of water required for centering the curve at 500 BU line.
- ii) *Dough development time (DDT):* The time in minutes required for centering the peak of the farinograph on the 500 BU line.
- iii) *Mixing tolerance index (MTI):* The drop in peak consistency of the dough in five minutes as measured from the top of the curve in BU. This is the difference in Brabender units (BU) measured from the top of the curve at the peak and top of the curve 5 min after.
- iv) *Dough stability (DS):* This was recorded from the difference in time (m) between the first intersection of the curve at 500 BU line and the point where the curve just dropped from the 500 BU line.
- v) *Time to breakdown:* It is the time in minutes elapsed from the start of mixing upto a drop of 30 BU in the peak consistency measured from the center of the curve.

Chapati making characteristics: The whole meal was produced by grinding the grains in a laboratory stone grinder (*Chakki*). The gap between the two stone discs was adjusted so as to pass the meal through 40 micron mesh sieve. The whole meal so produced was used in the chemical analysis and *chapati* studies. For baking *chapatis* the method used in the quality laboratory Department of Plant Breeding and Genetics was employed. The 50 g whole meal (*atta*) and optimum quantity of water were mixed mechanically for 2 min using Swanson mixer. The dough was evaluated for stickiness while rounding it up manually and kept in the humidity cabinet maintained at 30°C and 80 per cent R.H for 30 min. The dough was sheeted to 2mm thickness with the rolling pin and *chapatis* of 15.0 cm diameter were cut using appropriate die. *Chapatis* were baked on an automatic roti maker having thermostatically controlled constant temperature for 20 sec on one side and for 40 sec on other. Finally it was puffed for 10 second by turning the *chapati* and bringing the upper plate of the Rotimaker in contact with the *chapatis*. *Chapatis* were cooled to room temperature in the humidity cabinet and evaluated by a panel of trained judges using the following evaluation performa.

Characteristic	Maximum score
Dough stickiness	5
Puffing of <i>chapati</i>	5
Color of <i>chapati</i>	5
Texture of <i>chapati</i>	5
Taste of <i>chapati</i>	5
Flavor of <i>chapati</i>	5
Texture of <i>chapati</i> after 2 hrs	5
Total	35

The total score was finally calculated out of a maximum of ten.

Results and discussion

The performance of the set of wheat genotypes for *chapati* making score during 2005-06 and 2006-07 season is given in table 1. The farinographic characteristics observed for the genotypes are given in table 2 (2005-06) and table 3 (2006-07). The Farinographic curve (Fig. 1) provides information about the behaviour of dough during mixing. Farinograph water absorption is the amount of water that must be added to flour to give the required consistency. It is reported as a percentage. Dough development time (DDT) is the time required for the curve to reach its maximum height. Mixing tolerance index (MTI) is the difference, in Brabender units, between the top of the curve at the peak and the top of the curve measured five minutes after the peak is reached. Stability is defined as the difference in time between the point at which the top of the curve first intersects the 500-BU line (arrival time) and the point at which the top of the curve leaves the 500-BU line (departure time).

Farinographic water absorption (FWA): FWA of wheat flour is a good indicative of its baking quality. More is the water absorption capacity, higher is the ability to retain water during baking and storage and it leads to an increased bread output. The value of water absorption for the wheat whole meals ranged from 61.54 per cent for DI 9 to 70.24 per cent for PBW 550 in 2005-06 season. The tall wheat varieties which gave best *chapatis* in the season showed intermediate values of water absorption. The advanced lines PBW 554 and PBW 531 showed high values of 69.48 per cent and 69.34 per cent respectively. The commercial wheat varieties, except PBW 550 which showed highest water absorption in this season, gave intermediate values of farinographic water absorption. The genetic stocks however showed lot of variation for this trait with values ranging from low to medium.

In 2006-07 the values of farinographic water absorption ranged from 61.54 per cent for C 591 to 70.24 per cent for PBW 534. The advanced lines PBW 534 (70.24%) and PBW 554 (69.48%) again showed high values where as genetic stocks recorded low values of water absorption in this season. The tall wheats and the released varieties with

known quality showed medium range of water absorption values with C 306 (with best *chapati* score) giving a value of 65.86 per cent. Although the water absorption is related to the protein content and gluten strength of a wheat variety but the higher values are preferred for *chapati* making in spite of moderate requirements for those in such varieties.

The damaged starch controlled mainly by the grain hardness also contributes to the water absorption of the whole meals. Singh *et al.* (1999) reported similar results thus confirming that at least 60 per cent or more water absorption is desirable for good *chapati* making properties.

Table 1. The set of genotypes evaluated in 2005-06 and 2006-07 seasons and their *chapati* score

Season 2005-06		Season 2006-07	
Genotype	Mean <i>chapati</i> score	Genotype	Mean <i>chapati</i> score
C 273	7.9	8A	7.9
C 306	8.1	9D	7.8
C 518	8.0	C 273	8.0
C 591	8.0	C 306	8.1
WG 357	7.6	C 518	8.1
PBW 343	7.6	C 591	8.0
PBW 550	7.4	WG 357	7.9
PBW 502	7.4	PBW 343	7.6
PBW 509	7.6	PBW 502	7.1
PBW 554	7.6	PBW 550	7.4
PBW 531	7.6	DBW 16	7.4
PBW 534	7.5	PBW 533	7.4
Pusa 5-3	7.2	PBW 534	7.3
DI 105	7.8	PBW 554	7.6
DI 9	7.8	HI 1418	7.8
WH 423	7.7	HI 1479	7.5
WH 595	7.6	PBW 154	7.2
WH 712	7.5	PBW 175	7.3
KO 123	7.4	PBW 226	7.3
KYZ K2K-13	7.5	LOK 1	7.9
HD 2793	7.5	KO 123	7.5
WH 800	7.5	HD 2793	7.6
WH 1003	7.4	WH 712	7.3
Glupro	5.3	WH 1003	7.4
Mean	7.5	Mean	7.6
CD (5%)	0.41	CD (5%)	0.31

Table 2. Farinographic curve characteristics of selected cultivars and genetic stocks evaluated during the season 2005-06

Genotype	Farinographic water absorption (%)	Dough development time (min)	Dough stability (min)	Time to breakdown (min)	Mixing tolerance index (BU)
1. Tall wheats known for chapati quality: 8A, 9D, C 306, C 273, C 591, C 518, WG 357					
C 273	65.76	5	3	8.5	60
C 306	67.84	3.5	2	6.5	80
C 518	68	3.5	1.5	5	80
C 591	67.14	5	3	8.5	60
WG 357	66.76	3.5	2	6	100
Mean	67.1	4.1	2.3	6.9	76
2. High yielding wheats: PBW 343, PBW 502, PBW 509, PBW 533, PBW 550, DBW 16					
PBW 343	66.06	3	1.5	5.5	100
PBW 550	70.24	6	3	8.5	90
PBW 502	67.09	2.5	1.5	4.5	110
PBW 509	68.06	5	4	8.5	80
Mean	67.86	4.13	2.50	6.75	95.00
3. Good chapati quality wheat varieties: PBW 154, PBW 175, PBW 226, Lok 1, HD 2793					
PBW 554	69.48	4.5	2	6.5	110
PBW 531	69.34	4.5	2	7	90
PBW 534	66.76	4	3.5	6	80
Mean	69.41	4.33	2.50	6.50	93.33
4. Trait specific genetic stocks: Pusa 5-3 (High protein and Lysine), DI 105 (C 591 + rht 3), DI 9 (C 306 + rht 1), WH 423 (High protein), WH 595 (High protein), WH 712 (High sedimentation value), K 0123 (High protein), KYZ K2K-13 (High protein), WH 800 (High protein & sedimentation value), WH 1003 (High sedimentation value)					
Pusa 5-3	65.86	4	3	7.5	70
DI 105	66.48	4.5	2	7.5	70
DI 9	61.54	6	4	9.5	60
WH 423	67.05	5	2.5	7.5	80
WH 595	67.21	4	2.5	7.5	80
WH 712	66.99	6	4	9.5	60
KO 123	67.8	3.5	2	5	80
KYZ	65.58	3	2	3.5	90
HD 2793	62.38	4.5	3.8	7	80
WH 800	65.2	3.5	3	6	70
WH 1003	65.2	6.5	6	10.5	50
Mean	65.57	4.59	3.16	7.36	71.82
Glupro	66.82	5.5	7	13	60

Table 3. Farinographic curve characteristics of cultivars and genetic stocks evaluated during the season 2006-07

Genotype	Farinographic water absorption (%)	Dough development time (min)	Dough stability (min)	Time to break down (min)	Mixing tolerance index (BU)
8A	69.34	3.5	2	6	80
9D	67.09	4	3	7	60
C 273	68.06	4	3.5	6	70
C 306	65.86	3.5	3	5.5	70
C 518	66.48	3	2	5.5	80
C 591	61.54	4	2.5	7.5	70
WG 357	67.05	3	2	5	100
Mean	66.49	3.57	2.57	6.07	75.71
PBW 343	66.82	2.5	2	3.5	90
PBW 502	65.76	2.5	1.5	4	90
PBW 550	67.84	4.5	4	7.5	60
DBW 16	68.00	2.5	1.5	3.5	90
PBW 533	66.86	2.5	1.5	4	140
Mean	67.06	2.90	2.10	4.50	94.00
PBW 534	70.24	4	3.5	6	80
PBW 554	69.48	4	2.5	6	80
HI 1418	66.99	3.5	2	2	110
HI 1479	67.8	4	3	3	80
Mean	68.63	3.88	2.75	4.25	87.50
PBW 154	67.14	3.5	2	5	90
PBW 175	66.76	2.5	1.5	4	90
PBW 226	66.06	2.5	1.5	4	100
LOK 1	67.21	2.5	1.5	4	100
Mean	66.79	2.75	1.63	4.25	95.00
KO 123	65.58	4	3	3	60
HD 2793	62.38	5.5	4.5	4.5	70
WH 712	65.2	5.5	4	4	60
WH 1003	65.2	6.5	5.5	5.5	40
Mean	64.59	5.38	4.25	4.25	57.50

Dough development time: The dough development time for genotypes varied from 2.5 min for PBW 502 to 6.5 min for WH 1003 in 2005-06. The tall wheats gave medium to high values with C 273 and C 591 giving a value of 5 min. The commercial wheat varieties PBW 550 (6 min) and PBW 509 (5 min) gave high values where as PBW 343 (3 min) and PBW 502 (2.5 min) gave low values of dough development time. The advanced lines and the

genetic stocks showed medium to high values and the winter wheat, Glupro (5.5 min), gave high values in this season. In 2006-07 season, the commercial wheat varieties PBW 343, PBW 502, PBW 533 and DBW 16 gave a dough development time of 2.5 min where as PBW 550 recorded 4.5 min. The lowest value of 2.5 min in the season was also observed for PBW 175, PBW 226 and LOK 1, the released varieties known for *chapati* quality. The highest value of

6.5 min was recorded for WH 1003. Other genetic stocks and the advanced lines showed medium to high values of dough development time. The tall wheats group gave medium dough development time with C 306 recording a value of 3.5 min. The average dough development time values for the tall varieties correspond with their medium strong gluten as shown by the gluten and mixographic characteristics.

Dough stability: Dough stability values ranged from 1.5 min for C 518, PBW 343 and PBW 502 to 6 min for WH 1003. A high value of 7.0 min was however recorded for Glupro. Tall wheats showed low values with best *chapati* quality wheat (*chapati* score 8.1) giving a value of 2 min. the commercial wheats and the advanced lines also gave low values with PBW 509 recording a value of 4 min. The genetic stocks gave low to medium values with only WH 1003 giving high value. DI 9, which is a derivative of C 306, gave a value of 4 min of dough stability. In 2006-07 the lowest value of 1.5 min was observed for PBW 502, PBW 533, DBW 16, PBW 175, PBW 226 and LOK 1, while highest value of dough stability (5.5 min) was recorded for WH 1003. The released varieties with known quality gave lowest value of dough stability where as the genetic stocks gave high values. Medium to low values of dough stability were recorded for the tall wheats, advanced lines and the commercial wheats. Dough stability is governed mainly by the protein content and the gluten strength. Since most of our wheat varieties and genetic stocks especially the tall varieties possess medium strong gluten, the dough stability figures are also in line with those values.

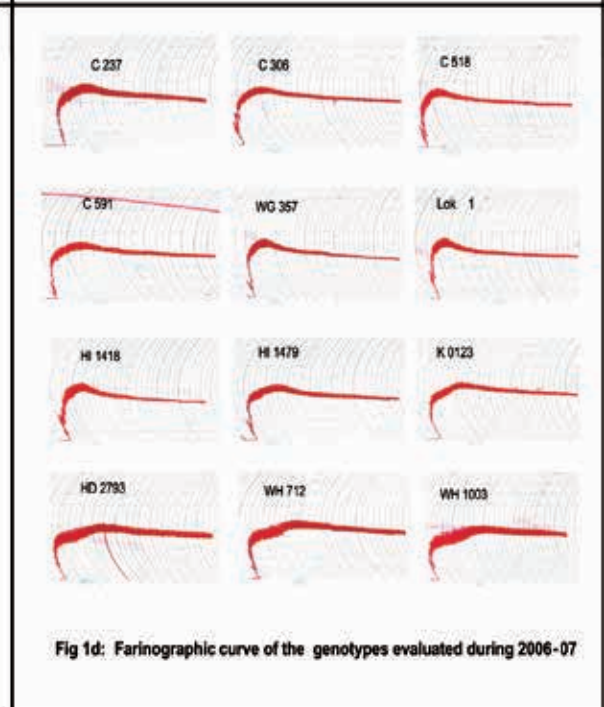
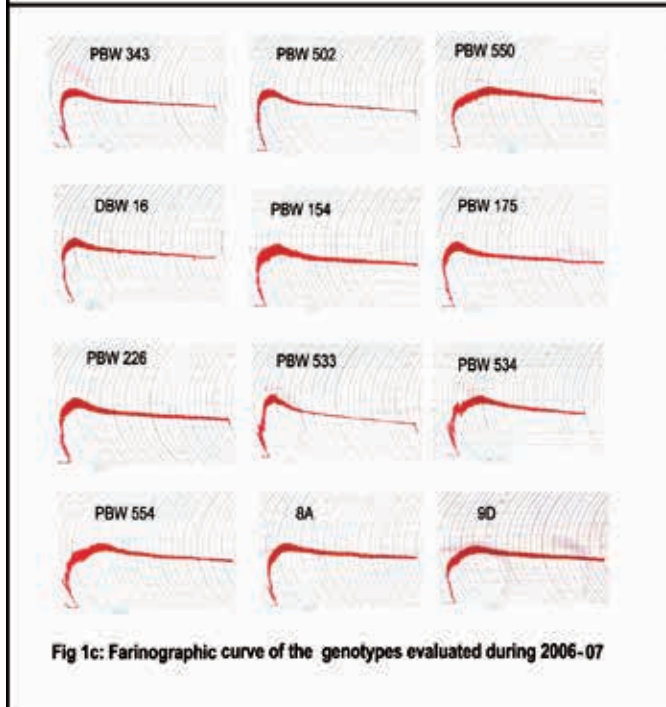
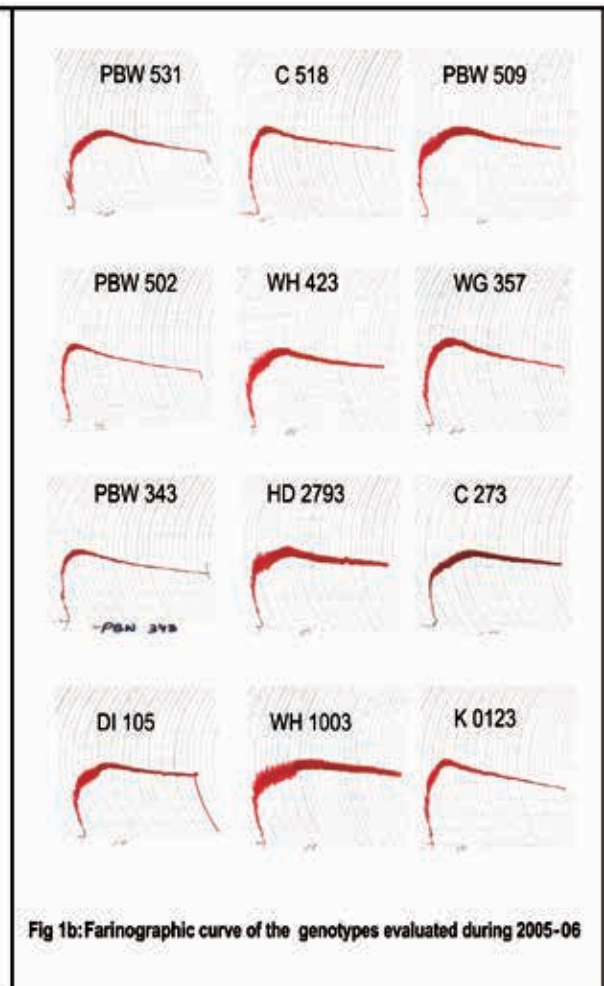
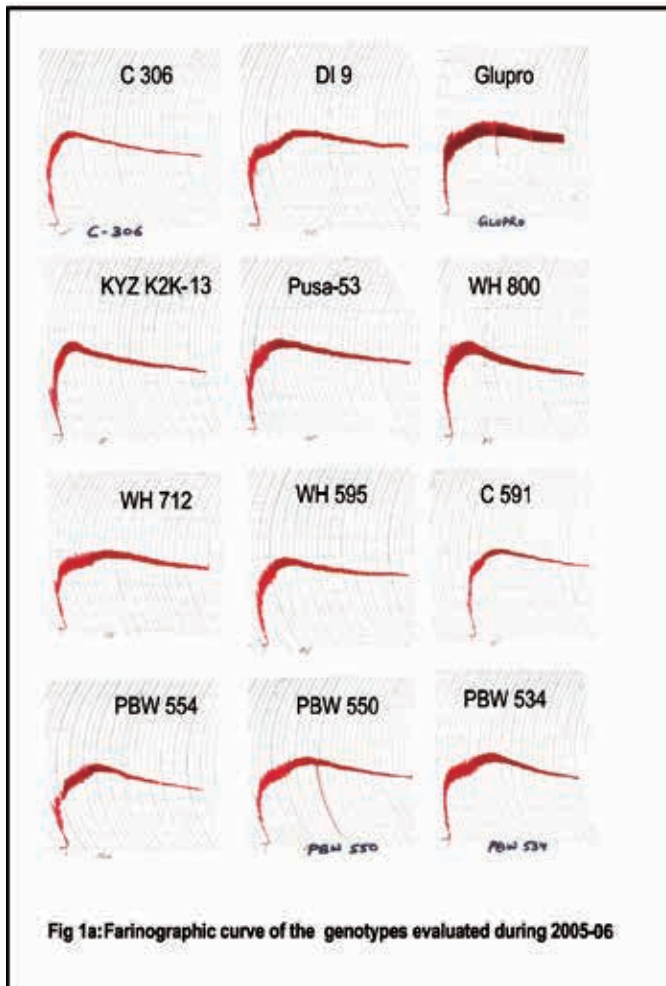
Time to breakdown: The time to breakdown determines the ability of wheat dough to withstand the total force of manipulation. The time to breakdown ranged from 3.5 min for KYZ-K2K-13 to 10.5 min for WH 1003 in 2005-06. A high value of 13 min was however observed for winter wheat Glupro. All the genetic stocks except KYZ-K2K-13 gave high values of time to breakdown. The commercial varieties PBW 509 and PBW 550 gave high value of 8.5 min where as PBW 343 (5.5 min) and PBW 502 (4.5 min) gave somewhat lower values. Medium high values of time to breakdown were observed for tall wheats (except C 518 with 5 min) and advanced lines in this season. In 2006-07 the values of time to breakdown ranged from 2 min for HI 1418 to 7.5 min for PBW 550 and C 591. The tall wheat varieties gave medium to high values of time to breakdown with C 591 recording highest value in the season. The commercial wheats with an exception of PBW 550 gave low values, as was the case with released varieties with known quality. The genetic stocks also gave medium values of time to breakdown in 2006-07 season. The advanced lines PBW 534 and PBW 554 gave a high value of 6 min, whereas HI 1418 and HI 1479 gave low values of 2 min and 3 min respectively. In fact the time

to breakdown is another measure of the dough stability and is recorded as the time from start of mixing until a drop of 30 BU in the average consistency of the dough. The values are in line to those of dough stability and the gluten index.

Mixing tolerance index: The mixing tolerance index determines the extent of breakdown in dough consistency in five minutes of over mixing. The mixing tolerance index value in 2005-06 ranged from 50 BU for WH 1003 to 110 BU for PBW 554 and PBW 502. The genetic stocks gave low to medium values of mixing tolerance index with KYZ K2K-13 giving a high value of 90 BU. The advanced lines PBW 554 (110 BU), PBW 531 (90 BU) and PBW 534 (80 BU) gave values on higher side. The commercial wheat varieties also gave high values of tolerance index with PBW 502 recording highest value in the season. The tall wheats gave low to medium values ranging between 60-80 BU, where as WG 357 gave a value of 100 BU. The winter wheat Glupro however recorded a low value of 60 BU in this season.

In 2006-07 season the values of mixing tolerance index ranged from 40 BU for WH 1003 to 140 BU for PBW 533. The genetic stocks again gave low values of mixing tolerance index whereas the commercial wheats and the released varieties with known quality gave high values. Medium to high values were observed for genetic stocks with HI 1418 giving a high value of 110 BU. The tall wheats gave low to medium values where as WG 357 gave a value of 100 BU mixing tolerance index. The lower mixing tolerance values are preferred as a measure of insurance against accidental over mixing of dough. The stronger wheats show a lower value for mixing tolerance index and conversely high values are recorded for weak wheat varieties. The values are on the expected lines as our wheat varieties fall in the medium strong category with minor variations. In general superior *chapati* quality wheats scored low for almost all the farinographic characteristics thus negative correlation as observed in one or the other season was expected. Consistent trends were however not observed possibly due to change in set constituents and differential environment prevailing in two seasons.

The results are in line to those of Panozzo and Eagles (2000) who observed that the dough rheological properties were more influenced by environment than by genotype. Jha *et al.* (2010) working on the rheological characteristics of a diverse set of advanced winter x spring lines of wheat also observed similar results. From this study it may be concluded that the farinographic characteristics which show a high correlation with bread making quality, were of little importance as far as *chapati* making quality for the set of genotypes. However a further study on segregating populations for this trait may be useful for better understanding of this trait.



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