

# Relationship of Dough Rheological and Pasting characteristics with Chapatti Quality of Indian wheat varieties

Manju Kundu<sup>1</sup>, Neelam Gulia<sup>2</sup> and B. S. Khatkar<sup>3</sup>

Research Scholar, Department of Food Technology, GJUS&T, Hisar, Haryana, India<sup>1</sup>

Research Scholar, Department of Food Technology, GJUS&T, Hisar, Haryana, India<sup>2</sup>

Professor, Department of Food Technology, GJUS&T, Hisar, Haryana, India<sup>3</sup>

**ABSTRACT:** Chapatti is an unleavened and baked flat bread widely consumed in India. The major raw material for chapatti is whole wheat flour which directly impacts its quality and acceptability. Whole wheat flours obtained from five different wheat varieties were evaluated for rheological and pasting properties and their impact on the chapatti quality. It was found that whole wheat flours with lower ash content, dough development time and Gluten Index resulted in better chapattis. Wheat variety HI 1544 was found to be the best; DBW 17, DL 788-2 and HD 2932 were moderate, while MACS 2496 was poor for chapatti making.

**KEYWORDS:** Whole wheat flour, dough, rheological, pasting, chapatti quality

## I. INTRODUCTION

Wheat (*Triticum aestivum*) is the most suitable crop for making yeast-leavened breads and other baked products due to its unique gluten forming ability imparted by protein fractions glutenin and gliadin that give wheat flour dough its desirable viscoelastic properties (Morita et al., 1998). Wheat is the leading cereal grain produced, consumed and traded worldwide. In the Indian sub-continent and parts thereof, wheat is generally consumed as unleavened, single-layered flat bread, commonly known as '*chapatti*'. Protein quality and composition, wet and dry gluten content, starch properties, mineral content and composition, type of enzymes present in wheat flour, and water absorption capacity of whole wheat flour play a role in the overall acceptability of chapatti (Sharma et al., 2004). 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 *chapatti* is different from that required to make a pan type bread. The functional characteristics of wheat flour dough to prepare the *chapattis* are mainly governed by the rheological and pasting properties of dough. Studies on the dough quality and rheological aspects of wheat varieties are, therefore, important to establish the suitability of wheat varieties for chapatti making. Dough quality is a crucial aspect of wheat product quality and serves as important criteria when the breeder selects promising breeding lines, the miller attempts to meet flour-quality specifications and when the baker produces the end product. The present study was aimed to understand the rheological characteristics of wheat dough and their correlation with chapatti-making properties.

## II. RELATED WORK

The studies on rheological characteristics of 25 varieties from the four wheat growing states on the Farinograph and their categorization for different purposes was done by Sinha and Singh (1974). Studies on the rheological aspects of improved wheat varieties were obtained by Austin and Hanslas (1983). They observed that for chapatti making, medium-strong dough is the ideal choice. Kumar et al. (2013) conducted a study on wheat genotypes to understand the rheological characteristics of wheat dough and their correlation with chapatti-making properties. It has been already established that rheological tests on

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

dough can predict their behaviour in a bakery (Dobraszczyk and Roberts, 1994). In addition, pasting properties highly correlate with bread staling kinetics parameters, especially in the case of peak viscosity, pasting temperature and setback, whose are useful predictors of bread firming behaviour during storage (Collar, 2003).

## 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 i.e. ARI, Pune, CCSHAU, Hisar and IARI, Indore. All wheat varieties were cleaned and milled in a laboratory mill to obtain whole wheat flour.

### B. 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). Gluten content and gluten index (GI) of the whole wheat flour were examined using Glutomatic (Perten Instruments, Sweden) as per standard ICC method.

### C. DOUGH RHEOLOGICAL PROPERTIES

Dough rheological characteristics of the flour samples were evaluated using Micro-doughLAB (Chopin Technologies, France). Flour sample (4 g) was mixed with water at a constant speed using a Micro-dough labmixer (Perten Instruments, Australia). The amount of water added was determined to achieve a dough consistency of 500 BU. Water absorption and dough mixing parameters such as maximum peak, arrival time, development time and departure time were obtained to assess the dough mixing properties.

### D. CHAPATTI PREPARATION AND QUALITY EVALUATION

- Preparation of chapatti- Chapattis were prepared using the method of Haridas Rao et al. (1986) with slight modifications. Puffed height of chapatti was measured by using a centimeter scale mounted on a platform. Further, hot chapatti was cooled at room temperature for 10 min. After cooling, the chapatti was wrapped in aluminum foil and placed in a resealable (ziplock) plastic bag. The chapattis were stored for instrumental and sensory evaluation.
- Overall acceptability-Sensory analysis was done to examine the chapatti overall acceptability score using five panel members previously trained on chapatti characteristics. Sensory analysis was done using composite scoring method in which scores were given to various quality characteristics of the product i.e. Colour/ Appearance (10), Puffed height (10), Pliability (15), Nature of spot (10), Hand feel (10), Shape (10), Texture (15), Mouth feel (10), Taste and aroma (10). The average total score assigned out of 100 by panelists was used to assess the overall acceptability of the product.
- Texture analysis of chapatti-Texture measurements were carried out using Texture Analyser (Stable Micro Systems TA-XT 2i, U.K.). Three replicates were taken for each chapatti sample and the results have been presented as Compression Force (g) and Extensibility (mm).

### E. Statistical evaluation

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).

## IV. EXPERIMENTAL RESULTS

### Whole wheat flour characteristics

The whole wheat flour characteristics of wheat varieties have been represented in Table 1. Wheat Flour moisture, fat and ash content ranged from 8.1 to 12.5 %, 1.2 to 2.4 % and 1.2 to 1.7 %, respectively. Protein content ranged from

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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11.1 to 13.2 %. Wheat variety HD 2932 showed lowest protein, while DBW 17 showed the highest. Dry gluten and gluten index ranged from 5.5 to 9.6 % and 42.8 to 92.0, respectively. Wheat variety HI 1544 showed lowest GI, whereas maximum was shown by MACS 2496. SDS sedimentation volume (SDS SV) which reflects the swelling ability of wheat glutenin proteins ranged from 35.0 (DL 788-2) to 47.0 mL (HI 1544). SDS SV of DBW 17 and DL 788-2 was comparable, whereas significantly different from HD 2932, HI 1544 and MACS 2496. HI 1544 which had maximum dry gluten content and SDS sedimentation volume, whereas depicted least gluten index volume which clearly shows that protein content and quality can be different in a wheat variety and it is important to evaluate the protein quality in addition to the content.

**Table 1 Whole wheat flour characteristics of wheat varieties**

Variety Name	DBW 17	DL 788-2	HD 2932	HI 1544	MACS 2496
Moisture (%)	8.1a	9.1c	9.3c	8.5b	12.5d
Fat (%)	1.2a	1.9b	1.8b	2.2c	2.4c
Ash (%)	1.5b	1.4b	1.4b	1.2a	1.7c
Protein (%)	13.2d	11.5b	11.1a	11.7b	12.7c
Dry Gluten (%)	5.5a	7.9c	9.0d	9.6e	6.3b
Gluten Index	68.3b	83.3d	78.4c	42.8a	92.0e
SDS Sedimentation Volume (ml)	35.3a	35.0a	45.3c	47.0d	42.3b

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

## Rheological characteristics of whole wheat flours

The Micro-doughLAB was used to obtain information about the rheological behaviour of dough during mixing. Water absorption (WA) is the amount of water added to flour to give the required consistency. Water absorption of flour was lowest for DBW 17 (67.5 %) and highest for HI 1544 (75.2 %). Dough development time (DDT) is the time required for the curve to reach its maximum height. Variety HI 1544 showed minimum (2.6 min) DDT, whereas DBW 17 showed the maximum (4.5 min). Dough Stability (DS) is 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). Dough stability ranged from 1.6 min to 3.3 min. DS followed the similar trend as development time i.e. varieties which have lower DDT also showed lower values for dough stability. WA 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 as well as soft texture which is desirable for bread or chapatti products.

**Table 2. Rheological characteristics of whole wheat flours**

Variety Name*	Water absorption (%)	Dough Development (min)	Dough stability (min)	Softening (FU)
DBW 17	67.5a	4.5d	3.3e	56.0a
DL 788-2	70.9b	3.3b	1.9b	64.5d
HD 2932	72.5c	3.6c	2.1bc	79.0e
HI 1544	75.2d	2.6a	1.6a	69.0d
MACS 2496	72.0b	4.3d	2.8d	64.0b

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

## Pasting characteristics of whole wheat flours

The pasting properties of whole wheat flour were analysed using RVA and have been presented in Table 3. Significant differences were observed, among the whole wheat flour samples tested, in their behaviour during heating and cooling phases in excess of water. Peak viscosity ranged from 1329.0 cP (DBW 17) to 2758.0 cP (DL 788-2). Trough and final viscosity ranged from 607.0 to 1640.0 cP and 1647.5 to 3086.5 cP, respectively. Among selected wheat varieties, whole wheat flour obtained from variety DL 788-2 had the highest peak viscosity (PV), trough viscosity (TV), and final viscosity (FV), while the variety DBW 17 flour exhibited much lower values of PV, TV and FV than the other whole

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wheat flours. PV, TV and FV of variety HD 2932 and MACS 2496 were similar, whereas HI 1544 and MACS 2496 showed similar Breakdown (BD) viscosity and Set back (SB) viscosity. During RVA testing, starch granules of the flours when heated to high temperature and subjected to mechanical shear stress in excess water, are disrupted, resulting in amylose leaching out and granule alignment, which cause a decrease in viscosity associating with BD viscosity (Ragae and Abdel-Aal, 2006). In general, higher PV values are related to high BD viscosity, which is related to starch swelling capacity. Higher BD values could imply lower hot starch paste stability (Choi et al., 2012).

**Table 3 Pasting characteristics of whole wheat flours**

Variety Name*	Peak Viscosity (cp)	Trough (cp)	Breakdown (cp)	Final Viscosity (cp)	Setback (cp)
DBW 17	1329.0a	607.0a	720.5b	1647.5a	1043.0a
DL 788-2	2758.0d	1640.0e	1116.0d	3086.5d	1445.5c
HD 2932	1928.0b	1269.5c	654.0a	2576.0b	1292.0b
HI 1544	2263.0c	1495.0d	766.5c	2913.5c	1421.0c
MACS 2496	1916.0b	1154.0b	760.5c	2572.5b	1421.0c

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

During the cooling periods, the starch molecules (especially linear chains, such as amylose) are reassociated, and starch molecules are aligned to form a gel structure. This phase is referred to SB viscosity, which is related to starch retrogradation (Gray et al., 2010). The SB viscosity values were highest in DL 788-2 followed by HI 1544 and MACS 2496.

## Chapatti characteristics of whole wheat flours

Overall acceptability scores of chapatti (COA) prepared from selected wheat varieties ranged from 55.0 to 72.0. Results indicated that there were significant differences among the chapatti samples. Chapatti prepared from variety MACS 2496 scored lowest, while HI 1544 had highest score. It was observed that chapatti prepared from wheat variety MACS 2496 and DBW 17 were darker in colour, while HI 1544 was lighter in colour with few brown spots and therefore, was better in appearance. Texture analysis of prepared chapattis also showed significant differences. MACS 2496 showed highest compression force and HI 1544 showed minimum, whereas extensibility was minimum for DBW 17 (18.9mm) and maximum for DL 788-2 (23.6mm). In terms of sensory, chapattis made from HI 1544 were soft and pliable, while MACS 2496 were quite hard and stiff which categorized it as a poor variety for chapatti.

**Table 4 Chapatti characteristics of wheat flours**

Variety Name	Overall Acceptability score	Compression Force (g)	Extensibility (mm)	Puffing Height (cm)
DBW 17 (H)	63.5	705.8	18.9	4.6
DL 788-2 (I)	63.8	864.8	23.6	3.9
HD 2932 (I)	63.8	818.9	21.9	4.6
HI 1544 (I)	69.5	687.6	19.7	4.1
MACS 2496 (P)	56.5	787.4	20.9	5.1

It was observed that COA showed significant negative correlated with ash content ( $r = -0.883$ ) and gluten index ( $r = -0.882$ ), while showed positive correlation with wet gluten ( $r = 0.728$ ) and dry gluten content ( $r = 0.657$ ). The overall acceptability of chapattis is very much dependent on appearance and texture, which in-turn was found to be related to the ash content and gluten strength. Chapatti compression force was positively correlated with gluten index ( $r = 0.643$ ), whereas puffing height of chapatti was positively correlated with R/E ratio ( $r = 0.635$ ). Among the dough rheological and pasting characteristics, it was observed that overall acceptability of chapatti showed significant negative correlation with dough development time ( $r = -0.762$ ). Chapatti compression force showed no significant correlation with rheological and pasting characteristics. Chapatti extensibility was found to be positively correlated with pasting

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characteristics PV ( $r = 0.742$ ), TV ( $r = 0.681$ ), BD ( $r = 0.652$ ), FV ( $r = 0.668$ ). Puffed height of chapatti was significantly correlated with DDT ( $r = 0.703$ ), DS ( $r = 0.650$ ), PV ( $r = -0.640$ ), BD ( $r = -0.636$ ).

**Table 5 Relationship of whole wheat flour, rheological and pasting characteristics of whole wheat flour with Chapatti quality**

Chapatti characteristics	Whole wheat flour characteristics					Dough Rheological parameters		Pasting parameters				
	FM	Ash	GI	RbyE	SDS	DDT	STAB	PV	TV	BD	FV	PTe
COA	-.537	-.617	-.644	-.465	Ns	-.762	Ns	Ns	Ns	Ns	Ns	Ns
CFo	Ns	Ns	.657	Ns	.533	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CExt	Ns	Ns	.479	Ns	Ns	Ns	Ns	.742	.681	.652	.668	-.669
CPH	Ns	.626	Ns	Ns	Ns	.703	.650	-.640	Ns	-.636	Ns	.638

\* COA- Chapatti overall acceptability, CFo- Chapatti compression force, CExt- Chapatti Extensibility, CPH- Chapatti Puffing Height, FM- Flour Moisture, GI- Gluten Index, RbyE- Resistance to extension ratio, SDS- SDS Sedimentation Volume, DDT- Dough development time, STAB- Stability, PV- Pasting Viscosity, TV- Trough Viscosity, BD- Breakdown, FV- Final viscosity, Pte- Pasting Temperature

## V. CONCLUSION

With respect to a higher awareness of a healthy lifestyle, baked products with whole wheat flour are becoming more important. Chapatti is one of the staple dietary elements in majority of Indian household and brings the goodness and nutrition of whole wheat. The present study revealed that not all the wheat varieties are suitable for chapatti preparation and therefore, it is of extreme important to identify the cultivars suitable for chapatti making to provide the consumers with softer, pliable and sensorially superior chapattis. Among the wheat varieties studied, the wheat variety HI1544 exhibited good chapatti making potential, while MACS 2496 was found to be poor for chapattis.

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