Test Baking of Chapati—Development of a Method

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ABSTRACT

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With the goal of developing a standard method for test baking of chapati, a staple food in the Indian subcontinent, studies were made on the standardization of conditions for preparing chapati dough. Variables considered were consistency and rolling characteristics, thickness of the dough sheet, time and temperature of baking, and puffing conditions of the chapati. Water requirements for preparing chapati doughs of desired consistency were determined with a research water absorption meter (Henry Simon). The values compared well with those recorded on a Brabender farinograph under modified conditions. The method developed for test baking of chapati used a Hobart mixer for preparing the dough, a specially designed platform for rolling the dough sheet to a uniform thickness, a circular die for cutting the sheet, an electric hot plate for baking, and a gas *tandoor* oven for puffing the baked chapati. The test baking method was applied successfully to evaluate chapati-making quality of six commercial wheat varieties. The results also showed that, in addition to the subjective evaluation of texture, three objective parameters—height of puffed chapati, pliability as measured by a newly designed device, and shear value—can serve as simple indices of chapati quality.

Just as bread is a staple food item in the Western world, chapati, a flat unleavened baked product prepared from whole wheat flour (locally known as *atta*), is the staple food of a majority of the population in many regions of the Indian subcontinent. Of the 45 million tons of wheat produced in India, about 75% is used for preparation of chapati and other similar traditional foods. Generally, whole wheat flour obtained by grinding wheat in a disk mill (locally known as a *chakki*) is used to prepare chapati. Conditions for preparation of chapati with respect to recipe, dough consistency, thickness, size, shape of the dough sheet, and baking conditions vary widely in different regions and laboratories (Shurpalekar and Prabhavathi 1976, Rattan Singh and Bailey 1940, Austin and Ram 1971). Consequently, the chapati-making quality of a given wheat may be assessed differently by different investigators.

In this situation, there is an urgent need to develop a standard method for test baking of chapati, as for bread, to obtain reliable and comparable results, particularly in research and development institutions and other wheat quality control laboratories.

The results of studies leading to the development of a standard method for test baking of chapati with respect to preparing and rolling the dough, baking and puffing the chapati, and their interrelationships, are presented in this paper.

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MATERIALS AND METHODS

Wheat

For different studies, a locally procured, commercial, medium hard variety of wheat, grown in Punjab, and specific varieties of wheat of commercial importance, obtained from different agricultural research stations of the Indian Council of Agricultural Research, were used.

Whole Wheat Flour

Wheat was ground in a laboratory Kamas hammer mill (model Slaggy-200 A) using a 0.8-mm sieve to obtain whole wheat flour for use in different chapati-making studies. A part of the wheat was also ground in a disk mill to obtain a whole wheat flour of the type commonly used in households and to compare its particle size distribution with that of the flour obtained from the Kamas mill.

Water Absorption of Chapati Dough

Water absorption of the chapati dough of optimum consistency has been determined by using a research water absorption meter (Henry Simon) as well as a Brabender farinograph. When the water absorption meter is used, the amount of water required for a dough to extrude in 60–62 sec at a pressure of 4.4-kg weight is the measure of water absorption (Haridas Rao 1982). Farinograph water absorption is measured as the quantity of water required to get a dough consistency of 450–500 BU, with the lever setting changed from the normal 1:1 position to 1:3 when a mixing bowl of 50-g capacity is used.

Preparation of the Dough

Chapati dough was prepared by mixing 200 g of flour with the predetermined amount of water for 3 min in a Hobart mixer (model N-50), setting the beater at position 1 (58 rpm).

Rolling the Dough

About 40 g of the dough was rounded and placed in the center of a specially designed platform (Fig. 1). An open rectangular aluminum frame was placed in the groove provided on the platform to facilitate rolling the dough to uniform thickness. Chapaties of different thicknesses (1.0–3.0 mm) could be rolled by using frames of varied heights.

The dough was rolled with a wooden rolling pin, the length of which exceeded the width of the aluminum frame; therefore, roller force was applied to the dough only when its thickness exceeded the height of the frame (Fig. 2). The rolled dough sheet was then cut into a circle 15 cm in diameter using a die with a sharp edge, and carefully removed from the platform with a stainless steel spatula. The cut dough sheet weighed 32–35 g. A line diagram of the devices used to prepare chapati dough sheets of the required thickness is given in Figure 3.

Baking of Chapati

The chapati was baked on a thermostatically controlled hot plate with a temperature range of 125–250° C. After baking on one side (side 1), it was turned over (side 2) and baked for different times.

Puffing of Chapati

A gas *tandoor* oven (model Supercook) normally used for baking tandoori chicken was used for puffing. The oven has a domed structure that facilitates uniform distribution of heat. The

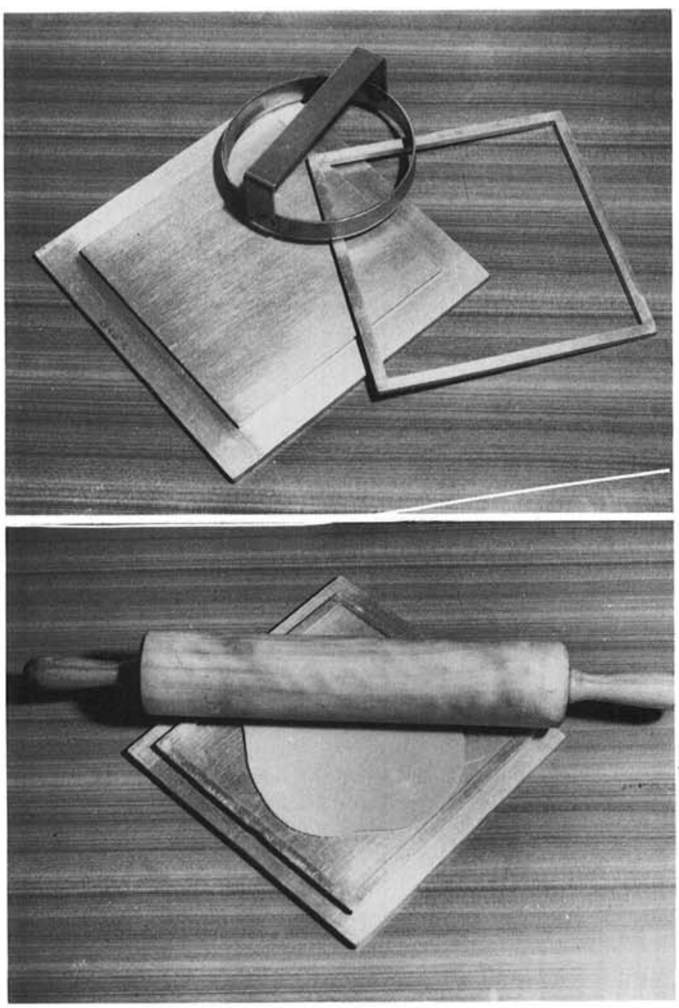

Fig. 1. Top, platform, frame, and cutter designed for sheeting chapati, and chapati dough after sheeting to required thickness, **bottom**.

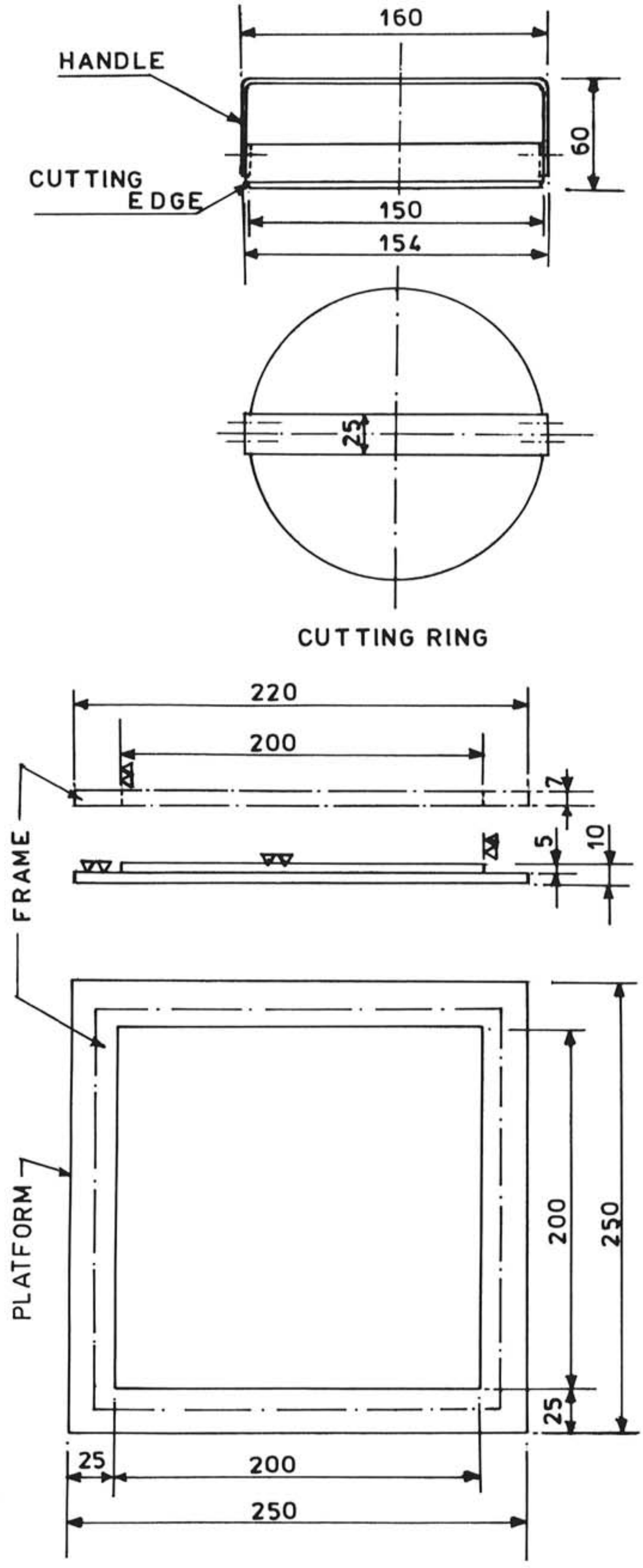

Fig. 2. Details of various devices used for sheeting chapati to uniform thickness (dimensions are in millimeters).

lower portion of the oven, which is heated by a gas flame, is fitted with a circular, wire mesh on which the baked chapati is placed for puffing. The top of the oven consists of a hemispherical lid (Fig. 3). The oven temperature could be varied (176–393° C) by adjusting the gas flame. The inside temperature was measured with an oven thermometer.

After transferring the baked chapati to the *tandoor* oven, the lid was closed; the instantaneous conversion of moisture into steam caused the chapati to puff out (Fig. 4). After puffing for a specific period, the chapati was removed and placed on a hollow wooden frame, where it cooled for 15 min at room temperature.

The different studies described above were carried out in quadruplicate.

Evaluation of Chapati

Height measurement. The height of the chapati in centimeters was measured immediately after puffing.

Determination of chapati pliability. The pliability of the chapati was determined by the method standardized by Haridas Rao (1982), using the device shown in Figure 5. It consists of an iron channel with a vertically movable clamp for fixing a strip of chapati. At one end of the base of the stand, a movable graduated scale is fixed to measure the height of the bent chapati. A chapati strip of 2 × 7 cm is used for measuring pliability. Of a total strip length of 7 cm, 2 cm is fixed between the two plates of the clamp, and the remaining 5 cm is allowed to bend under its own weight. The extent of bending is measured against the scale. The difference between the horizontal height at the center of the clamp, where the chapati strip is fixed, and the height of the bent chapati strip is taken as an index of pliability and expressed in centimeters.

Measurement of shear value. Shear value of chapati was measured using the Warner Bratzler shear press, normally used to determine the tenderness of meat. The chapati was folded into four layers and placed in the center of the conical blade provided with the instrument. The force indicated on the dial for shearing the chapati was recorded in pounds. The average value was taken for three chapaties.

Chemical analysis. Moisture in chapati was determined by two-stage drying, as described in AACC method 44-15A for bread. Protein (method 46-13), ash (method 08-01), and sedimentation value (method 56-61A) in wheat flour were determined according to the standard AACC methods (1976).

Scoring. In general, chapati of good overall quality should possess an appealing color with light brown spots spread evenly over the surface, a smooth, soft, and pliable hand feel, the desired soft chewing quality, sweetish taste, and it should be optimally baked and puffed so as to impart a pleasant wheaty aroma. Physical and sensory quality parameters of the chapati were assessed by a panel of six judges. The characteristics considered and the maximum score possible for each were: height on puffing, 10; pliability, 10; appearance, 20; hand feel, 10; texture, 25; and taste, 25; so that the maximum total score would equal 100.

The scores for height on puffing and pliability were calculated from the values recorded, which fell within the ranges given. For height on puffing, 1–3 cm was scored from 1 to 4, 4–6 cm from 5 to 7, and 8–10 cm from 8 to 10. Pliability for 0–1.5 cm was scored

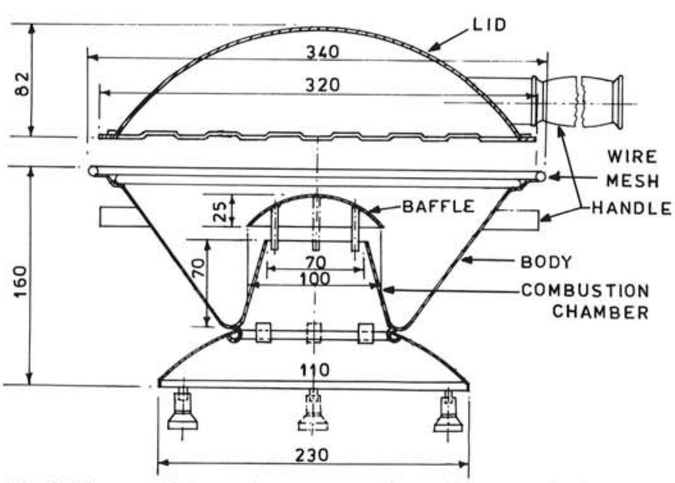

Fig. 3. Diagram of the *tandoor* oven used for puffing chapati (dimensions are in millimeters).


Fig. 4. Puffed chapati.

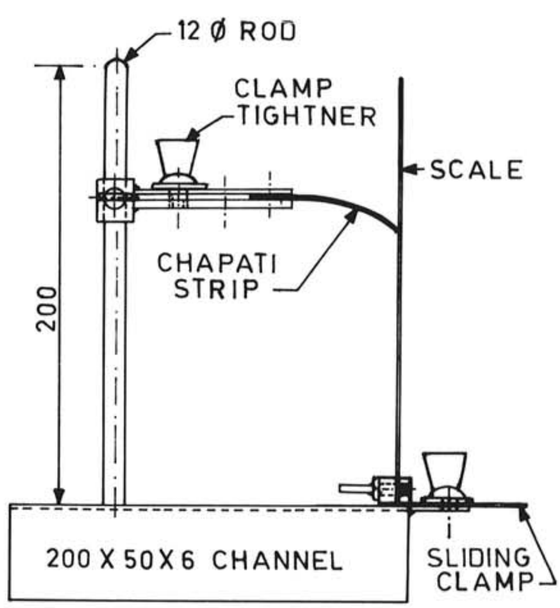

Fig. 5. A device for measuring the pliability of chapati (dimensions are in millimeters).

from 1 to 4, 1.6–2.0 cm from 5 to 7, and 2.1–2.5 cm from 8 to 10.

The panel members were also requested to grade the overall quality of the chapaties as poor, fair, satisfactory, good, or excellent on the basis of the sensory parameters evaluated.

Statistical analysis. The sensory scores and values recorded for physical parameters were statistically treated by analysis of variance and Duncan's new multiple range test to determine the significance of results.

RESULTS AND DISCUSSION

Flour Analysis

Whole wheat flour used in the present study contained 8.1% moisture, 10.6% protein, and 1.45% ash. Sieve analyses of whole wheat flours obtained by grinding wheat in a laboratory Kamas hammer mill and a locally used disk mill (*chakki*) are given in Table I. In both, the maximum percent flour fractions are found in −10 XX and +12 XX sieves. However, the particle size distribution of flours ground in different disk mills varied widely, as there is no provision to control the clearance between the disks. It has been reported that the particle size considerably influences the dough characteristics as well as the chapati quality (Haridas Rao 1982, Sharma and Bains 1976). In contrast, the range of particle size variation was narrow among flours milled in a Kamas mill where the material is ground until it passes through a 0.8-mm sieve. This was found to be ideal. As such, hammer mills of the Kamas type are well suited for grinding wheat into flour for use in the test baking of chapati. By this means, the effect of variation in grinding on the quality of chapati could be minimized.

TABLE I
Sieve Analysis of Whole Wheat Flour (WWF)

Sieve		Percent Overtailings of WWF from			
		Kamas Mill		Disk Mill	
Type	Opening (μm)	Range	Average[a]	Range	Average[b]
32	670	···	···	0.3–2.5	1.2
45	480	0.3–1.0	0.6	0.5–3.4	2.8
50 GG	355	5.0–5.3	5.1	2.0–7.1	6.0
7 XX	193	18.8–19.0	18.9	5.0–15.5	13.0
10 XX	129	17.0–17.2	17.1	8.5–15.5	15.0
12 XX	112	38.0–42.0	40.8	35.0–43.2	38.5
15 XX	85	7.5–8.2	8.0	3.0–6.0	5.5
25 P	62	3.5–4.0	3.8	6.0–9.0	7.1
Pan	···	3.8–5.0	4.0	2.5–9.0	8.5

[a] For five trials.
[b] For nine trials.

Standardization of Baking Time

Data on the effect of varying baking times on the quality of chapati are given in Table II. Baking both sides of the chapati for the same time (trials 1–4) resulted in variations in the color of the spots on two sides. Side 1, baked first, was found to have darker spots than side 2. Even the eating quality of two layers of the chapati was different; side 1 was always more baked than side 2. Increasing the total baking time from 60 to 180 sec significantly changed the color from dull grey to dark brown, and the taste from raw to slightly caramelized.

The height of the puffed chapati increased significantly with baking time up to 180 sec, possibly because of a hardening of the surface, resulting in better retention of the steam during puffing. Baking the two sides alternately for 45 sec twice on each side (trial 4) did not improve the uniformity of baking. However, it produced a chapati with better eating quality, as indicated by the higher score. Hence, it was found necessary to bake the two sides of chapati for varied periods to obtain the desired appearance.

Different trials carried out by baking side 1 for a longer period than side 2 (trial 5) gave an optimally baked chapati, but it had a somewhat raw taste. In addition the chapati had a rough surface and low pliability. As such, these chapaties had lower total scores.

When side 2 of the chapati was baked for a longer period than side 1 (trial 6), it had the desired uniform light brown spots as well as an optimally baked taste. However, it had a poor score for eating quality. Trials conducted to further improve the quality of chapati by varying the baking periods showed that baking side 1 for 45 sec, side 2 for 105 sec, and puffing for 25 sec were the optimum conditions, as indicated by higher scores for the different quality parameters and for the total score. Chapaties thus prepared had uniform, light brown spots, optimally baked taste, soft texture, and good overall quality as graded by panel members.

Standardization of Baking Temperature

As expected, baking at the relatively low temperature of 150°C increased the baking time and also resulted in chapati of a lower score with undesirable greyish spots (Table III). However, increasing the baking time in order to get the desired light brown colored spots often resulted in a tough chapati, with a somewhat dry mouthfeel. Chapati baked at 269°C appeared optimally baked

TABLE II
Effect of Baking and Puffing Time on the Quality of Chapati[a]

Trial	Baking Time[b] (sec)		Puffing Time[b] (sec)	Shear Value (lb)	Height on Puffing (10)[d]	Pliability (10)[d]	Appearance (20)[d]	Hand Feel (10)[d]	Eating Quality[c] (25)[d]	Taste (25)[d]	Total Score (100)[d]
	Side 1	Side 2									
1	30	30	40	7.5 a[e]	5.0 (4.0 a)[f]	4.0 (1.5 a)	6.8 a	4.3 a	8.5 a	6.0 a	34.6 a
2	60	60	30	4.8 b	7.0 (6.0 b)	9.0 (2.3 b)	7.3 ab	7.8 b	15.8 bc	15.0 b	61.9 b
3	90	90	15	5.1 c	8.3 (7.2 c)	8.0 (2.1 c)	9.5 c	8.3 bc	15.5 c	7.8 c	57.4 c
4	90[g]	90[g]	15	5.1 c	8.0 (6.9 c)	7.0 (2.0 c)	8.0 b	7.5 d	15.5 c	10.0 d	56.0 c
5	60	120	15	6.8 d	8.0 (7.0 c)	5.8 (1.7 d)	9.8 c	5.0 e	13.8 d	9.3 d	51.7 d
6	120	60	15	5.5 e	8.0 (7.0 c)	8.0 (2.1 bc)	11.0 d	6.5 d	11.5 d	17.3 e	62.3 b
7	45	105	25	5.2 c	8.5 (7.3 c)	9.0 (2.4 b)	14.5 e	8.0 c	17.0 b	17.0 e	74.0 c
SEM	···	···	···	±0.07	±0.1	±0.05	±0.35	±0.31	±0.43	±0.47	±0.8

[a] From a dough sheet of 2-mm thickness.
[b] Baked at 205°C and puffed at 343°C.
[c] Indicated by chewing characteristics.
[d] Maximum score.
[e] Any two means followed by different letters differ significantly.
[f] Figures in parentheses indicate height on puffing and pliability (cm).
[g] Both sides baked for 45 sec twice.

but had a slightly underbaked taste, as baking had to be discontinued earlier than normal to avoid charring of surfaces, and the inner portions of the chapati remained underbaked.

No significant difference was observed among puffed heights of chapati baked at different temperatures except in the case of the batch baked at 150° C, which had a low puffed height of 5.5 cm. This low value might be caused by greater loss of moisture during the longer period of baking. Thus, the steam formed was insufficient to get maximum puffing. The moisture content as well as the pliability of the chapati increased when the baking temperature was raised from 150 to 269°C. However, the shear value decreased, indicating a softer texture. A significant improvement was observed in appearance, eating quality, and taste when the chapati was baked at 205 and 232° C. However, baking at 269°C resulted in inferior quality chapati, as indicated by lower scores of several of the quality parameters. Hence, the temperature range of 205–232° C was considered optimum.

Standardization of Puffing Time

Puffing time was found to be critical, as even a slight variation greatly influenced the chapati quality, particularly with respect to color and pliability. In general, full puffing was observed within 10 sec of placing the baked chapati in the *tandoor* oven. Instant puffing resulted from subjecting the chapati to flash heat from all sides (as the oven is a closed system), facilitating instantaneous formation of steam. Continuation of puffing for 15 sec more was necessary to get chapati with the desired appearance.

Standardization of Puffing Temperature

Puffed height of chapati (Fig. 6) depended on the temperature used in the *tandoor* oven. As the temperature increased up to 343° C, there was an increase in the height of the puffed chapati. However, further rise in temperature did not increase the puffed height significantly. The puffing was only partial when the temperature was 176°C. Poor puffing at lower temperature was caused by a slower rate of steam formation. The temperature range of 337–343° C was found to be optimum, resulting in maximum puffing height. A further increase in the temperature, however, resulted in undesired charred spots on the chapati.

Other Variables Influencing Puffing

The moisture content of the dough affected the puffed height of the chapati. Chapati from a dough with a moisture content higher than the optimum puffed more than from a dough containing lesser moisture.

Baking time on the hot plate was also found to influence the extent of puffing (Table II). The underbaked chapati (baked for 30 sec on each side) had the lowest height on puffing (4.0 cm); normal height was 7.0 cm. Perhaps the surface was not rigid enough because of inadequate removal of surface moisture. However, overbaking led to formation of an excessively rigid surface and a poorly puffed chapati.

Effect of Dough Mixing Time

The quality of chapati made from doughs mixed for varying periods showed that the puffed height of chapati improved significantly with increased mixing time up to 3 min (Table IV). Mixing longer than 3 min did not increase the puffed height. The chapati made from a dough mixed only for 1 min did not puff; the dough had not been fully developed because of inadequate hydration and subsequently, incomplete gluten development. Such undermixed doughs could not form a continuous sheet during rolling. Although mixing the doughs for a time exceeding 5 min did not affect the puffing quality of chapati, their rolling characteristics were poor, as the doughs became sticky.

The appearance of chapaties prepared from undermixed dough was poor, as they had dull, greyish, and nonuniform spots. The texture was slightly tough, as indicated by the high shear value and

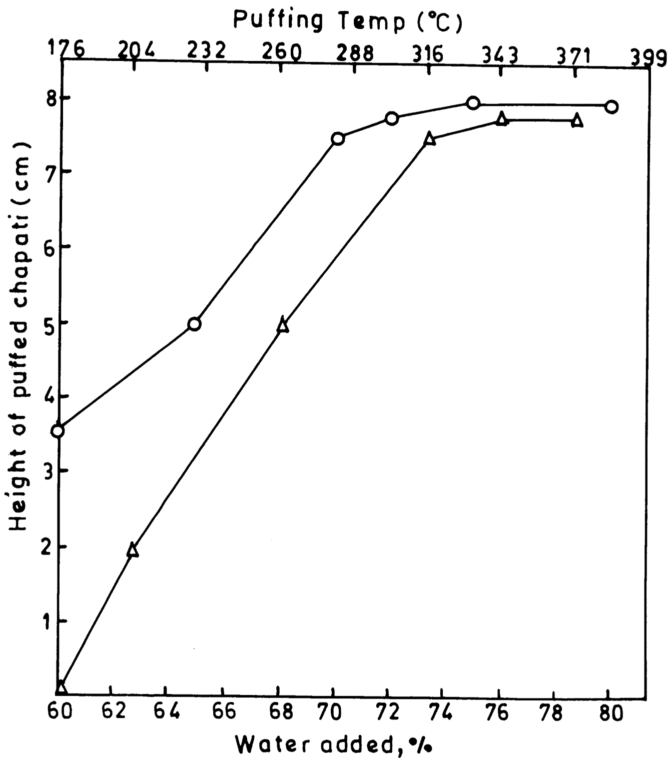

Fig. 6. Effect of water added to the dough (-o-) and puffing temperature (-Δ-) on the height of puffed chapati (all other conditions optimal).

TABLE III
Effect of Baking Temperature on the Quality of Chapati[a]

Baking Temperature (°C)	Baking Time (sec) Side 1	Baking Time (sec) Side 2	Moisture[b] (%)	Shear Value (lb)	Height on Puffing (10)[c]	Pliability (10)[c]	Appearance (20)[c]	Hand Feel (10)[c]	Eating Quality (25)[c]	Taste (25)[c]	Total Score (100)[c]
150	100	150	28.2	6.2 a[d]	6.5 (5.5 a)[e]	9.0 (2.3 a)	10.8 a	8.0 ab	14.8 a	15.5 a	64.6 a
205	45	105	29.1	6.0 a	8.3 (7.3 b)	8.0 (2.1 a)	14.5 b	8.0 ab	17.0 b	16.5 b	72.3 b
232	30	90	30.0	5.7 b	8.0 (7.1 b)	8.5 (2.2 a)	14.5 b	9.3 a	17.8 b	18.5 c	76.6 c
269	25	60	30.6	5.0 c	8.0 (7.1 b)	6.0 (1.8 b)	7.0 c	6.5 b	12.8 c	11.5 d	51.8 d
SEM	...	...	...	±0.06	±0.06	±0.05	±0.4	±0.5	±0.4	±0.3	±0.7

[a] Chapati of 2-mm thickness and puffed at 343°C for 25 sec.
[b] Average value of four replicates.
[c] Maximum score.
[d] Any two means followed by different letters differ significantly.
[e] Figures in parentheses indicate height on puffing and pliability (cm).

the low score for eating quality. However, no significant difference was observed, either in the texture or taste of chapaties made from doughs mixed for 3 min or longer. Only chapati made from a dough mixed for 6 min had a significantly lower total score. Considering the rolling characteristics as well as the quality of the chapati, a dough mixing time of 3–4 min was found to be optimum.

Effect of Thickness of the Dough Sheet

The quality of chapati as affected by different thicknesses is shown in Table V. The data indicated that optimum baking time increased with thickness. Very thin chapati (1.00 mm) puffed to 8.6 cm and thick chapati (3.00 mm) puffed to 5.2 cm. However, because the layers were very thin in the lighter weight chapati, the baking and puffing times were more critical. Even a slight variation in the baking time rendered the chapati, either under- or overbaked.

The chapati less than 2.0 mm thick had a rough hand feel and was tough to chew, resulting in a lower score. It was also graded by panel members as poor for overall quality.

Although the chapati more than 2.5 mm thick appeared optimally baked on the surface, it had a slight underbaked taste. As the thickness of chapati increased, the pliability increased while the shear value decreased. This was indicative of improvement in texture. The moisture content in chapati also increased with thickness, which possibly contributed to its softer texture.

Chapaties with thickness in the range of 2.0–2.5 mm were highly acceptable with desired appearance, texture, and taste. The overall quality of these chapaties was also rated good by the panel members.

Standard Chapati Test Baking

Based on our observations from different trials and experiments, the following method was chosen for test baking of chapati: cleaned wheat was ground in a Kamas mill (model Slaggy 200A) or other laboratory hammer mill, using a 0.8-mm sieve. The water requirement for making a chapati dough of optimum consistency was determined on either a farinograph or research water absorption meter. A 50-g mixing bowl was used on the farinograph and the quantity of water required to bring the farinograph consistency of 450 BU was determined at a lever position of 1:3 (instead of the 1:1 used for bread doughs). When using the water absorption meter, the water absorption of chapati dough was determined as the amount of water required to obtain a dough that had an extrusion time in the range of 60–62 sec, when a weight of 4.4 kg was used. A dough of optimum consistency was prepared by mixing 200 g of flour weighed on 14% moisture basis and the predetermined quantity of water in a Hobart mixer for 3 min, using the beater arm at the low speed of 58 rpm. A dough piece weighing approximately 40 g was rolled to a thickness of 2.0 mm on a specially designed platform. The dough sheet was cut into a

TABLE IV
Effect of Mixing Time of the Dough on the Quality of Chapati[a]

Mixing Period (min)	Dough Characteristics: Handling	Ease of Rolling	Sheeting	Shear Value (lb)[b]	Height on Puffing (10)[b]	Pliability (10)[b]	Appearance (20)[b]	Hand Feel (10)[b]	Eating Quality (25)[b]	Taste (25)[b]	Total Score (100)[b]
1	Discrete lumps, moist surface	Difficult[c]	Not continuous	6.2 a[d]	Not puffed	5.0 (1.6 a)[e]	7.5 a	3.0 a	11.3 a	5.0 a	31.8 a
2	Discrete lumps, dry surface	Somewhat difficult	Continuous	6.9 a	4.8 (3.8 a)	6.5 (1.9 b)	11.5 b	6.3 b	12.0 a	13.0 b	54.1 b
3	Cohesive, dry surface	Easy	Continuous	5.8 bc	8.0 (7.1 b)	8.0 (2.1 c)	14.5 c	8.3 c	16.5 b	17.0 c	72.3 c
4	Cohesive, dry surface	Easy	Continuous	5.7 bc	8.0 (7.1 b)	7.0 (2.0 bc)	15.0 c	8.0 c	17.5 b	17.3 c	72.8 c
5	Cohesive, moist surface	Easy	Continuous	6.0 b	8.0 (7.0 b)	8.5 (2.2 c)	15.0 c	8.5 c	16.5 b	16.5 c	73.0 c
6	Cohesive, sticky	Easy	Continuous, sticky	5.5 c	8.2 (7.2 b)	8.0 (2.1 c)	13.8 cd	8.3 c	15.0 b	16.1 c	69.4 d
SEM				±0.07	±0.09	±0.05	±0.48	±0.36	±0.44	±0.50	±0.88

[a] Chapati of 2 mm thickness, baked at 205°C, and puffed at 343°C.
[b] Maximum score.
[c] The sheet tends to break due to incomplete formation of the dough.
[d] Any two means followed by different letters differ significantly.
[e] Figures in parentheses indicate height on puffing and pliability (cm).

TABLE V
Effect of Thickness of Dough Sheet on the Quality of Chapati[a]

Thickness (mm)	Baking Time (sec): Side 1	Side 2	Moisture[b] (%)	Shear Value (lb)	Height on Puffing (10)[c]	Pliability (10)[c]	Appearance (20)[c]	Hand Feel (10)[c]	Eating Quality (25)[c]	Taste (25)[c]	Total Score (100)[c]
1.0	20	60	27.0	7.8 a[d]	9.0 (8.6 a)[e]	3.0 (1.1 a)	12.0 ad	3.5 a	4.5 a	5.0 a	37.0 a
1.5	30	75	29.5	7.1 b	8.5 (7.6 b)	3.8 (1.4 b)	13.0 ab	6.3 b	14.0 b	11.8 b	57.4 b
2.0	45	105	31.1	6.4 c	8.2 (7.2 c)	8.0 (2.1 c)	14.8 c	8.5 c	17.0 c	17.0 c	73.5 c
2.5	50	130	32.4	5.5 d	8.0 (7.0 c)	9.5 (2.4 c)	14.0 bc	8.3 c	17.0 c	17.5 c	74.3 c
3.0	60	170	35.0	4.1 e	6.2 (5.2 d)	10.0 (3.3 d)[f]	10.5 d	8.0 c	17.5 c	10.3 b	62.5 d
SEM	...	...	...	±0.05	±0.07	±0.06	±0.54	±0.30	±0.36	±0.56	±0.79

[a] Baked at 205°C and puffed at 343°C.
[b] Average value of four replicates.
[c] Maximum score.
[d] Any two means followed by different letters differ significantly.
[e] Figures in parentheses indicate height on puffing and pliability (cm).
[f] The high value recorded was caused by underbaking.

TABLE VI
Chapati-Making Quality[a] of Some Commercial Varieties of Wheats

Variety	Water Absorption[b] (%)	Shear Value (lb)	Height on Puffing (10)[c]	Pliability (10)[c]	Appearance (20)[c]	Hand Feel (10)[c]	Taste (25)[c]	Eating Quality (25)[c]	Total Score (100)[c]
Kalyan Sona	73.2	6.0 ac[d]	7.5 (6.6 a)[e]	8.0 (2.1 a)	15.0 a	8.5 ab	18.0 ab	16.8 a	73.8 a
Sharbati Sonora	73.0	6.0 ac	8.0 (7.0 b)	9.0 (2.3 ad)	15.3 a	8.0 ab	17.0 b	15.8 a	73.1 ab
Sonalika	74.6	6.5 ac	7.8 (6.8 b)	8.0 (2.1 a)	14.5 a	8.0 ab	17.0 b	15.8 a	71.1 b
WG-357	76.6	5.4 a	8.4 (7.5 c)	10.0 (2.9 b)	17.8 b	8.8 a	19.8 a	22.0 b	86.8 c
Pissi-local	67.8	7.0 bc	6.4 (5.4 d)	4.0 (1.5 c)	8.5 c	4.0 c	13.3 c	8.0 c	44.2 d
Punjab[f]	75.1	6.3 ac	8.1 (7.3 c)	9.5 (2.4 d)	14.5 a	7.5 b	17.5 ab	16.5 a	73.6 ab
SEM		±0.32	±0.06	±0.05	±0.56	±0.36	±0.45	±0.40	±0.84

[a] Determined according to standard baking test developed.
[b] Determined on a water absorption meter.
[c] Maximum score.
[d] Any two means followed by different letters differ significantly.
[e] Figures in parentheses indicate height on puffing and pliability (cm).
[f] Procured from a local market.

circular shape using a punching die of 15 cm diameter.

On a hot plate maintained at 205° C, one side of the rolled dough sheet was baked for 45 sec and the other side for 105 sec. The baked chapati was placed in a gas *tandoor* oven maintained at 340 ± 3° C, and the lid was closed immediately. The chapati was puffed for 25 sec.

The height of puffed chapati in centimeters was measured immediately after puffing. The chapati was cooled on a hollow wooden stand for about 15 min and preserved in a closed container for evaluation. Sensory attributes of chapaties were evaluated by a panel of judges. The scoring allotted a maximum total of 100 on the basis of individual maximum scores for appearance (20), puffed height (10), pliability (10), hand feel (10), eating quality (25), and taste (25). Texture was measured with the Warner Bratzler shear press after folding the chapati into four layers; shear value was recorded in pounds.

Chapati-Making Quality of Commercial Wheat Varieties

The standardized method described here was applied for evaluating the chapati-making quality of some commercial wheat varieties, and the results are given in Table VI. The water absorption of chapati dough ranged from 67.8 to 76.6%. The soft variety, Pissi-local, had the lowest water absorption, whereas the medium hard variety WG-357 had the highest.

The total score of 40.8% for chapati made from soft wheat Pissi-local indicated its poor quality, as it had a rough surface, low pliability of 1.5 cm, a somewhat hard texture (indicated by a comparatively high shear value of 7.0 lb), and a low score for eating quality. Its low height on puffing (5.4 cm) could possibly be attributed to the poor quality of its gluten. On the other hand, the variety WG-357 had excellent chapati-making quality with a score of 86.8%. The total scores of chapaties made from Sharabati Sonora (73.1%), Sonalika (71.0%), Kalyan Sona (73.8%), and commercial Punjab wheat (73.0%) were comparably high, indicating good chapati-making quality.

Summary

The results of studies carried out for the development of a standard method to evaluate chapati-making quality of different wheats indicated that the method could be adopted for comparative evaluation at different institutions and that pliability, shear value, and height on puffing could be used as objective parameters for assessing the chapati-making quality of wheats.

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LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1976. Approved Methods of the AACC. Method 08-01, approved April 1961; Method 56-61A, approved April 1964; Method 44-15A, approved October 1975; Method 46-13, approved October 1976. The Association: St. Paul, MN.

AUSTIN, A., and RAM, A. 1971. Studies on chapati-making quality of wheat. Indian Council of Agricultural Research, Tech. Bull. No. 31. ICAR: New Delhi.

HARIDAS RAO, P. 1982. Studies on chapati and similar traditional foods. Ph.D. thesis. University of Mysore, India.

RATTAN SINGH, and BAILEY, C. H. 1940. A biochemical and technological study of Punjab wheat varieties. Cereal Chem. 17:169.

SHARMA, H., and BAINS, G. S. 1976. Effect of grinding on the quality of whole wheat meal. J. Food Sci. Technol. 13:92.

SHURPALEKAR, S. R., and PRABHAVATHI, C. 1976. Brabender farinograph, research extensometer, and Hilliff chapatti press as tools for standardization and objective assessment of chapatti dough. Cereal Chem. 53:457.

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