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RESEARCH TITLE

The Effect of Flour Particle Size Distribution on Sorghum Gluten-Free Flat Bread Quality (Roti)

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ABSTRACT

The goal of this study was to see how sorghum flour particle size distribution affected the gluten-free roti formulation. Four different sorghum flour fractions (150 µm, 1800 µm, 210 µm, and 250 µm) were sieved to create distinct roti formulations. The rotis' dimension, texture, and colour were all assessed. The rheology of roti dough and the hydration parameters of flour were also researched. Sorghum roti offers its own set of advantages from a culinary aspect. It's high in dietary fibre but, because it's produced from cereals, it's also easy to digest. However, it has a comparatively short shelf life. It turns dried and rotten after 10-15 hours of preparation. Smooth, fluffy, and slightly sweet, with a distinct delectable flavour, an excellent roti should be.

Keywords: Particle size, water absorption, sieve, elasticity, sorghum genotypes (Parbhani Moti, Parbhani super moti)

Introduction

The second most important component of sorghum and millet grains is protein. Due to the fact that it is grown under a variety of agro-climatic conditions, all of which affect grain composition, sorghum has a lot of unpredictability. A protein's basic amino acid composition impacts its dependability. In sorghum, lysine is the limiting essential amino acid. Grain proteins are divided into four groups based on their solubility characteristics: albumin (water soluble), globulin (soluble in dilute salt solution), prolamin (soluble in alcohol), and glutelin (soluble in alcohol) (extractable in dilute alkali or acid solutions). The proteins included in grain sorghum are albumin and globulin together (15%), prolamin (26%), and glutelin (15%). (44 %). In sorghum, the proportion of cross-linked prolamin, ß-prolamin, increased in comparison to albumin and globulin fractions. The prolamin fraction was high in proline, glutamic acid, and leucine, but low in lysine, arginine, histidine, and tryptophan.

In rural and small towns, sorghum roti is a traditional Indian meal served as a side dish to rich meat and vegetable curries.

Sorghum roti is an unleavened circular, flat bread popular in western and central food cultures, particularly in Gujarat. Chapati (Hindi), bhakri (Hindi), roti (Hindi). rotla (Gujarati), rotte (Telugu), etc. (Subramanian and Jambunathan, 1982). Spreading the dough without breaking the shape is incredibly tough with sorghum flour, and it takes a lot of practice and several failed efforts to master. There are no leavening agents or oil/ghee to be found in this recipe. Sorghum roti offers its own set of advantages from a culinary aspect. It's high in dietary fibre, but because it's produced from grains, it's also easy to digest.

However, it has a somewhat short shelf life. It turns dried and rotting after 10-15 hours of preparation (Unhale *et al*., 2012). An excellent roti should be smooth, fluffy, and somewhat sweet, with a distinct sorghum aroma (Amerine *et al*., 1980). Sorghum bicolor is an important grain crop mostly used for fruit. It is a common jowar species native to Africa. Animal fodder, alcoholic beverage consumption, kernel features, proximate analyses, flour composition, and roti final product were all assessed. Water uptake was highest in the flour with the lowest particle size. The size of the flour particles has a big impact on water penetration.

Materials and Methods

Materials

Raw Materials

Sorghum Research Station Parbhani, Maharashtra, provides high-quality rabi sorghum (*Sorghum bicolor*) raw materials, including Parbhani moti and Parbhani super moti. The moisture, protein, ash, crude fibre, and total carbs of the sorghum varieties were determined according to the method given by Ranganna (1986). All of the materials were milled (AACCI technique) and screened through appropriate mesh sizes using a Brabender quandrumat junior.

Characterization of Flour

The size of flour particles was determined using a Master sizer 3000 particle size analyser (Malvern Instruments, Malvern, UK). D[4,3], which represents the equal spherical diameter of the particles, as well as D(10), D(50), and D(90), which represent the maximum particle diameter below which 10%, 50%, and 90% of the sample, respectively, decreased were obtained. All of the measurements had already been taken.

Qualities of Roti

Colour

Roti colour vs. the Munsell soil colour chart with Hue, Value, and Chroma description (Rooney *et al*., 1980).

Diameter of roti

The diameter of the sorghum roti was measured using an automatic vernier caliper (A.A.C.C., 2000).

Thickness

The thickness of the sorghum roti was measured using an automatic vernier caliper (A.A.C.C., 2000).

Standardization of a flat bread recipe based on particle size

Traditional sorghum roti is created by mixing flour and water in a 1:1 ratio and vigorously kneading the dough. 30 gram of dough are flattened into a ball and shaped into a 15-cm-diameter, 2-mm-thick round disc with fingers. Then it was baked on a hot plate, turning it over every few minutes until it was cooked properly. Found that the serving temperature was about 110^{0}C (Chavan *et al.,* 2009 and Unhale *et al.,* 2012).

Flow chart for making Roti (flat bread):

Raw material

↓

Cleaning

↓

Sorting and Grading

↓

Ground to fine flour (By using Hammer mill)

↓

Flour is sifted through a sieve

↓

Mixing a 1:1 ratio of flour and hot water (45^{0}C)

↓

Make soft dough of uniform consistency

↓

30 grams of dough was rolled into small ball

↓

Flattened on hard wooden or metal surface sprinkled with a small quantity of flour

↓

Place flat bread on hot iron pan (110^{0}C)

↓

A small amount of water will be sprinkled on top of the flat bread

↓

When the surface of the flat bread is done, turn it over(40 sec)

↓

Both sides should just be baked

↓

Remove flat bread from pan

↓

Cooled to room temperature (±37^0

Standardization of a sorghum-based roti recipe made from various sorghum varieties.

Sorghum-based roti were made with a variety of sorghum flours. The optimum formulation is determined by the particle size of sorghum flour. Gluten-free sorghum roti with different particle sizes of sorghum flour. The particle size percentages of sorghum flour and fractions are 150µm, 180 µm, 210 µm, and 250 µm.

Sr. No.	Treatment	Particle Size(µm)	Sorghum Flour (gm)	Water (ml)
1	T_0	150	50	37
2	T_1	180	50	36
3	T_2	210	50	35
4	T_3	250	50	33

Table 1: Standardization of a sorghum-based roti dish made from several sorghum varieties

A 9-point hedonic scale was used to rate the sensory acceptability of the prepared sorghum-based roti. Treatment (T1) with sorghum flour size (180µm) and water in the ratio of (50:36) earned the greatest score when compared to the other treatments. As a result, this proportion of flours was used in the formulation of different varieties of sorghum-based roti with particle size-based flour.

Textural characteristics of sorghum based roti

A Stable Micro System TAXT2 plus Texture Analyzer was used to perform texture profile analysis (TPA) of sorghum-based roti made using lab sample. A 6.35 mm diameter spherical-end probe was used for TPA analysis, with a test speed of 1 mm/sec for both the pretest and post-test speeds; and 50 percent compression.

Organoleptic evaluation of sorghum based roti

On a 9-point Hedonic scale, ten semi-trained panel members comprised of academic staff members of the Department of Food Process Technology, College of Food Technology Parbhani, who had some previous experience in sensory evaluation evaluated freshly prepared Sorghum-based roti for sensory characteristics such as appearance, colour, flavour, taste, texture, and overall acceptability evaluated freshly prepared Sorghum-based roti.

The products were graded on a 9-point Hedonic scale, with descriptive words ranging from 9 (very like) to 1 (not at all like) (extremely dislike). The results were jotted down on a sensory score card. Tables illustrate how to format the sensory score sheet.

Results and Discussion

Sensory analysis of roti made from several sorghum varieties

On a 9-point hedonic scale, sensory evaluation of sorghum-based roti for several organoleptic properties such as colour, taste, texture, and flavour, as well as the organoleptic score

Sorghum cultivar	Sensory evaluation of roti				
	Color and Appearance	Flavor	Taste	Texture	Overall Acceptability
Parbhani Moti	8.0	8.3	8.1	8.0	8.1
Parbhani Super Moti	7.5	8.0	7.9	7.7	8.0

*Each value is a mean of three determinations

Table 2: Sensory evaluation of roti made from various rabi sorghum cultivars

The total acceptability score for roti made from two sorghum genotypes was 8.1 to 8.0, with an average of 8.05. Parbhani moti received the highest overall approval score (8.1), followed by Parbhani super moti (8.0) Chavan *et al.,* (2009). Sorghum's nutritional and roti-making qualities were documented, with significant diversity in appearance, colour, flavour, taste, texture, and overall acceptance.

Effects of varied flour particle sizes on physical properties of sorghum-based roti from various cultivars

From the viewpoint of both customers and manufacturers, physical analysis of sorghum roti is critical. The physical features of roti, such as colour, thickness, and diameter, were examined, and the results are reported in Table 3

Sr.No.	Physical characteristics of roti	Sample Name	
		Sorghum roti Pbn Moti	Sorghum roti Pbn super Moti
1	Color	White	Pearly White
2	Thickness (mm)	2.8	2.7
3	Diameter (cm)	16	17

*Each value is a mean of three determinations

Table 3: Physical properties of sorghum-based roti prepared from various sorghum types when varying particle sizes of flour

The observations from table-3 revealed the sorghum based roti prepared from parbhani moti recorded white colour whereas thickness and diameter was 2.58 mm and 16 cm respectively. The roti prepared from Parbhani super moti flour gave white colour. Thickness and diameter of roti sample was 2.7 mm and 17 cm respectively. Similar result was recorded by Murty *et al.,* (1981).

Textural properties of sorghum based roti made from different sorghum varieties

A Texture TA-XT2 texture analyser was used to examine the roti's texture properties (Stable Micro Systems, Surrey, UK). The elastic modulus (N/mm2) and peak force (N) were determined by compressing a 'three-point bending' test with a three-point bending rig probe (HDP/3PB). The test circumstances were: a 20 mm travel distance, a 5 g trigger force, and a 2.0 mm/s test speed.

Sr. No	Textural properties of sorghum based roti	Particulars	
		Sorghum roti Pbn Moti	Sorghum roti Pbn Super Moti
1	Hardness (kg)	5.611	11.984
2	Adhesiveness	-0.003	-0.002
3	Springiness	0.95	0.32
4	Cohesiveness	0.788	0.726
5	Gumminess	4.421	8.702
6	Chewiness	4.199	7.135
7	Resilience	0.39	0.34

*Each value is a mean of three determinations

Table 4: Textural properties of sorghum based roti made from different sorghum varieties

While sorghum roti made from Parbhani moti had the highest cohesiveness and chewiness values (0.788 and 4.199 kg), Parbhani super moti roti had the lowest cohesion and chewiness (0.726 and 7.135). The springiness of a product refers to how effectively it physically springs again after being distorted during the first compression.

Sorghum roti prepared from Parbhani moti had the highest springiness value (0.95), whereas Parbhani super moti roti had the lowest (0.32). Furthermore, the highest adhesiveness was discovered in sorghum roti (Parbhani Moti) (-0.003), whereas the lowest was reported in sorghum based roti (Parbhani Super moti) (-0.002).

Conclusion

The sorghum flour, as well as the carbohydrate and protein it contains were briefly discussed in this work. The Influence of Flour Particle Size Distribution on the Quality of Gluten-Free Sorghum Flat Bread (Roti). Thus, it can be stated, based on the scientific data collected and processed, that distinct particle size flour of sorghum Parbhani moti and Parbhani super moti are essential for good roti quality qualities such as its color and extensibility.

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