JOURNAL OF CURRENT RESEARCH IN FOOD SCIENCE

E-ISSN: 2709-9385
P-ISSN: 2709-9377
JCRFS 2021; 2(2): 01-04
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www.foodresearchjournal.com
Received: 03-05-2021
Accepted: 04-06-2021

Gajmal DB
Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Dr. Pawar VS
Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Shinde EM
Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Shingote AB
Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Correspondence
Gajmal DB
Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

The effect of flour particle size distribution on sorghum gluten-free flat bread quality (Roti)

Gajmal DB, Dr. Pawar VS, Shinde EM and Shingote AB

Abstract
The aim of this analysis was to see how the particle size distribution of sorghum flour affected the gluten-free roti formulation. Distinct roti formulations were developed using four different sorghum flour fractions (150µm, 250µm, 350µm, 450µm) obtained by sieving. Dimension, texture, and color of the rotis all were evaluated. The hydration properties of flour and the rheology of roti dough were also tested. From a culinary standpoint, sorghum roti has its own set of benefits. It is rich in dietary fibre but also easy to digest since it is made from cereals. It does, however, have a rather short shelf life. After 10-15 hours of preparation, it becomes dried and rotten. A good roti should be smooth, fluffy, and slightly sweet, with a distinctive delicious taste.

Keywords: Sorghum, Sorghum flour, particle size, water absorption, sieve, extensibilty

Introduction
Protein is the second most important ingredient of sorghum and millet grains. Sorghum has a lot of uncertainty, owing to the fact that it is grown under a variety of agro-climatic conditions, all of which effect grain composition. The basic amino acid composition of a protein determines its reliability. Lysine is the limiting essential amino acid in sorghum. According to their solubility characteristics, grain proteins are divided into four groups: 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). Albumin and globulin together (15%), prolamin (26%) and glutelin (15%) are the proteins contained in grain sorghum (44 percent). In comparison to albumin and globulin fractions, the proportion of cross-linked prolamin, ß-prolamin, became higher in sorghum. Proline, glutamic acid, and leucine were abundant in the prolamin fraction that was deficient in lysine, arginine, histidine, and tryptophan.
Sorghum roti is a traditional Indian recipe that is offered as an accompaniment to gravy meat and vegetable curries in villages and small towns.
Sorghum roti is a round, flat, unleavened bread common in western and central Food culture, especially in Gujarat. It is known by various names in India's various languages: chapati (Hindi), bhakri (Hindi), roti (Hindi), roti (Hindi), roti (Hindi), roti (Hindi), roti (Hindi), roti (Hindi), roti (Hindi), roti (H (Marathi), rotla (Gujarati), rotte (Telugu), etc. (Subramanian and Jambunathan, 1981) [8]. Since sorghum flour is gluten-free, spreading the dough without breaking the shape is extremely difficult, and it takes a lot of practise and several failed attempts to master. There are no leavening agents or oil/ghee attached. From a culinary standpoint, sorghum roti has its own set of benefits. It is rich in dietary fibre but also easy to digest since it is made from cereals.
It does, however, have a rather short shelf life. After 10-15 hours of preparation, it becomes dried and rotten (Unhale *et al*., 2012). Smooth, fluffy, and slightly sweet, with a distinct sorghum aroma, a good roti should be (Amerine *et al*., 1980). Sorghum bicolor, a common jowar species native to Africa, is a major cereal crop primarily used for fruit. Animal fodder, alcoholic beverage consumption, and kernel characteristics, proximate analyses, flour composition, and end product in roti were all evaluated. The flour with the smallest particle size had the highest water uptake. The size of the flour particles has a big impact on water penetration.

Materials and Methods
Materials
Raw materials

Sorghum Research Station Parbhani, Maharashtra, provided high-quality raw materials of rabi cultivars of sorghum (Sorghum bicolor), such as Parbhani moti as well as Parbhani super moti. The moisture, protein, ash, crude fibre, and total carbohydrates of the sorghum varieties were measured using the procedure suggested by Ranganna (1986) [11]. Brabender quandrumat junior has been used to mill all of the grins (AACCI method) and screened through suitable mesh sizes.

Flour Characterization

A Master sizer 3000 particle size analyser was used to determine the size of flour particles (Malvern Instruments, Malvern, UK). D [4, 3], which represents the particles' equal spherical diameter, as well as D(10), D(50), and D(90), which reflect the maximum particle diameter below which 10%, 50%, and 90% of the sample, respectively, fell, were obtained. All of the measurements were completed.

Roti quality

Colour

Color of roti compared to Munsell soil colour chart and Hue, Value, and Chroma notation (Rooney *et al*., 1980) [12].

Diameter of roti

A automated verneircaliper was used to calculate the diameter of the sorghum roti (A.A.C.C., 2000) [2].

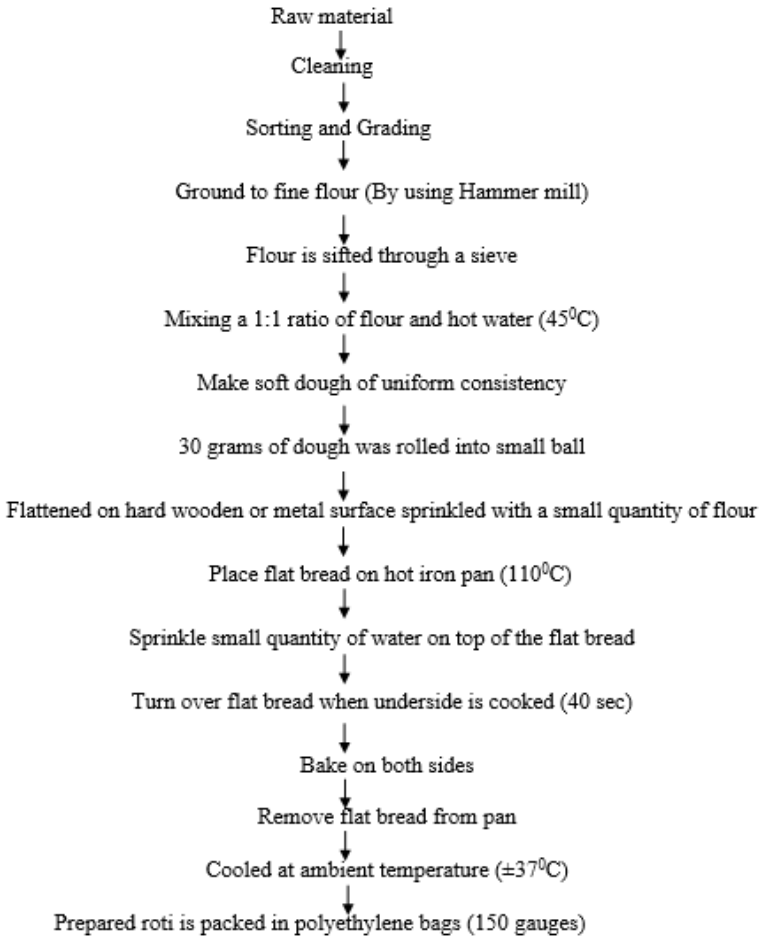
Thickness

A automated verneircaliper was used to test the thickness of the sorghum roti (A.A.C.C., 2000) [2].

Standardization of recipe for particle size based flat bread

Sorghum roti is traditionally made by combining flour and water in a 1:1 ratio and kneading thoroughly 30 grams of dough is rolled into a ball and then tapped with fingers to shape a 15-cm-diameter, 2-mm-thick circular disc. Then it was baked on a hot plate, turning it over regularly until it was cooked thoroughly. Chavan *et al*., 2009 and Unhale *et al*., [3] found that the serving temperature was about 110 ^{0}C. (Chavan *et al*., 2009 and Unhale *et al*., 2012) [4].

Flow chart in preparation of Flat Bread (Roti)



Standardization of recipe for sorghum based roti made from different sorghum varieties.

Multiple sorghum varieties flours were used to make sorghum-based roti. The particle size of sorghum flour determines the best formulation. Gluten-free sorghum roti formulations of various sorghum flour particle sizes. 150µm, 250µm, 350µm, 450µm are the particle size percentages of sorghum flour and fractions.

Table 1: Standardization of recipe for sorghum based roti made from different sorghum varieties.

Sr. No.	Treatment	Particle Size(µm)	Sorghum Flour (gm)	Water (ml)
1	T_0	150	50	37
2	T_1	250	50	36
3	T_2	350	50	35
4	T_3	450	50	33

The sensory acceptability of the prepared sorghum-based roti was assessed using a 9-point hedonic scale. In comparison to the other treatments, treatment (T1) containing sorghum flour size (250µm) with water in the ratio of (50:36) received the highest score. Hence this proportion of flours was used for further formulation with particle size based flour for preparation of sorghum based roti.

Textural characteristics of sorghum based roti

Texture profile analysis (TPA) of sorghum-based roti prepared by lab sample was performed using a Stable Micro System TAXT2 plus Texture Analyzer. TPA analysis was performed using a 6.35 mm diameter spherical-end probe with a test speed of 1 mm/sec for both the pretest and post-test speeds; and 50 percent compression (Manisha and Uday, 2013).

Organoleptic Evaluation of sorghum based roti

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 on a 9-point Hedonic scale evaluated freshly prepared Sorghum-based roti for sensory characteristics namely appearance, colour, flavour, taste, texture, and overall acceptability.

Products were rated on a 9-point Hedonic scale with corresponding descriptive words ranging from 9 (extremely like) to 1 (extremely dislike). The findings were actually written on a sensory score card. The sensory score card is formatted as shown in tables.

Results and Discussion

Sensory evaluation of roti prepared from different sorghum varieties

Sensory evaluation of sorghum based roti for various organoleptic attributes like color, taste, texture and flavor on 9 point hedonic scale and the organoleptic score.

Table 2: Sensory evaluation of roti prepared from different rabi varieties of sorghum

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

The overall acceptability score for roti prepared from two sorghum genotypes ranged between 8.1 to 8.0 with mean 8.05. The overall acceptability score was the highest for Parbhani moti (8.1) followed by Parbhani super moti (8.0). Chavan *et al.*, (2009).[4] reported nutritional and roti making quality of sorghum and observed that there is great variation in appearance, color, flavor, taste, texture and overall acceptability.

Effect of different particle sized flour on physical characteristics of sorghum based roti from different cultivars

Physical analysis of sorghum roti is important from both consumers and manufacturers point of view. Roti were analyzed for physical characteristics including color, thickness and diameter and results are presented in Table No.3

Table 3: Effect of different particle sized flour on physical characteristics of sorghum based roti made from different sorghum varieties

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

*Each value is a mean of three determinations

The observations from table-3 revealed the sorghum based roti prepared from parbhani moti recorded white colour whereas thickness and diameter was 2.58mm 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 reported by Murty *et al.*, (1981) [8].

Textural properties of sorghum based roti made from different sorghum varieties

Texture parameters of the roti were analysed by using a Texture TA-XT2 texture analyser (Stable Micro Systems, Surrey, UK). The peak force, or hardness, (N) and the elastic modulus (N/mm^2) were obtained by the compression of a 'three-point bending' test with a three-point bending rig probe (HDP/3PB). The measurement conditions were: travel distance of 20 mm, trigger force of 5 g and test speed of 2.0 mm/s.

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

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	-0.003
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

Whereas sorghum based roti found to have the least cohesiveness and chewiness value (0.788 and 4.199 kg), However cohesiveness and chewiness of sorghum based multigrain roti was recorded (0.726 and 7.135).

Springiness is how well a product physically springs back after it has been deformed during the first compression. The highest springiness value was found in sorghum roti (0.95), whereas the least in sorghum based multigrain malt roti (0.87) followed by sorghum based roti (0.82).
Moreover, adhesiveness was found to be significantly highest in sorghum roti (-0.003), whereas the least in sorghum based roti (-0.002).

Conclusion
In this paper, the sorghum flour and the starch and protein contained were introduced briefly. The Effect of Flour Particle Size Distribution on Sorghum Gluten-Free Flat Bread Quality (Roti**)**. Thus based on the scientific data collected and analyzed, it can be concluded that different particle size flour of sorghum pbn moti and pbn super moti are vital for good Quality of roti attributes like its color extensibility.

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