Effects of Bran and Hull Retention on the Sensory and Nutrients Composition of "Ogi" prepared from Maize, Millet and Sorghum

ABSTRACT

The effect of Bran and Hull retention on the sensory and nutrient composition of "Ogi" prepared from maize, millet and sorghum was investigated. The Maize and Sorghum were soaked for 72h, while the Millet was soaked for 48h, decanted and washed, wet milled, then allowed to sediment for 12h and oven dried at 50°C for 24h. The "Ogi" was further milled into fine flour. The proximate composition, functional properties, pasting properties of the "Ogi" flour was determined and the sensory properties were evaluated. The proximate composition reported moisture content that ranged from 2.63±0.18 to 8.67±0.02%, the ash content ranged from 1.13±0.04 to 1.41±0.02%, the fat content ranged from 4.57±0.26 to 7.20±0.29%, the fibre content ranged from 1.30±0.14 to 5.75±0.78%, the protein content ranged from 4.27±0.02 to 7.87±0.02% and carbohydrate content ranged from 75.84±0.81 to 82.88±0.81%. The functional properties showed bulk density that ranged from 0.56±0.00 to 0.61±0.01 g/g, water absorption capacity ranged from 1.00±0.00 to 2.00±0.00 g/g, swelling power ranged from 5.50±0.04 to 6.95±0.41 g/g and solubility index ranged from 1.80±0.28 to 24.40±0.00%. The pasting properties reported peak viscosity that ranged from 196.25±0.06 to 311.42±0.03 RVU, trough viscosity ranged from 97.33±0.14 to 208.42±0.59 RVU, breakdown viscosity ranged from 74.33±0.47 to 185.48±0.11 RVU, final viscosity ranged from 100.07±0.10 to 354.08±0.11 RVU, setback viscosity ranged from 63.33±0.00 to 145.67±0.42 RVU, peak time ranged from 4.53±0.00 to 5.80±0.00 min and pasting temperature ranged from 77.45±0.07 to 88.00±0.00 ^{0}C. For sensory properties values for mouth feel ranged from 5.25±1.74 to 7.90±0.97, sourness from 4.80±1.94 to 6.70±2.36, colour from 4.00±1.75 to 8.35±0.75, taste ranged from 4.75±1.94 to 8.10±0.97 and overall acceptability ranged from 4.78±1.28 to 7.69±0.96. This study revealed that the bran and hull retention in Ogi increased the nutrient composition of ogi flour but did not affect positively its sensory appeal.

Key Words: Brand, Hull, Ogi, Unsieved ogi, Sieved ogi.

1. INTRODUCTION

Ogi or pap is a fermented semi solid food made from cereals such as maize (*Zea mays*), sorghum (*Sorghum vulgare*) or millet (*Penniselum typoideum*). It is cheap, extremely light, easily digestible. It is a staple food in West Africa where it serves as a weaning food for infants and also consumed by adults, where it is taken with beans cake, popularly known as "Akara" as breakfast meal [1].

Since it is not an adequate source of micro and macro nutrients [2], sieving ogi leads to loss of vital nutrients, micro nutrients deficiency associated with under nutrition is prevalent in families that are unable to purchase food adequately rich in vitamins and minerals. Common risk groups include women of child bearing age, infants and elderly in risky situations, especially refugees or displaced persons [3]. The nutritional composition of ogi is mainly starch and it is low in protein, vitamins and minerals. This is because during sieving, most water soluble vitamins and some minerals have leached into the water, leaving the slurry deficient in essential nutrients [4].

Maize is a cereal plant that produces grain which can be cooked, roasted, fried, ground, pounded or crushed to prepare various food items [5]. Maize has a high carbohydrate content of 72 – 73%. Protein content ranging from 10.10, 11.25%. Ash content ranging from 1.4 – 3.3% and fat content ranging from 4.17 – 5.0% [6].

Millets are one of the cereals asides the major wheat, rice and maize. Millet is the major source of energy and protein for millions of people in Africa. It has been reported that millet has many nutritious and medical functions [7][8]. They contain 60 – 70% carbohydrate, 7 – 11% protein, 1.5 – 5.5% fat and 2.1% crude fibre, and are rich as excellent source of other minerals like, manganese, phosphorus and iron [9].

Sorghum (*Sorghum bicolor*) is similar in composition to maize. Starch is the major grain component followed by protein. Serna-Saldirar and Rooney [10] reported a range for composition of sorghum to be 8.1 – 16.8% protein, 1.4 – 6.2% fat, 0.4 – 7.3% crude fibre, 1.2 – 7.1%, ash, 6.5 – 7. 9% dietary insoluble fibre and 1 – 1.2 dietary soluble fibre. It is an important source of minerals and phosphorous. They are also rich energy foods for both humans and livestock containing about 66 – 70% carbohydrates [11].

Cereal bran is a nutritional store house of the grains. The chemical composition of cereal bran is highly complex and the multiple beneficial effects of cereal bran could be exploited by incorporating into the daily diet [12]. Besides, regular nutrients like protein, vitamins, minerals and fats, it contains may bioactive compounds such as dietary fibne, phytosterols, polyphenols and phenonic acids which may provide a wide spectrum or biological activities and other health benefits as seen among populations consuming diets based on cereal grains [13][14], a bulk of these nutrients are lost during the wet sieving process during ogi preparation. This study seek to investigate the effect of by-passing the sieving process on ogi prepared from these grains (maize, sorghum and millet).

2. MATERIALS AND METHOD

2.1. Preparation of Ogi Samples:

Maize grain was sorted, the cleaned maize grain was soaked in water for 72 hours at room temperature (30 ±20°C). Soaking water was decanted, then the grains were washed and wet milled into paste, using a commercial attrition milling machine [15]. The paste by-passed sieving and was poured into a muslin cloth to sediment for 12 hours [16].

Millet grains were cleaned to remove stones, dirts, chaffs and other foreign bodies that may affect the quality of the final products. The cleaned grains were steeped for 38 hours at room temperature, after which the grains were rinsed with clean water and wet-milled into paste in a commercial attrition milling machine [17]. The paste was not sieved. The unsieved paste was poured in a muslin cloth to sediment for 12 hours [16].

The sorghum was first cleaned by winnowing, sorted and washed. Soaked for 3 days, to allow fermentation to take place, using the method of Ogiehor *et al.*, [15]. The fermentation process time was reduced by processing in a warm environment. The soaked grain was then rinsed and wet milled to smooth paste. The paste was left unsieved and then poured in a muslin cloth to sediment for 12 hours [16].

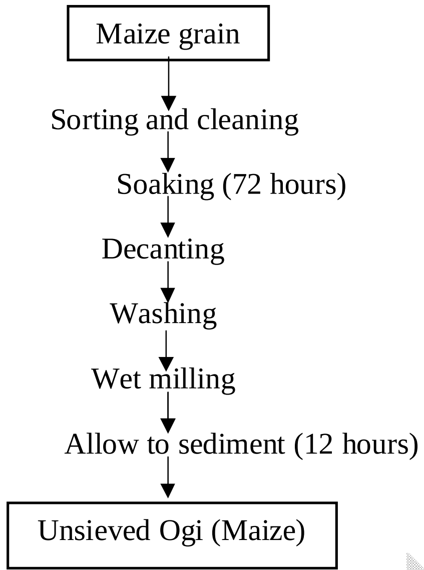

Fig. 1: Flow chart of Unsieved "Ogi" made from Maize

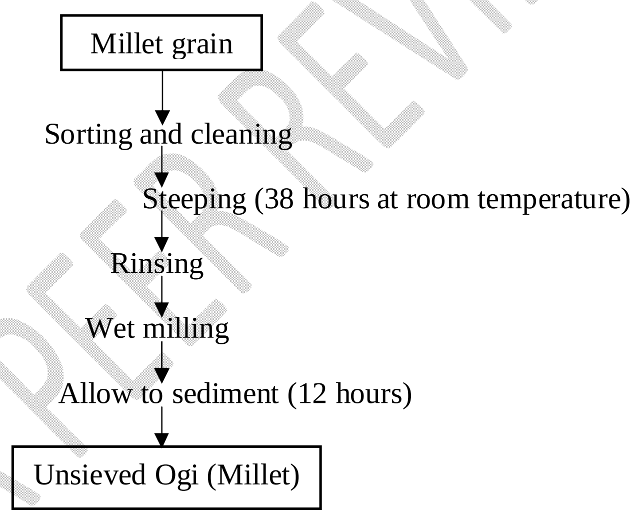

Figure 2: Flow chart of Unsieved "Ogi" made from Millet

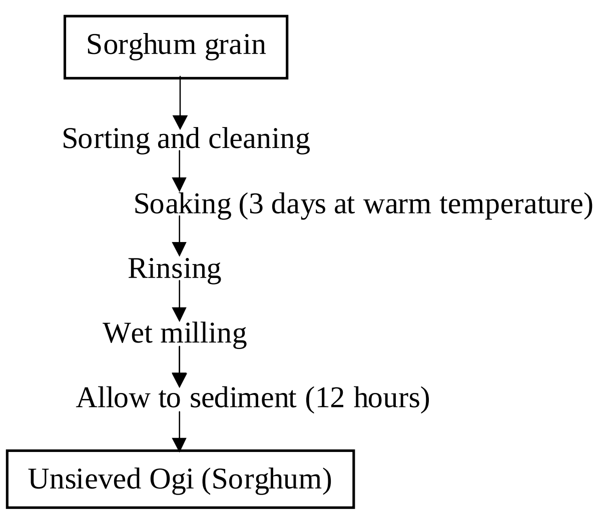

Figure 3: Flow chart of Unsieved "Ogi" made from Sorghun

2.2 Preparation of Ogi Flour

The sediments of the paste (millet, maize and sorghum) were oven dried at 50°C for 24 hours, milled into the powder and kept in an air tight container at room temperature (30 ± 20°C) for further analysis.

Six ogi flour were designated as A, B, C, D, E and F. A, B and C sieved as the control for maize, millet and sorghum respectively, while D, F and F are the unsieved Ogi flour obtained from maize, millet and sorghum respectively.

chart 1: Sample Labels for Ogi Flour

Levels	Samples
A	Maize Control
B	Millet Control
C	Sorghum Control
D	Unsieved Maize
E	Unsieved Millet
F	Unsieved Sorghum

2.3 Determination of Proximate Composition

Proximate compositions were determined according to the methods of the Association of Official Analytical Chemist [18].

2.4 Functional properties

The method described by Sathe and Salunkhe [19] was used to determine the least gelation concentration. Water Absorption Capacities were determined by the method of Beuchat [20], bulk density by the method described by Wang and Kinsella [21], swelling power and solubility were carried out using the method of Takashi and Sieb [22].

2.5. Pasting Properties

The pasting properties were carried out using a Rapid Visco-Analyser (RVA) model 3C, new port scientific Sydney) as described by Sanni *et al*. [23]

2.6. Sensory Evaluation

The "Ogi" powder was reconstituted and made into porridge by the addition of equal amount of water to form Slurry and then stirred with hot water at 10^0C. Twenty member semi-qualified panelists of the Department of Food Science and Technology, Rivers State University, Nigeria were selected based on experience/familiarity with "Ogi" for sensory evaluation. Unsieved Ogi prepared from maize, millet and sorghum were compared to Ogi prepared from the control (sieved Ogi). The samples were evaluated for colour, aroma, taste, sourness, mouthfeel (smoothness) and overall acceptability. Each attribute was rated on a 9-point hedonic scale of 1 to 9, with 1 representing disliked extremely, 5 representing neither liked nor disliked and 9 representing liked extremely [24].

2.7. Statistical Analysis

All the analysis were carried out in duplicate. Data obtained were subjected to Analysis of Variance (ANOVA). Difference between means were evaluated using Turkey's Multiple comparison tests with 95% confidence level. The statistical package in MINITAB software version 16 was used.

3. RESULTS

3.1. Proximate Composition of "Ogi"flour prepared from maize, millet and sorghum

The proximate composition was reported in table 1. The moisture content (%) of the samples ranged from 2.63 in sample B to 8.67 in sample C. The ash content (%) ranged from 0.13 in sample A to 1.41 in sample C. The fat content (%) ranged from 4.57 in sample F to 7.20 in sample D. The crude fibre content (%) ranged from 1.30 in sample A to 5.75 in sample F. The protein content (%) ranged from 4.27 in sample C to 7.87 in sample F. The carbohydrate (%) ranged from 75.84 in sample D to 82.88 in sample A.

Table 1. Proximate Composition of "Ogi" Prepared from Maize, Millet and Sorghum

Sample	Moisture (%)	Ash (%)	Fat (%)	Crude Fiber (%)	Protein (%)	Carbohydrate (%)
A	$3.46^{d}\pm0.20$	$0.82^{c}\pm0.03$	$5.30^{bc}\pm0.42$	$1.30^{b}\pm0.14$	$5.24^{c}\pm0.01$	$82.88^{a}\pm0.81$
B	$2.63^{e}\pm0.18$	$1.08^{b}\pm0.11$	$6.78^{ab}\pm0.88$	$2.30^{b}\pm0.14$	$6.12^{b}\pm0.02$	$81.11^{b}\pm0.93$
C	$8.67^{a}\pm0.02$	$1.41^{a}\pm0.02$	$5.28^{bc}\pm0.12$	$1.50^{b}\pm0.14$	$4.27^{d}\pm0.02$	$78.79^{b}\pm0.01$
D	$6.23^{b}\pm0.32$	$0.98^{bc}\pm0.04$	$7.20^{a}\pm0.29$	$1.90^{b}\pm0.14$	$7.78^{a}\pm0.02$	$75.84^{c}\pm0.81$
E	$5.22^{c}\pm0.26$	$1.13^{b}\pm0.04$	$6.49^{ab}\pm0.06$	$2.30^{b}\pm0.14$	$6.12^{b}\pm0.01$	$78.74^{b}\pm0.43$
F	$4.78^{c}\pm0.04$	$1.09^{b}\pm0.06$	$4.57^{c}\pm0.26$	$5.75^{a}\pm0.78$	$7.87^{a}\pm0.02$	$75.96^{c}\pm0.52$

[1] *Mean values are ± Standard deviation of duplicate samples. Means with the same superscript in a column are not significantly different ($p > 0.05$)*

[2] ***Keys:*** *A = Sieved maize; B = Unsieved maize; C = Sieved millet; D = Unsieved millet; E =Sieved sorghum; F = Unsieved sorghum*

Source: Author's computation based on experimental data

3.2. Functional Properties of Ogi" flour prepared from maize, millet and sorghum

Table 2 showed the functional properties. The bulk density ranged from 0.56g/g in sample B and E to 0.61g/g in sample C. Water absorption capacity ranged from 1.00g/g in sample A to 2.00 g/g in sample C and E. The swelling power ranged from 5.50g in sample D to 6.95g in sample E. Solubility index ranged from 18% in sample F to 24.4%. In sample B. Least gelation concentration of all samples is 2%. The gelation temperature ranged from 65.40^{0}C in sample D to 77.30^{0}C in sample F.

Table 2. Functional Properties of "Ogi" Prepared from Maize, Millet and Sorghum

Sample	Bulk Density (g/g)	Water Absorption Capacity (g/g)	Swelling Power (g)	Solubility Index (%)	Least Gelatin Concentration (%)	Gelation Temperature (^{0}C)
A	$0.60^{a}\pm0.01$	$1.00^{ab}\pm0.00$	$6.89^{a}\pm0.35$	$20.50^{ab}\pm2.40$	$2.00^{a}\pm0.00$	$70.65^{c}\pm0.07$
B	$0.56^{bc}\pm0.00$	$1.50^{a}\pm0.71$	$6.37^{ab}\pm0.16$	$24.40^{a}\pm0.00$	$2.00^{a}\pm0.00$	$72.15^{d}\pm0.21$
C	$0.61^{a}\pm0.01$	$2.00^{a}\pm0.00$	$5.56^{b}\pm0.21$	$16.10^{c}\pm0.14$	$2.00^{a}\pm0.00$	$66.10^{d}\pm0.28$
D	$0.59^{ab}\pm0.00$	$1.75^{a}\pm0.35$	$5.50^{b}\pm0.04$	$16.60^{bc}\pm0.00$	$2.00^{a}\pm0.00$	$65.40^{d}\pm0.57$
E	$0.56^{c}\pm0.01$	$2.00^{a}\pm0.00$	$6.95^{a}\pm0.41$	$20.00^{b}\pm0.00$	$2.00^{a}\pm0.00$	$73.65^{b}\pm0.35$
F	$0.60^{a}\pm0.01$	$1.25^{a}\pm0.35$	$6.44^{ab}\pm0.19$	$18.00^{b}\pm0.28$	$2.00^{a}\pm0.00$	$77.30^{a}\pm0.14$

[1] *Mean values are ± Standard deviation of duplicate. Means with the same superscript in a column are not significantly different ($p > 0.05$).*
[2] ***Keys:** A = Sieved maize; B = Unsieved maize; C = Sieved millet; D = Unsieved millet; E =Sieved sorghum; F = Unsieved sorghum*
Source: Author's computation based on experimental data

3.3. Pasting Properties of Ogi"flour prepared from maize, millet and sorghum

Table 3 shows the pasting properties of the samples. The peak viscosity ranged from 196.25 RVU in sample B to 311.42 RVU in sample E. The trough viscosity values ranged from 97.33 RVU in sample B to 208.42 RVU in sample E The mean values for the breakdown viscosity ranged from 74.33 RVU in sample F to 185.48 RVU in sample A. The final viscosity mean values ranged from 100.07 RVU in sample B to 354.08 RVU in sample E. The setback viscosity ranged from 63.33 RVU in sample B to 145.67 RVU in sample E.

The peak time has mean values ranged from 4.53 min in sample A to 5.80 min in sample C. The pasting temperature ranged from 77.45^{0}C in sample A to 88.00^{0}C in sample C.

Table 3 Pasting Properties of "Ogi prepared from Maize, Millet and Sorghum

Sample	Peak (RVU)	Trough (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Setback Viscosity (RVU)	Peak time (min)	Pasting Temperature (^{0}C)
A	306.43^{b}±0.00	141.33^{d}±0.47	185.48^{a}±0.11	247.08^{d}±0.00	105.75^{d}±0.28	4.53^{d}±0.00	77.45^{e}±0.07
B	196.25^{f}±0.06	97.33^{f}±0.14	98.92^{c}±0.00	200.07^{f}±0.10	63.33^{f}±0.00	4.80^{cd}±0.14	79.10^{d}±0.00
C	282.00^{c}±0.00	185.83^{b}±0.00	96.17^{d}±0.01	298.50^{c}±0.00	112.67^{c}±0.42	5.80^{a}±0.00	88.00^{a}±0.00
D	227.58^{e}±0.00	135.00^{e}±0.00	92.58^{e}±0.00	228.58^{e}±0.11	93.58^{e}±0.00	5.60^{ab}±0.00	87.85^{a}±0.07
E	311.42^{a}±0.03	208.42^{a}±0.59	103.00^{b}±0.00	354.08^{a}±0.11	145.67^{a}±0.42	5.27^{bc}±0.28	79.90^{c}±0.00
F	241.40^{d}±0.57	167.08^{c}±0.11	74.33^{f}±0.47	310.50^{b}±0.00	143.52^{b}±0.03	5.26^{bc}±0.05	82.45^{b}±0.00

[1] *Mean values are ± Standard deviation of duplicate. Means with the same superscript in a column are not significantly different ($p > 0.05$)*

[2] ***Keys:*** *A = Sieved maize; B = Unsieved maize; C = Sieved millet; D = Unsieved millet; E =Sieved sorghum; F = Unsieved sorghum*

Source: Author's computation based on experimental data

3.4. Sensory evaluation of Ogi" prepared from maize, millet and sorghum

Table 4 shows the mean Sensory attributes of "Ogi" Prepared from Maize, Millet and Sorghum. Values for mouth feel ranged from 5.25 in sample F to 7.90 in sample E. Sourness ranged from 4.80 in sample F to 6.70 in sample E. The colour ranged from 4.00 in sample D to 8.35 in sample A. The taste had a mean value that ranged from 4.75 in sample D to 8.10 in sample E. Aroma ranged from 5.00 in sample D to 7.75 in sample E. The overall acceptability of the samples recorded values ranging from 4.78 in sample D to 7.69 in sample E.

Table 4. Mean Sensory Scores of "Ogi" Prepared from Maize, Millet and Sorghum

Sample	Mouthfeel	Sourness	Colour	Taste	Aroma	Overall Acceptability
A	$7.60^{ab}\pm1.14$	$6.15^{a}\pm2.28$	$8.35^{a}\pm0.75$	$7.95^{ab}\pm1.19$	$7.20^{ab}\pm1.15$	$7.45^{ab}\pm0.80$
B	$6.30^{bc}\pm1.26$	$5.90^{a}\pm1.80$	$7.60^{a}\pm1.00$	$6.65^{bc}\pm1.27$	$6.30^{bc}\pm1.13$	$6.55^{b}\pm0.76$
C	$5.80^{c}\pm2.33$	$5.30^{a}\pm2.23$	$5.35^{b}\pm1.69$	$5.70^{cd}\pm1.72$	$5.15^{c}\pm1.84$	$5.46^{c}\pm1.63$
D	$5.05^{c}\pm1.82$	$5.10^{a}\pm1.80$	$4.00^{c}\pm1.75$	$4.75^{d}\pm1.94$	$5.00^{c}\pm1.45$	$4.78^{c}\pm1.28$
E	$7.90^{a}\pm0.97$	$6.70^{a}\pm2.36$	$8.00^{a}\pm1.30$	$8.10^{a}\pm0.97$	$7.75^{a}\pm1.07$	$7.69^{a}\pm0.96$
F	$5.25^{c}\pm1.74$	$4.80^{a}\pm1.94$	$6.25^{b}\pm1.45$	$5.40^{cd}\pm1.47$	$5.25^{c}\pm1.92$	$5.39^{c}\pm1.21$

[1] *Mean ± Standard deviation of duplicate. Means with the same superscript in a column are not significantly different (p > 0.05)*

[2] ***Keys:** A = Sieved maize; B = Unsieved maize; C = Sieved millet; D = Unsieved millet; E =Sieved sorghum; F = Unsieved sorghum*

[3] *Mean hedonic scores, where 9 = like extremely, 1 = dislike extremely, n = 20 assessors, duplicates*

4. DISCUSSION

The proximate composition of "Ogi" prepared from maize, millet and sorghum is as shown in table 1. The moisture content results showed that sample C was significantly (p<0.05) different from other samples. It was observed that the samples without the bran and hull had higher moisture content that the samples with the bran and hull. The low moisture content in samples with bran and hull could be attributed to the presence of the bran and hull. Hussain *et al*., [25] found that increase in maize bran ratio to wheat decreases the moisture content. Maximum moisture should be 14.5% and 15.5%, respectively, according to Turkish Food Codex [26] and Codex Alimentarius regulations. Flour becomes increasingly sensitive to fungus growth, taste modification, and enzymatic activity when the moisture level climbs over 14% [27].

In the ash content reported, sample C also was significantly different ($p < 0.05$) from other samples. The ash content reported for this study are relatively low, although they could be compared to ash content reported by Hussain *et al*., [25]. It was observed that the samples with bran and hull has higher ash content when compared with samples without bran and hull. Again Hussain *et al*., [25] also reported increase in maize bran, increased the ash content the sample they assessed. Elawad *et al*. [28] reported ash values of 0.8 - 2.3% for cereal/legume bran composite flour.

Result for fat content showed that sample B, sample D and sample E were not significantly different ($p > 0.05$) from each other. Except in sorghum, samples with bran and hull had higher fat content than samples without bran and hull. Yadav *et al*., [29] found that increase in wheat bran decrease fat content of samples they assessed, this statement is true of the sorghum sample reported in this study, but Hussain *et al*., [25] has increase in fat content with increase in maize bran ratio.

The crude fibre content also showed that samples with bran and hull had higher fibre content than samples without bran and hull. The reason for the increase in the fibre content could be because bran is particularly high in insoluble fibre [30].

The values for protein showed that sample D and sample F were significantly different ($p < 0.05$) from other samples. The protein content reported in this study is lower than the protein content reported by Bhosale and Vijayalakshmi [31]. The samples with bran and hull are higher than the samples without bran and hull. The protein content reported in this study could be compared to the protein content reported by Hussain *et al*., [25]. Owuno *et al* (32) reported increase in protein content of Gari-maize residue blend.

The carbohydrate content reported were high and sample A is significantly different from other samples. The samples with bran and hull are lower than the sample without bran and hull.

The functional properties are presented in table 2. Except in sorghum, the bulk density show that samples with bran and hull has lower bulk density content than samples without bran and hull. It may be expected that decreased bulk density would be advantageous in the preparation of weaning food formulations. Retention of bran and hull actually achieved that in maize and millet. The bulk density in this study is higher than the bulk density reported by Bhosale and Vijayalakshmi [33].

Water absorption capacity showed that there was no significant difference ($p > 0.05$) across the samples. Except for maize, the samples without bran and hull has higher water capacity than samples with bran and hull. Niba *et al*. [34] stated that water absorption capacity is important in bulking and consistency of product as well as baking applications. Water absorption capacity measures the volume occupied by the starch granule or starch polymer after swelling in excess water which can be used as an index of gelatinization [35].

In the swelling power reported, samples with bran and hull has lower swelling power than sample without bran and hull while in solubility index, samples without bran and hull has lower solubility index than samples with bran and hull except in sorghum. Swelling power of starch is attributed to the strength and character of the micellar network within the starch granule. As the temperature was increased, the starch granules were vibrated more vigorously, breaking intermolecular bonds and allowing hydrogen-bonding sites to engage more water molecules. Swelling power and water solubility index provide evidence of the magnitude of the interaction between starch chains within both the amorphous and crystalline domains [36]. The extent of interaction was influenced by the ratio and characteristics of amylose and amylopectin in terms of molecular weight distribution, degree of branching, length of branches and conformation of molecules [37].

Across all samples the least gelation concentration was at 2%. Sample F was significantly different ($p < 0.05$) from other sample in the gelation temperature reported. Except in sorghum, samples with bran and hull has lower gelation temperature samples without bran and hull.

The peak viscosity, trough viscosity, breakdown viscosity, final viscosity and setback viscosity showed that there was significant difference ($p < 0.05$) across the samples, also, in these parameters the samples with bran and hull were lower than the samples without bran and hull. Peak viscosity has been connected to starch's water binding capacity, which occurs when swelling increases viscosity while rupturing and realignment decreases it [23].

The samples containing bran and hull had a low breakdown viscosity, indicating that they can survive breakdown during heating and shearing. The low breakdown viscosity of the mixes reveals their capacity to withstand breakdown during heating and shearing. High breakdown viscosity may impair flour's ability to withstand heating and shear stress during cooking [38].

Pasting characteristics (excluding pasting temperature) and flour proximate composition, on the one hand, demonstrate a direct link between starch (carbohydrate) content and pasting properties, and on the other, an inverse relationship between protein and pasting properties. Pasting qualities declined as carbohydrate level decreased, but when protein quantity increased, pasting properties decreased as well. Protein's action on the starch might explain the decline in pasting characteristics (excluding pasting temperature) when protein content rises. Protein significantly influenced the pasting capabilities of rice, most likely via lowering heat-induced starch swelling [38]. With increasing protein content, the peak, trough, breakdown, set back, and ultimate viscosities of the sample with bran and hull decreased, but the pasting temperature increased. These findings are comparable to those published by Kiin-Kabari *et al.* [39].

Table 3 summarizes the texture, sourness, colour, taste, sourness, and overall acceptability of the samples. Across the table, it was observed that sample E was the most preferred sample. There was no significant difference ($p > 0.05$) across the samples assessed for sourness parameter. Sample D was the least preferred sample across the table. It was observed that samples without bran and hull were the most preferred samples in the sensory properties, the reason for this is not far-fetched, it is what the panelist are already used to since ogi is normally prepared without the bran and hull.

5. CONCLUSION

The effect of bran and hull retention was reported to be effective on some other properties assessed. One major impact of the bran and hull retention could be seen in the moisture content as it reduces it as this will enhance shelf stability. Ogi being a product for weaning, one of the desired nutrient content is protein, and from this study it was found that bran and hull retention increased the protein content of the samples. Also, a low bulk density properties are desirable in preparation of weaning food formulations, bran and hull also reduced the bulk density. This study shows bran and hull retention increased protein, fat and crude fibre content of the ogi flour, this mode of preparing ogi without sieving out the bran and hull should be encouraged for adults who consume it as a breakfast meal.

REFERENCES

1. Ome, K.A. and Micheal, U. (2015). Cereal-based fermented foods of Africa as functional foods. *International Journal of Microbiology and Application.*2(4), 71-83.
2. Fasasi, O.S. Adeyemi, I.A. and Fagbenro, O.A (2006).Physicochemical properties of maize. Tilapia flour blended of Fd. Tech 3(3): 342-345.
3. Al-Awwadi NAJ. Potential health benefits and scientific review of ginger. *Journal of Pharmacognosy Phytother.* 2017.9:111-116.
4. Ajala, A.S., Taiwo, T.F. (2018), Study on Supplementation of "Ogi" with oyster Mushroom flour (PleurotusOstreatus). *Journal of Nutritional Health and Food Engineering,* 8(3).287-291.
5. Abdurahman, A. and kolawole, M.K. (2006), Traditional Preparations and uses of maize in Nigeria, Ethnobotanical leaflets. 10. 219-227.
6. Ujabaderigi, A.O. and Adebolu, J.T. (2005), The effect of processing method on the

nutritional properties of Ogi produced from three maize varieties. *Journal of food, Agriculture and Environment.*11(3): 108-109.

7. Obilana A.B. and E. Manyasa (2002). Millets In: P.S. Belton and J.R.N. Taylor (Eds), Pp. 177-217. Pseudo Cereals and Less common cereals: Grain Properties and utilization potential springer – Verlag: New York.
8. Yang, X., Z. Wan, L. Periy, H. LV, Q. Wang, C. Hao, J. Li. F. Xie, J. Yu, T. Cui, T. Wang. In. Li and Q.H. Ge (2012).Early Millet use in northern China. *National Academic Science USA. 1-5.*
9. Singh M., Liu, S. X., Vaughn, S.F. "Effect of corn bran as dietary fiber addition on baking and sensory quality." Biocatalysis and Agricultural Biotechnology, 1(4): 348-352. Oct. 2012.
10. Serna-Saldivas, S. and Rooney, L.W. (1995), Structure and chemistry of Sorghum and millets. In: Dendy, D.A.V. (Ed.) Structure and Chemistry of Sorghum and millets. *American Association of Cereal Chemists.*St. Paul, MN, USA 69-124.
11. Ape, I. Nwogu, N.A., Uwakwe, E and Ikedinobi, C.S. (2016), Comparative analysis of maize and sorghum bought from Ogbete main market of Enugu State, Nigeria, Greenes. *Journal of Agricultural Sciences,* 6(9): 272-275.
12. Charalampollollour, D. Wang R., Pandiella, S.S., Webb, C. Application of Cereals and cereal components in functional food. *A review International Journal food Microbial*.2002; 79: 131-141.
13. Patel, S. Cereal bran: the next super food with significant antioxidant and anticancer potential. *Med J. Nutr.Metab.*2012: 5:91-104, doi: 10.1007/S12349-012-0091-1
14. MC Kevith B. Nutritional aspects of cereals. Nutrition Bill 2004; 29: 111-142.
15. Ogiehor I.S. Ekundayo, A.O. and Okuw, G.I. (2005), Shelf Stability of Agidi Produced from Maize and the effect with sodium Benzoate Treatment in Combination with low temperature storage. *African Journal of Biotechnology, 4(7): 733-743.*
16. Farinde, E.O. (2015), Chemical and Sensory Properties of Sieved and Unsieved fortified Ogi-Nature and Science, 13(1), 49-53.
17. Akusu, O.M., Emelike, N.J.T and Chibor, B.S. (2019), Physico chemical, functional and sensory properties of 'Agidi' produced from maize, millet and sorghum starch blends. Delta Agriculturist, 11(2/3): 47-56
18. AOAC (2012).Association of Official Analytical Chemists.Official Methods of Analysis, 19th Edition Washington, DC USA.
19. Sathe, S.K. and Salunkhe D.K., (1995). Structure and Chemistry of Sorghum and Millets. In: Dendy, D.A.V. (Ed.) structure and Chemistry of Sorghum and millets American Association of cereal chemists, St. Paul, MN, USA. 69-124.
20. Beuchat LR. Functional and electrophorectic characteristics of succunylated peanut four protein. Journal of Agriculture and Food Chemistry. 1977;25:258–262.
21. Wang JC, Kinseila JE. Functional properties of novel proteins. Alfalfa leaf protein. Journal of Food Science.1976;41:286–289.
22. Takashi S, Sieb PA. Paste and gel properties of prime corn starches with and without native lipids. Cereal Chemistry.1988;65:474–483.
23. Sanni L, Maziya-Dixon B, Onabolu AO, Arowosa FB, Okechukwu RU, Aixon AGO, Waziri ADF, Ezedinma C, Semakula G, Lemchi JO, Akoroda M, Ogbe F, Farawal G, Okoro E, Getoloma C. Cassava Recipes for Household Food Security, IITA, Integrated Cassava Project, Ibadan, Nigeria; 2006.
24. Iwe, M. O. (2010). Handbook of Sensory Methods and Analysis. Nigerian Rejoint Communication Science Limited, Enugu. Page 74-78
25. Hussain, M., Saeed, F., Niaz, B., Afzaal, M., Ikram, A., Hussain, S., Mohamed, A. A., Alamri, M. S., & Anjum, F. M. (2021). Biochemical and nutritional profile of maize bran-enriched flour in relation to its end-use quality. *Food science & nutrition*, 9(6), 3336–3345.
26. Turkish Food Codex (1999) Buğday unu tebliği. Resmi gazete, (17.02.1999), Tebliğ No: 1999/1, *Başbakanlık Yayınları, Ankara*

27. Batool, S. A., Rauf, N. , Tahir, S. S. , & Kalsoom, R. (2012). Microbial and Physico-chemical contamination in the wheat flour of the twin cities of Pakistan. *International Journal of Food Safety*, 14(6), 75–82
28. Elawad, R. M. O. , Yang, T. A. , Ahmed, A. H. R. , Ishag, K. E. A. , Mudawi, H. A. , & Abdelrahim, S. M. K. (2016). Chemical composition and functional properties of wheat bread containing wheat and legumes bran. *International Journal of Food Science and Nutrition*, 1(5), 10–15.
29. Yadav S, Pathera A, Islam R, Malik A, Sharma D (2018). Effect of wheat bran and dried carrot pomace addition on quality characteristics of chicken sausage Animal Bioscience;31(5):729-737.
30. Keith H (2007). Bran. *The Comprehensive Pharmacology. X Pharmaceutical*. Pages 1-3, ISBN 9780080552323.
31. Bhosale S, & Vijayalakshmi D. (2015). Processing and Nutritional Composition of Rice Bran. Current Research Nutrition Food Science ;3(1).
32. Owuno, F., Kiin-Kabari, D. B., Akusu, M. and Achinewhu, S. C. (2021). Nutritional, functional and sensory properties of Gari enhanced with fermented maize residue flour. *International Journal of Food Science and Biotechnology,* 6(2), 59 – 65.
33. Niba, L.L., Bokanga, M., Jackson,F.I., Schlimme, D.S. & Li,B.W. (2001). Physicochemical properties and starch granular characteristics of flour from various Manihot esculenta (cassava) genotypes. Journal of Science Education and Technology. 67,1701.
34. Altan, A., Mccarthy, K. L. & Maskan M. (2008). Evaluation of snack foods from barley tomato pomace blends by extrusion processing. *Journal of Food Engineering*. 84, 231–242
35. Tang, H., Mitsunaga, T. & Kawamura, Y. (2004). Relationship between functionality and structure in barley starches. *Carbohydrate Polymers* 57: 145-152
36. Singh, H., Singh Sodhi, N. and Singh, N. (2009). Structure and Functional Properties of Acid Thinned Sorghum Starch. *International Journal of Food Properties* 12: 713–725
37. Adebowale AA, Sanni, LO & Fadaunsi EL. (2008). Functional properties of cassava – sweet potato starch blend. *Proceeding of the 32nd Annual Conference of Nigerian Institute of Food Science and Technology*. pp 304-305.
38. Derycke, V., Veraverbeke, W. S., Vandeputte, G. E., De Man, W., Hoseney, R. C., & Delcour, J. A. (2005). Impact of proteins on pasting and cooking properties of non parboiled and parboiled rice. *Cereal Chemistry*, 82(4), 468– 474.
39. Kiin-Kabari, D. B., Eke-Ejiofor, J., and Giami, S. Y. (2015). Functional and pasting properties of wheat/plantain flours enriched with Bambara groundnut protein concentrate. *International Journal of Food Science and Nutrition Engineering,* 5(2), 75– 81.