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

ABSTRACT

The effect of Bran and Hull retention on the sensory and nutrient composition of "Ogi flour prepared from maize, millet are sorghum were investigated. The maize and sorghum were soaked for 72 hours, while the millet was soaked for 48 hours, decanted, washed and wet milled into a paste which was oven dried at 50^0C for 24 hours and milled into fine flour. The proximate composition, functional properties, pasting properties of the "Ogi" flour was determined as well as evaluating the sensory properties. The moisture content, ash, fat, crude fibre, protein and carbohydrate respectively ranged thus: 2.63 – 8.67%, 1.13 – 1.41%, 4.57 – 7.20%, 1.30 – 5.75%, 4.27 – 7.87% and 75.84 – 82.88%. The presence of Bran and Hulls led to a decrease in moisture content, on increase in ash fat and protein content with decrease in carbohydrate values. The bulk density, water absorption capacity, swelling power and solubility respectively ranged as follows: 0.56 – 0.61g/ml, 1.00 – 2.00g/g, 5.50 – 6.95g/g, 16.10 – 24.40% the presence of Bran led to a decrease in bulk density in maize and millet ogi, a decrease in water absorption capacity in millet and sorghum ogi. The pastry properties of peak, trough breakdown, final and setback viscosities showed a decrease in values from the control samples values for peak time died not differ significantly (P<0.05) between the sieved and unseived ogi flours. While the presence of Bran and Hulls increased pasting temperature in maize and sorghum ogi flours. Result for sensory evaluation showed the control samples were the most preferred for all the attributes. This study revealed that ogi flour can be prepared with a by-pass of the sieving process to enhance nutrient retention.

Key Words: Rapid Visco-Analyser, Sensory Evaluation, Sieved and Unsieved.

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 and easily digestible. It is a staple food in West Africa where it serves as a weaning food for infants and also consumed by adults. It is taken with beans cake, popularly known as "Akara" as breakfast meal" [1].

"Ogi is not an adequate source of micro and macro nutrients [2], sieving ogi leads to loss of vital nutrients". "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 are leached into the water, leaving the slurry deficient in essential nutrients" [4]. "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].

"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 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 also an important source of minerals like 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 many bioactive compounds such as dietary fibre, phytosterols, polyphenols and phenolic 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 therefore seek to investigate the effect of by-passing the sieving process on the nutrient and sensory attributes of ogi prepared from these grains (maize, sorghum and millet).

2. MATERIALS AND METHOD

2.1. Preparation of Ogi Samples:

Maize grain was sorted, cleaned, and soaked in water for 72 hours at room temperature (30 ±20°C). Soaking water was decanted; 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 tray and oven dried for 24 hours at 50^0C

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 48 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 into a tray and dried for 24 hours in air oven set at 50^0C.

The sorghum was first cleaned by winnowing, sorted and washed. It was soaked for 3 days to allow fermentation to take place Ogiehor *et al.*, [15]. The soaked grain was then rinsed and wet milled to smooth paste. The paste was left unsieved and spread thinly and dried at 50^0C for 24 hours for each of the ogi preparation. The control sample was taking out and sieved using a muslin cloth, the filterate was bagged and allowed to drain for 12 hours to obtain the sieved ogi which was also dried at 50^0C.

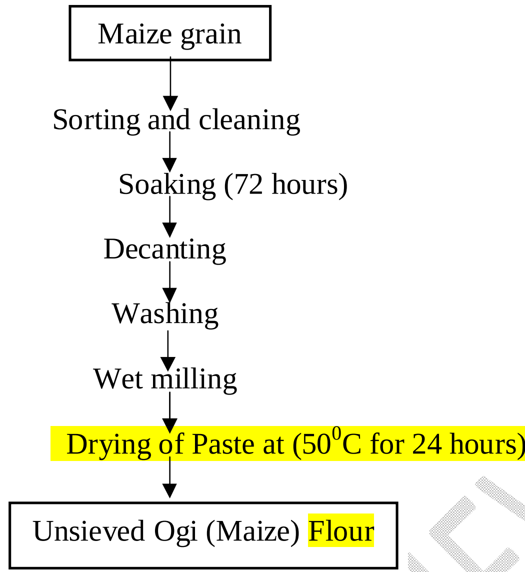

Fig. 1: Flow chart of Unsieved "Ogi" made from Maize

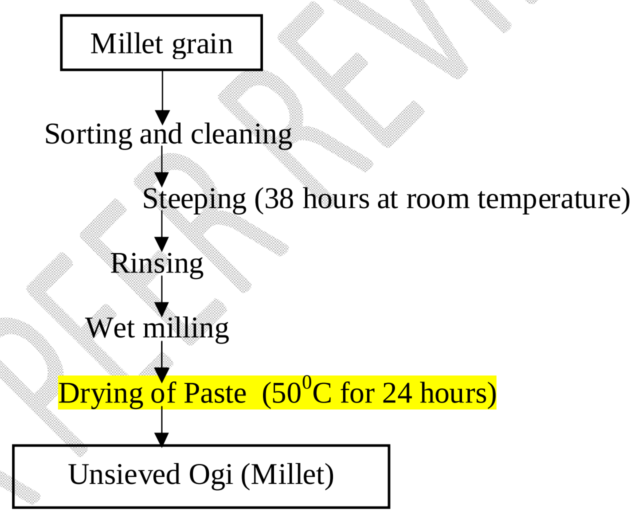

Figure 2: Flow chart of Unsieved "Ogi" made from Millet

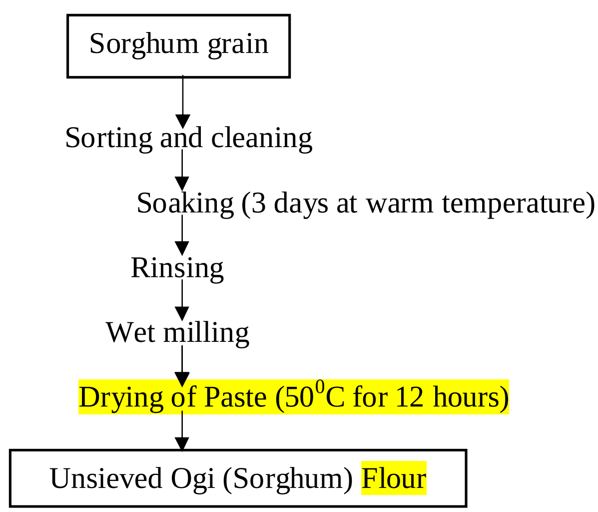

Figure 3: Flow chart of Unsieved "Ogi" made from Sorghun

2.2 Preparation of Ogi Flour

The 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 ± 2°C) for further analysis. The control ogi flour (sieved) were designated as samples A (maize), C (millet) and Sample E (sorghum) while the test samples (unsieved) were designated as B (maize), D (millet) and F (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 100^0C. 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). Differences 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

Table 1 shows the proximate composition of the ogi flour. 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*

3.2. Functional Properties

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/ml)	Water Absorption Capacity (g/g)	Swelling Power (g)	Solubility Index (%)	Least Gelatin Concentration (%)	Gelation Temperature (^{0}C)
A	$0.60^{a}\pm0.01$	$1.00^{a}\pm0.00$	$6.89^{a}\pm0.35$	$20.50^{ab}\pm2.40$	$2.00^{a}\pm0.00$	$70.65^{c}\pm0.07$
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*

3.3. Pasting Properties

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}±1.14	6.15^{a}±2.28	8.35^{a}±0.75	7.95^{ab}±1.19	7.20^{ab}±1.15	7.45^{ab}±0.80
B	6.30^{bc}±1.26	5.90^{a}±1.80	7.60^{a}±1.00	6.65^{bc}±1.27	6.30^{bc}±1.13	6.55^{b}±0.76
C	5.80^{c}±2.33	5.30^{a}±2.23	5.35^{b}±1.69	5.70^{cd}±1.72	5.15^{c}±1.84	5.46^{c}±1.63
D	5.05^{c}±1.82	5.10^{a}±1.80	4.00^{c}±1.75	4.75^{d}±1.94	5.00^{c}±1.45	4.78^{c}±1.28
E	7.90^{a}±0.97	6.70^{a}±2.36	8.00^{a}±1.30	8.10^{a}±0.97	7.75^{a}±1.07	7.69^{a}±0.96
F	5.25^{c}±1.74	4.80^{a}±1.94	6.25^{b}±1.45	5.40^{cd}±1.47	5.25^{c}±1.92	5.39^{c}±1.21

[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 than 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] reported a decrease in moisture content in maize bran-wheet composite flour with increase in bran content. Owuno and Achinewhu [26] also reported a decrease in moisture content of fermented maize residue-wheat composite flour. Flour becomes increasingly sensitive to fungus growth, taste modification, and enzymatic activity when the moisture level climbs over 14% [27].

The ash content results show sample C also was significantly different ($p < 0.05$) from other samples. The ash contents recorded for this study are relatively low, but it was observed that the samples with bran and hull had higher ash content when compared with samples without bran and hull. Elawad *et al*. [28] reported an increase in ash values of 0.8 - 2.3% for cereal/legume bran composite flour. The ash content of foods is indicative of the total minerals. This study thus show an increase in ash content in the unsieved ogi flour, thus suggesting a retention of minerals.

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] reported 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. This study also show an increase in protein content of the unsieved samples as values were higher when compared with the control for all the grains. Owuno *et al* (31) reported increase in protein content of Gari-maize residue blend.

The carbohydrate contents reported were high, with sample A significantly different from other samples. The samples with bran and hull had lower carbohydrate contents than the samples 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 could 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 was higher than the bulk density reported by Bhosale and Vijayalakshmi [33].

Water absorption capacity decreased in the unsieved samples except for maize. The presence of Bran and Hull thus decreased water absorption capacity. 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].

Unsieved ogi flour had lower swelling power than the control samples while values for solubility index increased in ogi flour and this show an increase in soluble nutrient 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 increased, the starch granules 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 samples in the gelation temperature reported. Except in sorghum, samples with bran and hull had lower gelation temperature than 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 samples. Also, 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. Peak viscosity is a parameter related to the capacity of starch to absorb water and swelling of the starch granules during heating [26], this decrease in peak viscosity can be attributed to a reduction in the ability of the starch to absorb water and this can be seen in the results for water absorption capacity reduced in the control for millet and sorghum.

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 blend 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,, and when the protein quantity increased. Protein's action on the starch might explain the decline in pasting characteristics (excluding pasting temperature) when protein content rises. 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 shows the texture, 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 ($p > 0.05$) in the samples assessed for sourness. Sample D was the least preferred sample. It was observed that samples without bran and hull were the most preferred in the sensory properties. The reason for this was not far-fetched; it was what the panelists were already used to, since *ogi* was normally prepared without the bran and hull.

5. CONCLUSION

The effect of bran and hull retention has shown to be effective in increasing the protein, fat, fibre, and total mineral (ash) content, another impact of the bran and hull retention could be seen in the reduced moisture content, which 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. A low bulk density which is a desirable property in preparation of weaning food formulations also decreased. This investigation thus show that nutrient retention in unsieved ogi flour was achieved through by-passing the sieving process, thus, the preparation of ogi flour without the sieving step should be encouraged as its nutrient content is enhanced and time and energy conserved and also leading to a reduction of waste as there are no resulting residues (Chaff) conventional to the sieved process.

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