Effect of Blending Millet Flour and Ginger Powder on Some Physicochemical Properties of Fermented Blends and Sensory Attributes of *Ibyer-Angen*

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Abstract
The effect of blending millet flour and ginger powder on some physicochemical properties of their fermented blends and sensory attributes of ibyer-angen was evaluated. The samples were formulated with respective addition of 0. 2.5, 5. 7.5 and 10 g of ginger powder to 100 g of millet flour to obtain MG_0, $MG_{2.5}$, MG_5, $MG_{7.5}$ and MG_{10}, and fermented for 48 h. The pH, proximate, pasting and sensory properties were carried out using standard methods. The results indicated that the average pH values decreased significantly ($p < 0.05$) from 5.60 – 3.86 after fermentation. The moisture, protein, fat, ash and fibre contents increased significantly ($p < 0.05$) from 8.18 – 13.23 %, 17.16 – 18.56 %, 4.31 – 4.96 % and 2.21 – 2.63 %, 0.93 – 1.29 %, respectively, while the carbohydrate decreased from 75.35 - 72.57 % and energy values ranged from 407.80 – 409.60 kcal/100 g sample. Peak viscosity, breakdown viscosity and holding strength decreased significantly ($p < 0.05$) from 1672.00 - 1469.00 cP; 223.50 - 121.00 cP and 1443 - 1350 cP, respectively, Setback and final viscosity ranged from 382.00 - 752.50 cP and 1813.00 – 2100.00 cP, respectively, with significant difference while pasting temperature and peak time ranged from 87.40 – 92.89 ^oC and 6.08 – 6.48 min., respectively and bulk density decreased from 0.75 - 0.69 g/cm^3. Appearance, aroma and mouth feel decreased from 8.13 - 7.67; 8.20 - 7.40 and 7.87 - 7.13, respectively, while taste and overall acceptability decreased significantly from 8.40 - 7.07 and 8.40 - 7.00, respectively. Blends with 2.5 – 5 % levels of ginger powder were most acceptable.

Key words: *pH, Bulk density, pasting properties, sensory attributes*

Introduction

Ibyer-angen is a semi-liquid fermented porridge commonly prepared by mixing fermented flours from maize, millet and sorghum with boiling water. It is a fermented, non-alcoholic beverage and commonly consumed by the Tiv people and also other tribes of the Middle Belt Region (MBR) of Nigeria (Adakole *et al*., 2021). It is consumed alone or together with *akpekpa* (steamed bean paste) as breakfast. The product derives its sour taste from natural and solid state fermentation prior to preparation of the final product. The utilisation of cereals in Nigeria for the production of *Kunu*, *burukutu*, *pito*, *kamu* (Tiv), *ndaleyi* and many other products has been reported by Ukwuru *et al*. (2018). Previous studies have attempted to produce instant *kunun-zaki* from sorghum-mango mesocarp blends and also fermented and non-fermented sorghum flours enriched with crayfish powder to produce porridge as complementary foods (Sengev *et al*., 2010; 2012; Sengev *et al*., 2016).

Fermentation is one of the oldest methods of food processing and preservation (Liptakova *et al*., 2017). Morales-de la Peña *et al*. (2023) and Nkhata *et al*. (2018) in their separate submissions stated that fermentation involves some biological activities such as the breakdown of food constituents using microorganisms and their enzymes leading to development of flavours, appearance (eye appeal) and modified texture in addition to the nutritional improvement of the products.

Spices play very important roles, including the sensory appeal of many food products and also provide anti-microbial, flavouring, colouring and preservative effects (Mokoshe *et al*., 2020). Spices such as *uda* and *uziza* have been used to spice *akamu* (Okwunodulu *et al*., 2023). Ginger, one of the spices, has been used extensively in many foods/beverages by several researchers (Olayiwola *et al*., 2017; Adakole *et al*., 2021; Mohammed, 2018; Olufunke *et al*., 2023). Adelekan *et al*. (2021) and Ejigbo *et al*. (2019) also evaluated some quality characteristics of maize *ogi* using ginger and turmeric, and ginger, garlic and cloves, respectively, at different levels. The aim of this study was to produce fermented flours from blends of millet flour and ginger powder and evaluate their physicochemical properties and sensory attributes of *Ibyer-angen* produced from the fermented blends.

Materials and Methods

Procurement of Raw Materials

About 3 kg of Pear Millet (*Pennisetum glaucum*) and 300 g of fresh ginger (*Zingiber officinate*) were purchased from Wurukum Market, Makurdi, Benue State and transported to the Department of Food Science and Technology, Joseph Sarwuan Tarka University, Makurdi, Benue State for processing.

Sample Preparation

Millet flour

The method described by Sengev *et al*. (2016) was adapted. In this method, millet grains were washed, spread (0.5 cm thick) on a tray and dried in a fan driven electric oven (Model: Genlab Widnes T12H, UK) at 70 ^oC for 6 h while stirring the grains with stainless table spoon at one hour interval. The dried millet grains were milled using a disc attrition mill (Asiko A11 Double grinding mill, Nigeria) and sieved through a mesh of 0.5 mm to obtain millet flour as shown in Figure 1.

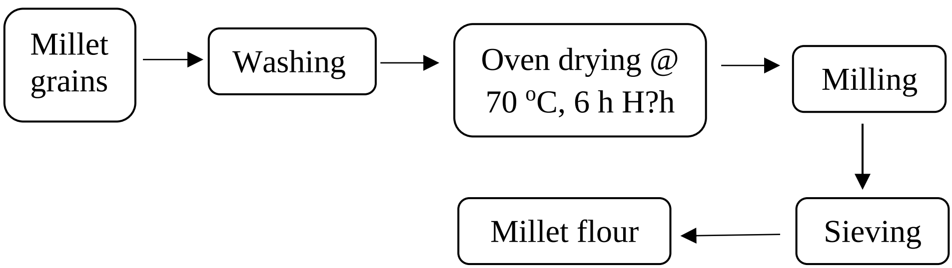

Figure 1: Production of Millet Flour
(Source: Sengev *et al*., 2016)

Ginger Powder

The method of Olufunke *et al*. (2023) was adapted. Fresh ginger rhizomes were peeled, washed with tap water and sliced (≈3.00 mm thick) with stainless knife and dried in a fan driven electric oven (Model: Genlab Widnes T12H, UK) at 70 °C for 12 h. The dried slices were milled using a disc attrition mill (Asiko A11 Double grinding mill, Nigeria) and sieved through a mesh of 0.6 mm to obtain ginger powder as shown in Figure 2.

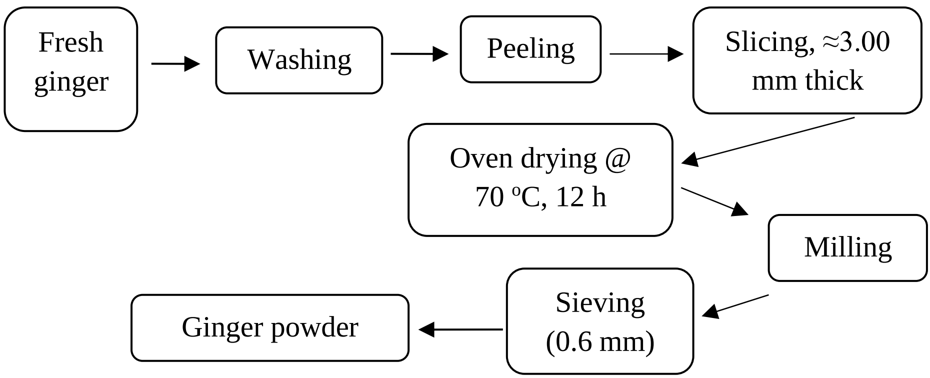

Figure 2: Production of Ginger Powder
(**Source:** Olufunke *et al*., 2023)

Fermentation of Blends of millet Flour and Ginger Powder

Ginger powder levels of 0, 2.5, 5, 7.5 and 10 g were respectively mixed with 100 g millet flour and made up to 500 g flour. The flour blends were mixed with tap water in the ratio of 2:1 w/v and subjected to natural fermentation at ambient temperature of 30 ± 2 °C in covered plastic bowls lebelled MG_0, $MG_{2.5}$, MG_5, $MG_{7.5}$ and MG_{10}, respectively, as presented in Table 1. The pH of the mixture was determined at 12 h interval for 48 h.

Table 1: Formulation (%) of Blends of Millet Flour and Ginger Powder

Product	Millet Flour	Ginger Powder
MG_0	100	0
$MG_{2.5}$	100	2.5
MG_5	100	5.0
$MG_{7.5}$	100	7.5
MG_{10}	100	10

Key:
MG_0 = 100 % millet + 0 % ginger, $MG_{2.5}$ = 100 % millet + 2.5 % ginger, MG_5 = 100 % millet + 5 % Ginger, $MG_{7.5}$ = 100 % millet + 7.5 % ginger, MG_{10} = 100 % millet + 10 % ginger

Analyses

Determination of pH

The pH of the samples was determined using the method described by Akpapunam and Safa-Dedeh (1995). In this method, 10 g of the sample was suspended in 100 mL distilled water in 100 mL beaker and the mixture was allowed to stand for 30 min. The pH of the supernatant was determined using pH meter (PHS-25, PEC Medical, USA).

Proximate composition

The proximate composition (moisture, protein, ash, fat and crude fibre) was determined using the methods of AOAC (2010). Carbohydrate was calculated by difference as reported by Sengev and Oguche (2017) and energy content was calculated using the Atwater factors as reported by Zou *et al*. (2007).

Pasting properties

The Pasting Properties of the samples were carried out using a Rapid Visco Analyser (RVA) (Model: RVA-4, Newport Scientific Pty. Ltd., Sydney, Australia) as described by Bolaji *et al*. (2017). The sample was prepared by adding 25 mL of distilled water to 3 g of fermented sorghum flour to make slurry in a RVA sample container. The RVA sample container was inserted into the RVA machine. The rate of viscosity of the sample was graphically displayed on the monitor in about 30 min. From the display, the peak, breakdown, final, setback and holding strength viscosities as well as pasting temperature and peak time were read from the amylograms.

Sensory evaluation

Fifty grams (50 g) of each sample was reconstituted with 70 mL of tap water and stirred thoroughly to avoid formation of lumps in the final products. Boiling water (250 mL) was added and heated for 5 min while stirring constantly to obtain cooked *ibyer-angen* as shown in Plate 1. On cooling, the product was sweetened with 20 g of sucrose and the products were coded and randomly presented to 15-member semi-trained panelists. The panelists were requested to evaluate the samples in a single session for appearance, aroma, taste, mouth feel and acceptability using a 9-point Hedonic scale as reported by Ihaotu and Igboh-Harlord (2023). During the session, Joseph Sarwuan Tarka University Water (JoSTUM Water) was provided for panelists to rinse their mouth after tasting each product.

MG_0 $MG_{2.5}$ $MG_{7.5}$ MG_5 MG_{10}

Sample MG_0 = 100 % millet + 0 % ginger, $MG_{2.5}$ = 100 % millet + 2.5 % ginger, MG_5 = 100 % millet + 5 % Ginger, $MG_{7.5}$ = 100 % millet + 7.5 % ginger, MG_{10} = 100 % millet + 10 % ginger

Plate 1: *Ibyer-angen* Produced from Blends of Millet Flour and Ginger Powder

Statistical analysis

Data were generated and subjected to analysis of variance (ANOVA). Means were tested for significance at 5 % level of probability ($p < 0.05$) as described by Wahua (1999).

RESULTS

Changes in pH of Fermented Blends of Millet Flour and Ginger Powder

The pH results of the fermentation of millet flour and ginger powder blends are presented in Figure 3. The results indicated that the pH for all the samples decreased from average values of 5.60 to 3.86 after fermentation for 48 h.

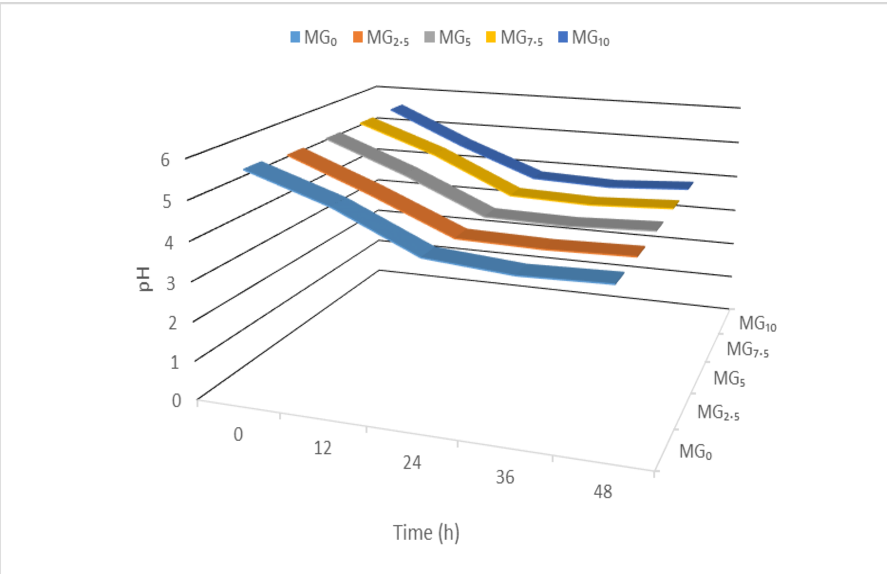

Figure 3: Changes in pH of fermented Blends of Millet flour and Ginger Powder

Sample MG_0 = 100 % millet + 0 % ginger,
$MG_{2.5}$ = 100 % millet + 2.5 % ginger,
MG_5 = 100 % millet + 5 % Ginger,
$MG_{7.5}$ = 100 % millet + 7.5 % ginger,
MG_{10} = 100 % millet + 10 % ginger

Proximate Composition of fermented Blends of Millet Flour and Ginger Powder

The proximate composition of the blends of fermented millet flour and ginger powder are presented in Table 2. The moisture, protein, crude fat and ash contents increased significantly ($p < 0.05$) from 8.18 – 13.23 %, 17.16 – 18.56 %, 4.36 – 4.96 % and 2.21 – 2.63 %, respectively, while crude fibre increased from 0.89 – 1.29 % with significant differences ($p < 0.05$) between samples. The carbohydrate decreased significantly ($p < 0.05$) from 75.35 - 72.57 % and energy values ranged from, 407.80 – 409.60 kcal/100g sample.

Pasting Properties and Bulk Density of Fermented Blends of Millet Flour and Ginger Powder

The results of pasting properties and bulk density of MG_0 (100 % millet + 0 % ginger), $MG_{2.5}$ (100 % millet + 2.5 % ginger), MG_5 (100 % millet + 5 % Ginger), $MG_{7.5}$ (100 % millet + 7.5 % ginger) and MG_{10} (100 % millet + 10 % ginger) are shown in Table 3. The peak viscosity (PV), breakdown viscosity (BV) and holding strength (HS) decreased significantly ($p < 0.05$) from 1672.00 - 1469.00 cP, 223.50 - 121.00 cP and 1443.00 - 1350 cP, respectively, with $MG_{2.5}$ maintaining the highest values for these properties. The setback viscosity (SV) increased significantly ($p < 0.05$) from 382.00 – 752.50 cP, with increase in ginger powder, while $MG_{2.5}$ recorded the least value and final viscosity (FV) increased from 1790.00 – 2100.00 cP, with MG_5 having the least value. The pasting temperature ranged from 87.40 – 92.89 ^oC and peak time ranged from 6.08 – 6.48 min. with significant differences. The bulk density of the blends decreased significantly ($p < 0.05$) from 0.75 – 0.69 g/cm^3 as ginger powder increased.

Table 2: Proximate composition (%) and Energy Values of Fermented Blends of Millet Flour and Ginger Powder

Sample	Moisture	Protein	Crude fat	Ash	Crude fibre	Carbohydrate	Energy (kcal/100 g)
MG_0	$8.18^e \pm 0.06$	$17.16^c \pm 0.06$	$4.36^{bc} \pm 0.10$	$2.21^c \pm 0.07$	$0.93^b \pm 0.08$	$75.35^{ab} \pm 0.16$	$408.30^{ab} \pm 0.54$
$MG_{2.5}$	$8.83^d \pm 0.13$	$17.32^c \pm 0.07$	$4.34^{bc} \pm 0.01$	$2.21^c \pm 0.03$	$0.89^c \pm 0.03$	$75.25^a \pm 0.06$	$409.30^{ab} \pm 0.05$
MG_5	$11.18^c \pm 0.09$	$18.09^b \pm 0.05$	$4.31^c \pm 0.14$	$2.39^b \pm 0.01$	$1.04^b \pm 0.04$	$74.16^b \pm 0.15$	$407.80^b \pm 0.84$
$MG_{7.5}$	$11.40^b \pm 0.06$	$18.71^a \pm 0.49$	$4.60^b \pm 0.14$	$2.30^{bc} \pm 0.09$	$1.05^b \pm 0.06$	$73.35^c \pm 0.37$	$409.60^a \pm 0.78$
MG_{10}	$13.23^a \pm 0.06$	$18.56^{ab} \pm 0.01$	$4.96^a \pm 0.02$	$2.63^a \pm 0.06$	$1.29^a \pm 0.02$	$72.57^d \pm 0.54$	$409.10^{ab} \pm 0.21$

Values are mean ± standard deviation of triplicate determinations.
Mean with different superscripts in the same column are significantly different ($p < 0.05$),
Sample MG_0 = 100 % millet + 0 % ginger, $MG_{2.5}$ = 100 % millet + 2.5 % ginger,
MG_5 = 100 % millet + 5 % Ginger, $MG_{7.5}$ = 100 % millet + 7.5 % ginger,
MG_{10} = 100 % millet + 10 % ginger

Table 3: Pasting Properties (cP) and Bulk Density (g/cm^3) of Fermented Blends of Millet Flour and Ginger Powder

Sample	Peak Viscosity	Breakdown Viscosity	Holding Strength	Setback Viscosity	Final Viscosity	Pasting Temperature (°C)	Peak Time (min)	Bulk Density
MG_0	$1592.00^b \pm 8.49$	$155.20^c \pm 0.28$	$1434.00^{ab} \pm 4.24$	$386.00^c \pm 8.44$	$1813.00^c \pm 2.83$	$91.31^b \pm 0.01$	$6.21^b \pm 0.01$	$0.75^a \pm 0.00$
$MG_{2.5}$	$1672.00^a \pm 3.54$	$223.50^a \pm 6.36$	$1443.00^a \pm 5.66$	$382.00^c \pm 5.66$	$1834.00^b \pm 1.41$	$91.86^b \pm 0.23$	$6.14^c \pm 0.01$	$0.73^b \pm 0.00$
MG_5	$1560.00^c \pm 2.12$	$169.00^b \pm 5.66$	$1381.00^c \pm 5.66$	$410.00^b \pm 1.14$	$1790.00^d \pm 5.66$	$91.38^b \pm 0.04$	$6.08^d \pm 0.01$	$0.72^c \pm 0.00$
$MG_{7.5}$	$1570.00^c \pm 5.66$	$159.00^{bc} \pm 5.66$	$1423.00^b \pm 5.65$	$419.00^b \pm 2.83$	$1832.00^b \pm 5.65$	$87.40^c \pm 0.76$	$6.21^b \pm 0.01$	$0.70^d \pm 0.00$
MG_{10}	$1469.00^d \pm 2.84$	$121.00^d \pm 0.71$	$1350.00^d \pm 0.71$	$752.50^a \pm 3.54$	$2100.00^a \pm 1.41$	$92.89^a \pm 0.01$	$6.48^a \pm 0.01$	$0.69^e \pm 0.00$

Values are mean ± standard deviation of triplicate determinations.
Mean with different superscripts in the same column are significantly different ($p < 0.05$),
Sample MG_0 = 100 % millet + 0 % ginger, $MG_{2.5}$ = 100 % millet + 2.5 % ginger,
MG_5 = 100 % millet + 5 % Ginger, $MG_{7.5}$ = 100 % millet + 7.5 % ginger,
MG_{10} = 100 % millet + 10 % ginger

Sensory Attributes of Fermented Blends of Millet Flour and Ginger Powder

The sensory attributes of fermented millet flour and ginger powder blends are presented in Table 4. The sensory scores for appearance (8.13 – 7.67), aroma (7.40 – 8.20), and mouth feel (7.87 – 7.13) decreased with no significant difference ($p \geq 0.05$) on ginger powder addition. The scores for taste decreased from 8.40 – 7.07 with the products containing ginger powder differing significantly ($p < 0.05$) from the MG_0. For overall acceptability, the scores decreased steadily from 8.40 – 7.00 with increase in ginger powder levels. However, the blends containing ginger powder were not significantly ($p \geq 0.05$) different but differ from the control (MG_0).

Table 4: Sensory Attributes of Fermented Blends of Millet Flour and Ginger Powder

Sample	Appearance	Aroma	Mouth feel	Taste	Overall Acceptability
MG_0	$8.13^a±0.83$	$8.20^a±0.41$	$7.87^a±0.74$	$8.40^a±0.74$	$8.40^a±0.63$
$MG_{2.5}$	$7.87^a±0.92$	$7.67^a±1.11$	$7.33^a±0.90$	$7.33^b±1.05$	$7.67^{ab}±0.90$
MG_5	$7.80^a±0.68$	$7.80^a±1.08$	$7.27^a±1.44$	$7.53^b±0.99$	$7.67^{ab}±1.98$
$MG_{7.5}$	$7.73^a±0.70$	$7.40^a±1.24$	$7.33^a±0.98$	$7.27^b±0.88$	$7.07^b±1.16$
MG_{10}	$7.67^a±0.82$	$7.47^a±0.74$	$7.13^a±0.74$	$7.07^b±0.88$	$7.00^b±1.20$

Values are means ± standard deviation of 15 panelists.
Mean with different superscripts in the same column are significantly different ($p < 0.05$), Sample MG_0 = 100 % millet + 0 % ginger,
$MG_{2.5}$ = 100 % millet + 2.5 % ginger, MG_5 = 100 % millet + 5 % Ginger,
$MG_{7.5}$ = 100 % millet + 7.5 % ginger, MG_{10} = 100 % millet + 10 % ginger

Discussion

pH of Fermented Blends Millet Flour and Ginger Powder

It was observed from Figure 3 that the relative stability of the fermentation process for 48 h started after 24 h. The decrease in pH may be ascribed to the production of acids by microorganisms during the fermentation process. This observation is in agreement with the findings of Kumari *et al*. (2015) and Oluwafemi *et al*. (2018) for cereal-based beverages. Mohammed (2018) also observed a slight decrease in pH during fermentation of *Kunun zaki* after 48 h. The authors further reported that lactic acid bacteria predominate fermentation of cereals products and produce acids that cause reduction in pH. The significant reduction in pH within 24 h of fermentation implies that the activities of lactic acid bacteria were not impaired by the antimicrobial properties of ginger. This is supported by the findings of Mayekar *et al*. (2021) who reported that the major active components (shogaol and gingerol) of ginger affect only *Salmonella typhi, Escherichia coli and Staphylococcus* species and not lactic acid bacteria.

Proximate Composition (% Dry matter) of Fermented Blends of Millet Flour and Ginger Powder

The moisture content of the samples increased progressively as the levels of ginger addition increased. This may be attributed to the increase in hydrophilic groups from ginger powder which retained more moisture on drying after fermentation. The values of moisture reported in this study are slightly higher than that reported by Adelekan *et al*. (2021) but lower compared to Ejigbo *et al*. (2019) who reported a moisture range of 13.65 – 14.39 % for maize *ogi* spiced with ginger, garlic and cloves. The low moisture content of the blends implies good shelf life. The high and increased protein content of the samples as the quantity of ginger powder increased may be attributed to the protein content of ginger powder. Al-Dhaheri *et al*. (2023) and Sangwan *et al*. (2014) in their separate findings reported that ginger powder contains 10.51 g/100 g, 5.63 g/100 g and 3.01 g/100 g, and 5.8 %, 3.5% and 5.4 %, respectively, for protein, ash and fibre. The fat content reported in this study were lower than 5.70 % reported by Fasasi (2009) for pearl millet flour. This may be due to utilization of fat by microorganisms as source of energy during fermentation (Nkhata *et al*., 2018). The carbohydrate and energy values reported compared favourably with the report of Fasasi (2009) but slightly lower than 69.91 % and 384.93 kcal/100g for carbohydrate and energy, respectively, as reported by Onuoha *et al*. (2017).

Pasting Properties and Bulk Density of Fermented Blends of Millet Flour and Ginger Powder

Pasting properties are functional properties of flour that indicates its ability to behave in a paste-like manner during cooking. The peak viscosity (PV) which indicates water absorption and the ease of cooking was higher in the sample with 2.5 % ginger powder and decreased with increasing levels of ginger powder. The decrease in PV with increase in ginger powder may be ascribed to the cross-linking of the active components (gingerol, hydroginger-dione and shogaol) of ginger with millet starch. This observation is supported by Xiao *et al*. (2012) who reported that cross-linking of starches inhibits the swelling of starches. The breakdown viscosity (BV) and holding strength (HS) also decreased as the level of ginger powder increased. Breakdown viscosity (BV) is an indication of paste stability during heating and lower values indicate the stability of the paste. The PV and BV values are lower when compared to values reported by Rao and Parimalavalli (2013) for cassava starch. This may be due to differences in the type of material used. Higher values of HS indicate the ability of the paste to maintain its gelatinised structural integrity when held at 95 ^{o}C for 2 min, 30 sec. The setback values of the samples containing ginger powder (GP) increased with increased levels of GP. High values of setback indicate the likelihood of retrogradation or syneresis. The higher final viscosity (FV) of the blends with ginger powder may be linked to the cross-linking of starch molecules caused by bifunctional entities in activated double bond and hydroxyl/methoxy phenyl residues contained in the active components of ginger (Rao and Parimalavalli, 2013) thereby resisting the loss of final viscosity as reported by Shah *et al*. (2016). Final viscosity (FV) is the viscosity of the products at the point of eating. It also indicates the ability of the products to form a firm, viscoelastic paste or gel after cooking and cooling due to re-association of starch molecules. Afoakwa *et al*. (2010) observed that viscosities measured at 50 ^{o}C are very significant with respect to the eating quality of most foods as they reflect the eating consistency of the products. The FV values obtained in this study are within the recommended range. Nout (1991) recommended FV in the range of 1000 – 3000 cP for complementary and related foods in the tropical climates. The pasting temperature and corresponding time indicate the point at which gelatinisation occurs. Pasting temperature implies the energy required in cooking the product. Therefore, higher pasting temperature implies higher energy requirement for cooking the products. The bulk density (BD) of the products decreased as the levels of GP increased. The range of values of BD reported in this study compared well with the findings of Adebiyi *et al*. (2016), Rathore and Singh (2018) reported 0.78 – 0.76 g/cm^3 and 0.61 – 0.56 g/cm^3 for fermented millet flour. The decrease in bulk density might be attributed to the increase in particle size (0.6 mm) of ginger powder. This is in agreement with findings of Raigar and Mishra (2015) who reported a reduction in bulk density Bengal gram flour from 0.78 – 0.53 g/cm^3 when the particle size changed from 150 – 212 µm.

Sensory Attributes of Fermented Blends of Millet Flour and Ginger Powder

The consumer perception of *ibyer-angen* from fermented millet flour and ginger powder blends was evaluated based on appearance, aroma, mouth feel, taste and general acceptability. The results showed that the likeness of the products decreased for all samples as the level of ginger addition increased. Samples MG_0 was liked very much for all the attributes evaluated while $MG_{2.5}$ and MG_5 also tended towards liked very much on the 9-point Hedonic scale. For appearance, all the sample were liked very much, however, $MG_{7.5}$

and MG_{10} were liked moderately in terms of aroma, mouth feel, taste and overall acceptability. The decline in likeness of the products as the levels of ginger powder increased may be attributed to the spicy nature of ginger. This is in conformity with the findings of Adakole *et al*. (2021) for millet *ibyer* enhanced with ginger powder. Other researchers (Adesokan *et al*., 2010; Eke-Ejiofor and Beleya (2017) also observed that addition of ginger and other spices such as *uda* and cloves, either singly or in combination caused a decline in the likeness of the products. Although, addition of ginger caused a decline in likeness of the products, it was not statistically significant in terms of appearance, aroma and mouth feel. For taste, MG_0 was significantly different from the samples containing ginger powder. Addition of ginger up to 5 % did not differ significantly from the control in terms of overall acceptability.

Conclusion

The study revealed that fermentation of millet flour and ginger powder blends decreased the pH significantly despite the reported antimicrobial nature of ginger, indicating successful fermentation. The moisture, protein, fat, ash and crude fibre increased significantly as the levels of ginger powder increased. Addition of ginger powder decreased the peak and breakdown viscosities, while the setback and the final viscosities increased. Ginger powder also tend to increase the pasting temperature. For sensory evaluation, the blends with ginger powder compared favourably with the control sample in terms of appearance, aroma and mouth feel while the taste of the blends containing ginger powder differed significantly from the control. In terms of overall acceptability, the products with 2.5 – 5 % levels of ginger powder were most acceptable and did not differ significantly from the control.

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