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Influence of biophysical attributes and locations on the consumer acceptability of backslopped fermented *gari*

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Abstract

The backslopped fermentation method was used to produce *gari* to reduce the variability in the sensory attributes and their composition. The relationship between the quality attributes of backslopped fermented *gari* (BFG) and the sensory and instrumental texture profile of the cooked dough (*eba*) has been reported. There is presently no information on the drivers of the consumer acceptability of the BFG based on locations. Hence, this study aimed to evaluate the influence of biophysical attributes and locations on the consumer acceptability of BFG. The BFG was produced using an established method with the traditional spontaneous fermentation used as a control in each location. The consumer acceptability of the *gari* samples was carried out using a well-structured questionnaire in each location, and the biophysical attributes were analyzed in the laboratory using standard methods. The principal component analysis results showed that the consumers prefer the BFG in the Tse-Hom community because of their starch and sugar contents, bulk density, and peak time. The consumer acceptability of the 24 hrs and 48 hrs BFG in the Amatta community and the 24 hrs BFG in the Ubomiri community was associated with the trough and final viscosities and sugar content of the product. Also, the *gari* consumers in the Obaagun community accepted the 48 hrs BFG due to the water absorption capacity, pasting temperature, and the peak time of the product. Therefore, the consumer acceptability of the BFG is attributed to its biophysical traits but differs between locations.

1. Introduction

Gari production and consumption vary from one location to another. The consumption of *gari* as a principal meal either in the dry form soaked in cold water or made into *eba* and eaten with preferred soups makes it the most popular diet amongst the rich and the poor, with acceptability cutting across the various socio-economic and multi-ethnic groups in Nigeria (Awoyale *et al.*, 2021a).

Traditionally, the cassava mash used for *gari* production is spontaneously fermented between 48 hrs and 96 hrs depending on its quality. Consequently, there is high variability in the sensory attributes of the *gari* and its composition. Additionally, the fermentation process takes a longer time in some communities where highly sour *gari* is preferred, reducing the quantity of *gari* produced within a specific period (Abass *et al.*, 2012). The backslopped method, where portions of the previously fermented cassava mash or its liquor are added to a freshly prepared cassava mash to act as an inoculum, allows for the gradual selection of lactic acid bacteria and accelerates fermentation (Awoyale *et al.*, 2021b).

Backslopping is a way to use a selected culture to shorten the fermentation process and produce a product of improved and consistent quality. This was necessary since the end product's quality and the fermentation time are dependent on the microbial load (Haakuria, 2005). To date, backslopping is still the preferred process to produce foodstuffs such as sauerkraut and sourdough (Harris, 1998). Backslopped fermentation has been used for cassava products such as *fufu* (Fayemi and Ojokoh, 2014), *lafun* (Adebayo-Oyetoro *et al.*, 2017), and stored cassava chips *gari* (Uvere and Nwogu, 2011). Awoyale *et al.* (2021a; 2021b) worked on comparing the qualities of *gari* produced using backslopped and spontaneous fermentation methods. The relationship between the quality attributes of backslopped fermented *gari* and the

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sensory and instrumental texture profile of the cooked dough (*eba*) was also reported by Awoyale *et al.* (2022). There is presently no information on the drivers of the consumer acceptability of the backslopped fermented *gari*.

Therefore, this study aimed to evaluate the consumer acceptability of backslopped fermented *gari* as influenced by locations and biophysical attributes.

2. Materials and methods

2.1 Materials

The TME 419 cassava variety used for the study was purchased from each of the locations: Benue, Imo, and Osun states.

2.1.1 Study locations

The study was carried out in Tyo-Mu (Lat 7º42'53"N: Long 8º40'7"E)-Makurdi, Abenga (Lat7º19'56"N: Long8º31'5"E)-Gwei-East and Tse-Hom (Lat7º13'17"N: Long8º30'51"E)-Konshisha LGAs of Benue state; Ubomiri (Lat5º33'23"N: Long7º1'3"E)-Mbaitoli, Amatta (Lat5º54'37"N: Long7º08'87"E)-Ikeduru and Egbelu Obibiezena (Lat5º25'0"N: Long7º4'45"E)-Owerri-North LGAs of Imo state, and Araromi-Ifon (Lat7º51'16"N: Long4º28'23"E)-Orolu, Ajaagba (Lat7º46'40"N: Long4º15'1"E)-Olaoluwa and Obaagun (Lat7º55'31"N: Long4º40'20"E)-Ifelodun LGAs of Osun state.

2.2 Gari production

The backslopped fermented *gari* (BFG) production method described by Awoyale *et al.* (2021a) was used. The optimum combinations of the fresh cassava mash (FCM) and the backslopped cassava mash (BCM) that produced *gari* that looks like the 24 hrs (88 g FCM: 20 g BCM), 48 hrs (90 g FCM: 20 g BCM), and the 72 hrs (87 g FCM: 20 g BCM), was used in Benue and Imo states. This is because these states do not like *gari* which is too sour. In the Osun state, the optimum combinations of the BCM and the FCM produced *gari* that looked like the 48 hrs, 72 hrs, and the 96 hrs (70 g FCM: 16 g BCM) were used. This is because people in Osun state, like *gari* that are sourer than Benue and Imo states. The traditionally made *gari* (TMG) in each community was used as a control (Table 1).

2.3 Functional properties of gari samples

2.3.1 Water absorption capacity

The water absorption method (WAC) of *gari* was determined as described by Oyeyinka *et al.* (2013) with a few modifications. *Gari* sample of 1 g was weighed into a clean pre-weighed dried centrifuge tube and mixed adequately with 10 mL distilled water by vortexing, after which the suspension could stand for 30 mins and centrifuged (Thelco GLC- 1, 60647: Chicago, USA) at 3,500 rpm for 30 min. The supernatant was decanted after centrifugation, with the tube and the sediment weighed. The weight of water (g) retained in the sample was reported as WAC.

2.3.2 Dispersibility

The method reported by Kulkarni *et al.* (1991) was used to determine dispersibility. About 10 g of the sample was dispersed in a measuring cylinder (100 mL), and distilled water was added up to the 50 mL mark. The mixture was stirred vigorously and allowed to settle for 3 hrs. The volume of settled particles was noted, and the percentage of dispersibility was calculated as:

$$Dispersibility\ (\%) = \frac{(50 - \text{volume of the settled particle})}{50} \times 100$$

2.3.3 Bulk density

Bulk density was determined using the standard methods described by Ashraf *et al.* (2012). *Gari* sample (10 g) was measured into a graduated measuring cylinder (50 mL) and lightly tapped on the workbench (10 times) to attain a constant height. The bulk density was then recorded and expressed as g/mL.

2.3.4 Pasting properties of gari samples

The pasting properties of the *gari* samples were measured using a Rapid Visco Analyser (Model RVA 4500, Perten Instrument, and Australia) equipped with a 1000 cmg sensitivity cartridge. *Gari* (3.5 g) was weighed into a dried empty canister, and 25 mL of distilled water was added. The mixture was thoroughly stirred, and the canister was fitted into the RVA as recommended. The slurry was heated from 50 to 95°C at a rate of 1.5°C/min, held at this temperature for 15 mins, and cooled to 50°C. Viscosity profile indices recorded from the pasting profile with the aid of Thermocline for Windows Software connected to a computer were peak, trough, breakdown, final, and setback viscosities, peak time, and pasting temperature (Falade and Olugbuyi, 2010).

2.4 Chemical composition of gari samples

2.4.1 pH value

The pH of the samples of *gari* was determined using the method of AOAC (2000). Ten grams of the sample were put into a 100 mL beaker, and 100 mL of distilled water was added to it. The pH was analyzed using a standardized pH meter (Mettler Toledo GmbH; 8606 Greifensee, Switzerland). Triplicate values were obtained, and the mean was taken as the pH value.

Table 1. Traditionally made *gari* in each community.

Location/Activities	Location 1	Location 2	Location 3
Benue state			
Communities	Tyo-mu	Abenga	Tse-hom
LGAs	Makurdi	Gwei-east	Konshisha
Gari production methods	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the cassava mash was left for 2 days in a bag to ferment. The mash was dewatered, pulverized, sieved, and partially roasted. The partially roasted mash was completely dried using sun-drying by spreading evenly on a broad black nylon sheet.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which it was left for 2 days in a bag to ferment. The mash was dewatered, pulverized, sieved, and thoroughly roasted on fire with the addition of a little palm oil.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the cassava mash was left for 2 days in a bag to ferment. The mash was dewatered, pulverized, sieved, and partially roasted. The partially roasted mash was completely dried using sun-drying by spreading it evenly on a broad black nylon sheet.
Imo state			
Communities	Ubomiri	Amatta	Egbelu Obibiezena
LGAs	Mbaitoli	Ikeduru	Owerri north
Gari production methods	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 2 days to ferment and a day for dewatering. The dewatered mash was pulverized, sieved, and thoroughly roasted on the fire.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 2 days to ferment and a day for dewatering. The dewatered mash was pulverized, sieved, and thoroughly roasted on the fire.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 2 days to ferment and a day for dewatering. The dewatered mash was pulverized, sieved, and thoroughly roasted on the fire.
Osun state			
Communities	Araromi-Ifon	Ajaagba	Obaagun
LGAs	Orolu	Olaoluwa	Ifelodun
Gari production methods	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 3 days to ferment and a day for dewatering. The dewatered mash was pulverized using a grating machine, sieved, and entirely roasted on the fire.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 3 days to ferment and a day for dewatering. The dewatered mash was pulverized, sieved, and entirely roasted on the fire, with minimal palm oil to prime the roasting pan.	All unit operations (peeling, washing, and grating) were carried out on the cassava roots, after which the mash was left for 3 days to ferment and a day for dewatering. The dewatered mash was pulverized, sieved, and entirely roasted on the fire.

2.4.2 Starch and sugar contents

Starch and sugar contents were determined by the method described by Onitilo *et al.* (2007). This involves weighing 0.02 g of the sample into a centrifuge tube with 1 mL ethanol, 2 mL distilled water, and 10 mL hot ethanol. The mixture was vortexed and centrifuged at 2000 rpm for 10 mins. The supernatant was decanted and used for determining sugar content while the sediment was hydrolyzed with perchloric acid and used to estimate starch content. Phenol and sulfuric acid reagents were used for color development, and glucose standards were used to estimate sugar. The absorbance was read with a spectrophotometer (Genesys 10S UV-VIS, China) at 490 nm.

$$\%Sugar = \frac{(A-1) \times D.F \times V \times 100}{B \times W \times 10^6}$$

$$\%Starch = \frac{(A-1) \times D.F \times V \times 100 \times 0.9}{B \times W \times 10^6}$$

Where A = Absorbance of the sample, I = Intercept of the sample, D.F = Dilution factor (depends on aliquot taken for assay), V = volume, B = Slope of the standard curve, and W = Weight of the sample

2.4.3 Cyanogenic potential content

Thirty grams of *gari* were milled and homogenized with 250 mL of 0.1 M orthophosphoric acid. The homogenate was centrifuged. The supernatant was taken as the extract; 0.1 mL of the enzyme was added to 0.6 mL of the extract. The 3.4 mL of the acetate buffer (pH 4.5) was added and stirred to mix. After which, 0.2 mL of 0.5% chloramines-T and 0.6 mL of color reagent were

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added and allowed to stand for 15 mins. for color development. The absorbance value was obtained at 605 nm against a blank similarly prepared to contain all reagents and 0.1 mL phosphate buffer added instead of KCN (Essers *et al.,* 1993).

The data from the standard were used to obtain a standard curve and its slope (b) by plotting absorbance values (Y-axis) against standard concentrations (X-axis). The unknown mean absorbance (A) and the weight of the sample (w) were used to calculate the residual cyanide, using the formula:

Residual cyanide = A × 250 × 0.4151b × w and the unit in mg HCN equivalent kg^{-1} sample.

2.5 Consumer acceptability of gari samples

2.5.1 Preparation of eba for consumer acceptability

Eba was prepared from the different BFG and the TMG by adding about 100 g of *gari* to 195 mL of hot boiling water and continuously stirred to form a smooth thick paste.

2.5.2 Consumer acceptability of gari/eba

The consumer acceptability was done using a well-structured questionnaire. The questionnaire contains some demographic information of the respondents, the consumption pattern of *gari*, and a 5-point hedonic scale rating, where 5 is like extremely, 4-like slightly, 3neither like/nor dislike, 2-dislike slightly 1-dislike extremely. About 50 participants were used in each community, making 150 participants per state. The uncooked *gari* was used for consumer acceptability in Benue state because, in the study area, most of the participants consumed *gari* in the uncooked form. For Imo and Osun states, the *gari* was prepared into *eba* for consumer acceptability. The authors of this study declare that the consumer acceptability of the BFG followed the tenets of the Declaration of Helsinki promulgated in 1964 and was approved by the institutional ethical review committee. In addition, verbal consent was obtained from the participants during the study.

2.6 Statistical analysis

A statistical package for social sciences (SPSS version 21) was used to analyze variance and separation of means of the data generated. The XLSTAT (Trial Version 2021) was used for the principal component analysis of the data.

3. Results and discussion

3.1 Functional properties of the backslopped fermented gari and traditionally made gari from different communities

The functional properties of foods affect how they behave during and after preparation for consumption (Adebowale *et al*., 2008; Adeleke and Odedeji, 2010). In the Benue state, the water absorption capacity (WAC) of the *gari* samples was higher in the Tyo-Mu community (573.29%) and lower in that of the Tse-Hom community (454.32%) (Table 2). In the Tse-Hom community, the WAC of the traditionally made *gari* (TMG) (468.11%) was higher and significantly different (< 0.05) from that of the 48 hrs (436.20%) and 72 hrs (443.96%) backslopped fermented *gari* (BFG), but not significantly different ($p > 0.05$) from the 24 hrs (469.03%) BFG. In the Tyo-Mu community, the WAC of the TMG (592.22%) was higher and significantly different ($p < 0.05$) from those of the 24 hrs (532.57%) and 72 hrs (576.31%) BFG, but not significantly different ($p > 0.05$) from that of the 48 hrs (592.08%) BFG. The WAC is an essential property for most starchy foods and is a function of smaller granule sizes and, thus, higher solubility (Tian *et al*., 1991). This implied that the *gari* samples from the Tyo-Mu community may be highly soluble in cold water due to their high WAC compared to the *gari* samples from the Tse-Hom community with lower WAC. In Imo State, the WAC of the *gari* samples was lower in the Ubomiri community (562.29%) and higher in the Amatta community (650.77%) (Table 2). In the Ubomiri community, the WAC of the TMG (597.16%) was higher but not significantly different ($p > 0.05$) from those of the 24 hrs (571.51%), 48 hrs (531.34%), and the 72 hrs (549.17%) BFG. In the Amatta community, the WAC of the TMG (650.77%) was higher and significantly different ($p < 0.05$) from those of all the BFG except for the WAC of the 72 hrs (626.82%) BFG, which was not significantly different ($p > 0.05$). The *gari* samples from the Amatta community may be highly soluble in cold water due to their high WAC compared to the *gari* samples from the Ubomiri community with lower WAC (Tian *et al*., 1991). In Osun State, the WAC of the *gari* samples ranged from 520.17 to 646.93%, with *gari*, produced from the Ajaagba community having the highest and that of the Araromi-Ifon community the lowest (Table 2). In the Araromi-Ifon community, the WAC of the TMG (542.43%) was significantly different ($p < 0.05$) from only that of the 96 hrs (444.,66%) BFG. In the Ajaagba community, the WAC of the TMG (635.11%) was not significantly different ($p > 0.05$) from those of the 48 hrs (627.07%), 72 hrs (667.07%), and the 96 hrs (613.47%) BFG. A similar WAC was reported for the BFG produced from different cassava varieties (Awoyale *et al*., 2022). The

Table 2. Functional properties of backslopped fermented gari and traditionally made gari from different communities.

State/communities	Sample	WAC (%)	Dispersibility (%)	Bulk density (%)
Benue State				
Tse-Hom	72 hrs BFG	443.96±1.82^{g}	35.50±0.71^{b-e}	67.50±0.11^{a}
	48 hrs BFG	436.20±0.64^{h}	34.00±0.00^{c-e}	60.00±0.00^{ab}
	24 hrs BFG	469.03±0.63^{f}	33.50±0.71^{de}	62.50±0.04^{ab}
	TMG	468.11±0.52^{f}	33.00±0.00^{e}	62.50±0.04^{ab}
	Mean	454.32	34.00	63.13
Abenga	72 hrs BFG	466.88±3.75^{f}	39.00±1.41^{b}	65.00±0.07^{ab}
	48 hrs BFG	446.23±3.48^{g}	43.50±0.71^{a}	72.50±0.11^{a}
	24 hrs BFG	491.74±0.34^{d}	38.00±0.00^{bc}	62.50±0.11^{ab}
	TMG	474.95±2.30^{e}	45.00±2.83^{a}	62.50±0.04^{ab}
	Mean	469.95	41.38	65.63
Tyo-Mu	72 hrs BFG	576.31±4.86^{b}	37.50±0.71^{b-d}	70.00±0.07^{a}
	48 hrs BFG	592.08±0.57^{a}	36.00±4.24^{b-e}	65.00±0.00^{ab}
	24 hrs BFG	532.57±2.43^{c}	37.50±2.12^{b-d}	50.00±0.00^{b}
	TMG	592.22±1.75^{a}	35.50±0.71^{b-e}	67.50±0.04^{a}
	Mean	573.29	36.63	63.13
Imo State				
Egbelu Obibiezena	72 hrs BFG	565.17±31.40^{b-d}	35.50±0.71^{ab}	102.50±0.11^{a}
	48 hrs BFG	558.67±36.74^{cd}	41.00±1.41^{a}	67.50±0.11^{b-e}
	24 hrs BFG	620.03±34.66^{a-c}	34.50±6.36^{ab}	55.00±0.07^{c-f}
	TMG	549.99±1.45^{d}	37.50±0.71^{ab}	105.00±0.14^{a}
	Mean	573.46	37.13	82.50
Ubomiri	72 hrs BFG	549.17±12.64^{d}	31.00±5.66^{b}	37.50±0.04^{f}
	48 hrs BFG	531.34±45.30^{de}	32.00±1.41^{b}	80.00±0.00^{a-d}
	24 hrs BFG	571.51±34.25^{b-d}	34.50±3.54^{ab}	67.50±0.32^{b-e}
	TMG	597.16±0.71^{a-d}	35.00±4.24^{ab}	40.00±0.00^{ef}
	Mean	562.29	33.13	56.25
Amatta	72 hrs BFG	626.82±15.78^{ab}	38.50±0.71^{ab}	90.00±0.00^{ab}
	48 hrs BFG	525.43±23.84^{b-d}	36.50±0.71^{ab}	47.50±0.11^{d-f}
	24 hrs BFG	476.69±12.71^{e}	35.00±0.00^{ab}	82.50±0.04^{a-c}
	TMG	650.77±12.11^{a}	36.00±2.83^{ab}	80.00±0.00^{a-d}
	Mean	569.93	36.50	75.00
Osun State				
Araromi-Ifon	96 hrs BFG	444.66±26.22^{c}	40.00±0.00^{bc}	67.50±0.04^{bc}
	72 hrs BFG	546.96±24.48^{b}	41.00±1.41^{b}	57.50±0.04^{c}
	48 hrs BFG	546.63±32.00^{b}	45.50±0.71^{a}	60.00±0.00^{c}
	TMG	542.43±17.33^{b}	47.00±2.83^{a}	60.00±0.00^{c}
	Mean	520.17	43.38	61.25
Obaagun	96 hrs BFG	544.03±21.81^{b}	39.50±2.12^{bc}	62.50±0.04^{bc}
	72 hrs BFG	604.62±87.05^{ab}	39.50±0.71^{bc}	70.00±0.00^{bc}
	48 hrs BFG	658.37±6.92^{a}	35.00±0.00^{d}	67.50±0.11^{bc}
	TMG	685.05±3.49^{a}	37.50±0.71^{cd}	60.00±0.00^{c}
	Mean	623.01	37.88	65.00
Ajaagba	96 hrs BFG	613.47±17.80^{ab}	35.50±0.71^{d}	75.00±0.07^{b}
	72 hrs BFG	667.07±31.80^{a}	36.00±0.00^{d}	87.50±0.04^{a}
	48 hrs BFG	627.07±7.74^{a}	37.50±0.71^{cd}	87.50±0.11^{a}
	TMG	635.11±43.62^{a}	35.00±0.00^{d}	75.00±0.00^{b}
	Mean	646.93	36.00	81.25
p states		***	***	***
p communities		***	*	***
p samples		***	NS	NS
p states × communities		***	***	***
p states × samples		***	NS	NS
p communities × samples		**	*	***
p states × communities × samples		***	**	***

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different (p<0.05). *p<0.05, **p<0.01, ***p<0.001, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari*.

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gari samples from the Ajaagba community may be highly soluble in cold water due to their high WAC compared to the *gari* samples from the Araromi-Ifon community with lower WAC (Tian *et al*., 1991). The values of the WAC reported in this study for the *gari* samples were higher than the 105% reported for *gari* by Owuamanam *et al*. (2010). However, the variations in the WAC of all the samples may be attributed to the age and type of cassava variety, harvesting period, the time and temperature of roasting, and the particle size of the *gari* (Owuamanam *et al*., 2010; Abass *et al*., 2012).

The dispersibility of starchy food is a measure of its reconstitutability in hot water (Kulkarni and Ingle, 1991). In Benue state, the dispersibility of the *gari* samples ranged between 34% and 41.38%, with samples from the Abenga community having the highest and that of the Tse-Hom community the lowest (Table 2). In the Tse-Hom community, the dispersibility of the TMG (33%) was not significantly different ($p > 0.05$) from that of the 24 hrs (33.50%), 48 hrs (34%), and 72 hrs (35.50%) BFG. In the Abenga community, the dispersibility of the TMG (45%) was higher and significantly different ($p < 0.05$) from those of the 24 hrs (38%) and 72 hrs (39%) BFG, but not significantly different ($p > 0.05$) from that of the 48 hrs (43.50%) BFG. So, *gari* produced from the Abenga community may reconstitute better in boiled water to *eba* without lumps formation because of its high dispersibility compared to the *gari* from the Tse-Hom community with low dispersibility (Kulkarni and Ingle, 1991). In the Imo state, the dispersibility of the *gari* samples was higher in the Egbelu Obibiezena community (37.13%) and lower in the Ubomiri community (33.13%) (Table 2). In Ubomiri, Egbelu Obibiezena, and Amatta communities of Imo state, the dispersibility of the TMG (35%, 37.50%, and 36% respectively) was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs, and 72 hrs BFG. This means that *gari* produced from the Egbelu Obibiezena community may reconstitute better in boiled water to *eba* without lumps formation because of its high dispersibility compared to the *gari* from the Ubomiri community with low dispersibility (Kulkarni *et al*., 1991). In the Osun state, the dispersibility of the *gari* samples was higher in the Araromi-Ifon community (43.38%) and lowered in the Ajaagba community (36%) (Table 2). In Obaagun (37.50%) and Ajaagba (35%) communities of Osun state, the dispersibility of the TMG was not significantly different ($p > 0.05$) from that of the 48 hrs, 72 hrs, and 96 hrs BFG, but in Araromi-Ifon community, the dispersibility of the TMG (47%) was significantly different ($p < 0.05$) from that of the 72 hrs (41%) and 96 hrs (40%) BFG. Kulkarni *et al*. (1991) reported that a positive correlation exists between the dispersibility of starchy foods and their reconstitution in hot water. This depicts that the BFG from the Araromi-Ifon community of Osun state might reconstitute aptly in hot water without lumps in *eba* preparation because of their high dispersibility compared with the BFG from the Ajaagba community with lower dispersibility. However, it is imperative to add that lump formation during the preparation of *eba* may be affected by how the *gari* sample was added to the boiled water during reconstitution (Awoyale *et al*., 2022).

The bulk density (BD) of the *gari* samples in Benue state ranged from 63.13 to 65.63%. *Gari* from the Abenga community had the highest BD, and *gari* from Tse-Hom and Tyo-Mu communities had the lowest (Table 2). The BD of the TMG (62.5%) in Abenga and Tse-Hom (62.50%) communities was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs, and 72 hrs BFG. The BD of the TMG (67.50%) of the Tyo-Mu community was significantly different ($p < 0.05$) from that of the 24 hrs (50%) BFG only. The BD of the *gari* samples in the Imo state ranged from 56.25% in the Ubomiri community to 82.50% in the Egbelu Obibiezena community (Table 2). The BD of the TMG (105%) in the Egbelu Obibiezena community was significantly different ($p < 0.05$) from that of the 24 hrs (55%) and 48 hrs (67.50%) BFG. In the Ubomiri community, the BD of the TMG (40%) was significantly different ($p < 0.05$) from that of the 48 hrs (80%) BFG. In the Osun state, the BD of the *gari* samples was higher in the Ajaagba community (81.25%) and lowered in the Araromi-Ifon community (61.25%) (Table 2). The BD of the TMG (75%) in the Ajaagba community was significantly different ($p < 0.05$) from that of the 48 hrs (87.50%) and 72 hrs (87.50%) BFG. No significant difference ($p > 0.05$) was observed between the BD of the TMG and the 96 hrs (75%) BFG in the Ajaagba community. There was no significant difference ($p > 0.05$) between the TMG (60%) and all the BFG in terms of the BD in the Araromi -Ifon community of Osun state. Ikujenlola (2008) reported that the lower the BD value, the higher the amount of the product that could be packaged in each container volume, and thus, the lower the packaging and transportation costs. The implies that a higher volume of the BFG from Tse-Hom and Tyo-Mu communities of Benue state, Ubomiri community of Imo state, and Araromi-Ifon community of Osun state may be packaged in a small container, thus, reducing the cost of packaging and transportation. In addition, the lower the BD the higher the floatation of the *gari* sample on top of the water, this is undesirable as the *gari* may not soak well in water and may therefore be rejected by consumers (Olanrewaju and Idowu, 2017). Hence, *gari* samples from the Tse-Hom and Tyo-Mu communities of Benue state, Ubomiri community of Imo state, and Araromi-Ifon community of Osun state may float on top of the water, which may lead to rejection by consumers because of their low BD. The range of BD of *gari* samples reported in this work was higher than that (54 – 61%) reported by Sanni *et al*. (2008) for *gari* samples produced in Lagos State. The variation in BD may be due to different cassava varieties and processing methods.

3.2 Pasting properties of the backslopped fermented gari and traditionally made gari from different communities

As the BFG may be reconstituted in hot water to *eba* before consumption, the pasting properties are fundamental in predicting their behavior during and after cooking (Awoyale *et al*., 2021a).

The peak viscosity is defined as the maximum viscosity developed during or soon after the heating process, which contributes to the excellent texture of the cooked starchy product (Shittu and Adedokun, 2010). In the Benue state, the peak viscosity of the *gari* samples was higher in the Tyo-Mu community (246.04 RVU) and lower in that of the Tse-Hom community (168.10 RVU) (Table 3). In the Tse-Hom community, the peak viscosity of the TMG (272.71 RVU) was significantly different (< 0.05) from that of the 24 hrs (110.88 RVU), 48 hrs (159.75 RVU), and 72 hrs (129.05RVU) BFG. Conversely, in the Tyo-Mu community, the peak viscosity of the TMG (248 RVU) was not significantly different ($p > 0.05$) from that of the 24 hrs (238.92 RVU), 48 hrs (237.96 RVU) and 72 hrs (259.29 RVU) BFG. In the Imo state, the peak viscosity of the *gari* samples was lower in the Ubomiri community (254.68 RVU) and higher in the Amatta community (334.08 RVU) (Table 3). In Ubomiri (238.59 RVU) and Amatta (362.50 RVU) communities, the peak viscosity of the TMG was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs, and the 72 hrs BFG. In the Osun state, the peak viscosity of the *gari* samples ranged from 425.71 – 499.53 RVU, with *gari* produced from the Obaagun community having the highest and that of the Araromi-Ifon community the lowest (Table 3). In Obaagun (499.55 RVU) and Araromi-Ifon (441.08 RVU) communities of Osun state, the peak viscosity of the TMG was significantly different ($p < 0.05$) from that of the 72 hrs and 96 hrs BFG. This shows that consumers who prefer the firm-textured *eba* may reconstitute the BFG from the Tyo-Mu community of Benue state, Amatta community of Imo state, and Obaagun community of Osun state in boiled water for the preparation of *eba* because of their high peak viscosity. Equally, the BFG from the Tse-Hom community of Benue state, Ubomiri community of Imo state, and Araromi-Ifon community of Osun state may be cooked in hot water and consumed by people who prefer the soft textured *eba* because of their low peak viscosity (Awoyale *et al*., 2021a). However, the quantity of hot water added to the BFG during the preparation of *eba* and the temperature and time spent for gelatinization may affect the texture of the starchy food. The peak viscosity of the *gari* samples in this study is higher compared to the result (133. 50 - 324.25 RVU) reported by Olanrewaju and Idowu (2017) for *gari* samples. The variations in peak viscosity of the *gari* samples may be attributed to varying degrees of garification as there are no specific or standard processing conditions of time and temperature (Olanrewaju and Idowu, 2017).

It was stated by Olatunde *et al.* (2017) that the ability of granules to remain undisrupted when the starch is subjected to a period of constant high temperature and mechanical shear stress is referred to as the trough viscosity. In the Benue state, the trough viscosity of the *gari* samples ranged between 147.22 RVU and 179.72 RVU, with samples from the Tse-Hom community having the lowest and the Tyo-Mu community having the highest (Table 3). In the Tse-Hom community, the trough viscosity of the TMG (228.55 RVU) was significantly different ($p < 0.05$) from that of the 24 hrs (92.34 RVU), 48 hrs (144.59 RVU), and 72 hrs (123.42 RVU) BFG. In the Tyo-Mu community, the trough viscosity of the TMG (191.13 RVU) was significantly different ($p < 0.05$) from those of the 24 hrs (167.83 RVU) and the 48 hrs (162.59 RVU) BFG. There was no significant difference ($p > 0.05$) in the trough viscosity between the TMG and the 72 hrs (197.34 RVU) BFG in the Tyo-Mu community of Benue state. In the Imo state, the trough viscosity of the *gari* samples was higher in the Amatta community (218.76 RVU) and lower in the Ubomiri community (209.90 RVU) (Table 3). The TMG was not significantly ($p > 0.05$) different from the 24 hrs, 48 hrs, and 72 hrs BFG in terms of the trough viscosity in Amatta (210.80 RVU) and Ubomiri (communities of Imo state. In the Osun state, the trough viscosity of the *gari* samples was higher in the Obaagun community (250.97 RVU) and lowered in the Araromi-Ifon community (215.54 RVU) (Table 3). In the Obaagun community of Osun state, the trough viscosity of the TMG was significantly different ($p < 0.05$) from only that of the 96 hrs BFG, but in the Araromi-Ifon community of Osun state, the trough viscosity of the TMG was significantly different ($p < 0.05$) from that of the 72 hrs BFG. Consequently, the BFG *eba* from the Tse-Hom community of Benue state, Ubomiri community of Imo state, and Araromi-Ifon community of Osun state may withstand mechanical shear stress, and the starch granules may not be disrupted because of their low trough viscosity (Olatunde *et al.*, 2017). The range of values reported for the trough viscosity of the *gari* produced from different particle sizes (70.92 -

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239.17RVU) agrees with that of the BFG from Imo and Osun states but differs from the trough viscosity of the *gari* from Osun state (Nwancho *et al*., 2014). The difference in trough viscosity may be attributed to the varietal effect and the processing method used in the preparation of the *gari* samples.

The breakdown viscosity of the *gari* samples in Benue state ranged from 20.87 – 66.32 RVU. *Gari* from the Tyo-Mu community had the highest breakdown viscosity, and *gari* from the Tse-Hom community had the lowest (Table 3). The breakdown viscosity of the TMG of Tyo-Mu and Tse-Hom communities of Benue state was not significantly different ($p > 0.05$) from those of the 24 hrs, 48 hrs, and 72 hrs BFG. The breakdown viscosity of the *gari* samples in the Imo state ranged from 44.78 RVU in the Ubomiri community to 115.32 RVU in the Amatta community (Table 3). The breakdown viscosity of the TMG in Ubomiri and Amatta communities of Imo state was not significantly different ($p > 0.05$) from those of the 24 hrs, 48 hrs, and 72 hrs BFG. In the Osun state, the breakdown viscosity of the *gari* samples was higher in the Obaagun community (248.56 RVU) and lowered in the Araromi-Ifon community (210.17 RVU) (Table 3). The breakdown viscosity of the TMG in the Obaagun community was significantly different ($p < 0.05$) from that of the 72 hrs BFG only. No significant difference ($p > 0.05$) was observed between the breakdown viscosity of the TMG and the 48 hrs and 96 hrs BFG in the Obaagun community of Osun state. There was a significant difference ($p < 0.05$) between the TMG and the 96 hrs BFG in terms of the breakdown viscosity in the Araromi-Ifon community of Osun state. Adebowale *et al.* (2008) observed that the higher the breakdown viscosity, the lower the ability of the starchy product to withstand heating and shear stress during cooking. This implies that the *eba* produced from the BFG of low breakdown viscosities may withstand mechanical shear stress with undisrupted starch granules. The breakdown viscosity of the BFG from the Osun state was very high compared to the breakdown viscosity of the *gari* (30.92 - 162.08 RVU) reported by Nwancho *et al*. (2014). This difference in the trend of the breakdown viscosity may be attributed to different processing methods.

The final viscosity indicates the ability of a starchy material to form a gel after cooking (Sanni *et al*., 2008). In the Benue state, the final viscosity of the *gari* samples ranged between 248.35 RVU and 293.61 RVU, with samples from the Tse-Hom community having the lowest and Tyo-Mu community having the highest (Table 3). In the Tse-Hom community, the final viscosity of the TMG was significantly different ($p < 0.05$) from that of all the BFG. In the Tyo-Mu community, the final viscosity of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs and the 48 hrs BFG. No significant difference ($p > 0.05$) in the final viscosity between the TMG and the 72 hrs BFG in the Tyo-Mu community. In the Imo state, the final viscosity of the *gari* samples was higher in the Amatta community (357.82 RVU) and lower in the Ubomiri community (337.50 RVU) (Table 3). The TMG was not significantly ($p > 0.05$) different from the 24 hrs, 48 hrs, and 72 hrs BFG in terms of the final viscosity in the Amatta and Egbelu Obibiezena communities of Imo state. However, in the Ubomiri community of Imo state, there was a significant difference ($p < 0.05$) in the final viscosity between the TMG and the 24 hrs BFG. In the Osun state, the final viscosity of the *gari* samples was higher in the Obaagun community (387.09 RVU) and lowered in the Araromi-Ifon community (331.63 RVU) (Table 3). In the Obaagun community, the final viscosity of the TMG was significantly different ($p < 0.05$) from only that of the 96 hrs BFG, but in the Araromi-Ifon community, the final viscosity of the TMG was not significantly different ($p > 0.05$) from the 48 hrs, 72 hrs and 96 hrs BFG. Also, the final viscosity of the TMG was significantly different ($p < 0.05$) from that of the 48 hrs and 72 hrs BFG in the Ajaagba community of Osun state. The higher the final viscosity of the BFG, the better the quality, as the gelatinization process may be faster when reconstituted in hot water to *eba* (Sanni *et al*., 2008). This depicts that the gelatinization process of the BFG from the Tyo-Mu community of Benue state, the Amatta community of Imo state, and the Obaagun community of Osun state may be faster when cooked into *eba* because of their high final viscosity. In addition, the final viscosity is useful in predicting and defining the final textural quality of starchy foods (Adebowale *et al*., 2008). This implied that the BFG from the Tyo-Mu community of Benue state, the Amatta community of Imo state, and the Obaagun community of Osun state may form sticky and mouldable *eba* which is preferable to most consumers. The mouldability of the dough which is influenced by the final viscosity is one of the factors that determine the consumer acceptability of *gari* (Arinola, 2016). The final viscosity of the BFG from Imo and Osun states was within the range of values reported for the final viscosity of the BFG produced from different cassava varieties (325 – 501 RVU) (Awoyale *et al.*, 2022) but higher compared to the final viscosity (244.25 RVU) of *gari* reported by Oluwamukomi and Jolayemi (2012). The variation in the final viscosity of the *gari* may be due to differences in cassava varieties and processing methods.

The setback viscosity is the stage where retrogradation or re-ordering of the starch molecules occurs (Adebowale *et al.*, 2008). The setback viscosity of the *gari* samples in Benue state ranged from 91.31 to

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Table 3. Pasting properties of backslopped fermented *gari* and traditionally made *gari* from different communities.

State/communities	Sample	Peak viscosity (RVU)	Trough viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Setback viscosity (RVU)	Peak time (min.)	Pasting Temp (^{o}C)
Benue State								
	72 hrs BFG	129.05 ± 4.07^{fg}	123.42 ± 6.36^{f}	5.63 ± 2.30^{e}	205.21 ± 4.54^{h}	81.79 ± 1.82^{de}	6.73 ± 0.28^{ab}	89.63 ± 1.17^{a}
	48 hrs BFG	159.75 ± 2.47^{ef}	144.59 ± 0.83^{ef}	15.17 ± 3.30^{de}	224.05 ± 1.24^{gh}	79.46 ± 0.41^{de}	$5.80\pm0.00^{c-e}$	66.00 ± 21.92^{bc}
Tse-Hom	24 hrs BFG	110.88 ± 20.68^{g}	92.34 ± 19^{g}	$18.54\pm1.36^{c-e}$	205.55 ± 23.16^{h}	$113.21\pm3.83^{a-c}$	6.87 ± 0.19^{a}	57.00 ± 9.33^{c}
	TMG	272.71 ± 15.61^{a}	228.55 ± 26.69^{a}	$44.17\pm11.08^{a-e}$	358.59 ± 7.19^{a}	130.04 ± 33.88^{ab}	6.23 ± 0.23^{bc}	90.43 ± 0.04^{a}
	Mean	168.1	147.22	20.87	248.35	101.13	6.41	75.76
	72 hrs BFG	$200.88\pm3.01^{c-e}$	$146.59\pm5.42^{d-f}$	$54.29\pm8.43^{a-d}$	252.13 ± 6.43^{ef}	$105.55\pm11.84^{a-d}$	$5.23\pm0.14^{e-g}$	83.58 ± 0.67^{ab}
	48 hrs BFG	$210.79\pm27.63^{b-d}$	$169.88\pm2.54^{c-e}$	$40.92\pm25.10^{a-e}$	266.42 ± 3.54^{de}	96.54 ± 1.00^{cd}	$5.44\pm0.23^{d-f}$	83.55 ± 4.10^{ab}
Abenga	24 hrs BFG	193.29 ± 32.47^{de}	152.59 ± 10.84^{de}	$40.71\pm43.31^{a-e}$	251.34 ± 5.54^{ef}	98.75 ± 16.38^{cd}	5.87 ± 0.76^{cd}	85.15 ± 5.16^{a}
	TMG	$198.09\pm1.29^{c-e}$	$173.21\pm7.60^{b-d}$	$24.88\pm6.30^{b-e}$	237.63 ± 22.69^{fg}	64.42 ± 15.08^{e}	6.07 ± 0.09^{c}	93.70 ± 0.00^{a}
	Mean	200.76	160.56	40.2	251.88	91.31	5.65	86.49
	72 hrs BFG	259.29 ± 33.64^{a}	197.34 ± 15.68^{b}	61.96 ± 17.97^{ab}	331.00 ± 15.91^{b}	133.67 ± 0.23^{a}	4.70 ± 0.04^{g}	58.18 ± 11.14^{c}
	48 hrs BFG	$237.96\pm11.37^{a-c}$	162.59 ± 1.65^{de}	75.38 ± 13.02^{a}	282.75 ± 1.65^{cd}	$120.17\pm3.30^{a-c}$	4.84 ± 0.05^{fg}	78.25 ± 0.07^{ab}
Tyo-Mu	24 hrs BFG	$238.92\pm0.00^{a-c}$	$167.83\pm0.00^{c-e}$	71.08 ± 0.00^{a}	267.33 ± 0.00^{de}	99.50 ± 0.00^{cd}	4.73 ± 0.00^{g}	76.70 ± 0.00^{ab}
	TMG	248.00 ± 11.07^{ab}	191.13 ± 0.77^{ab}	$56.88\pm11.84^{a-c}$	293.38 ± 0.18^{c}	$102.25\pm0.59^{b-d}$	$5.70\pm0.04^{c-e}$	86.08 ± 0.60^{a}
	Mean	246.04	179.72	66.32	293.61	113.9	4.99	74.8
Imo State								
	72 hrs BFG	235.92 ± 23.10^{bc}	186.92 ± 18.15^{ab}	49.00 ± 4.95^{b}	313.46 ± 1.36^{ab}	126.55 ± 16.80^{ab}	5.67 ± 0.00^{bc}	89.63 ± 4.63^{a}
	48 hrs BFG	$321.50\pm8.95^{a-c}$	213.67 ± 1.18^{ab}	107.83 ± 7.78^{ab}	340.84 ± 2.35^{ab}	127.17 ± 1.18^{ab}	5.20 ± 0.10^{cd}	72.13 ± 12.13^{a}
Egbelu Obibiezena	24 hrs BFG	$314.59\pm38.66^{a-c}$	206.58 ± 18.38^{ab}	108.00 ± 20.27^{ab}	333.21 ± 22.33^{ab}	126.63 ± 3.95^{ab}	$5.37\pm0.14^{b-d}$	80.03 ± 1.03^{a}
	TMG	381.04 ± 8.78^{a}	236.79 ± 13.85^{a}	144.25 ± 5.06^{a}	382.05 ± 6.54^{a}	145.25 ± 20.39^{a}	5.20 ± 0.10^{cd}	79.13 ± 0.03^{a}
	Mean	313.26	210.99	102.27	342.39	131.4	5.36	80.23
	72 hrs BFG	$238.46\pm19.98^{a-c}$	209.75 ± 10.37^{ab}	28.71 ± 9.60^{b}	369.33 ± 11.67^{ab}	159.59 ± 1.29^{a}	6.03 ± 0.14^{ab}	91.60 ± 1.63^{a}
	48 hrs BFG	191.09 ± 23.21^{c}	170.17 ± 11.67^{b}	20.92 ± 11.55^{b}	300.67 ± 38.42^{b}	130.50 ± 26.76^{ab}	6.40 ± 0.75^{a}	80.65 ± 17.11^{a}
Ubomiri	24 hrs BFG	350.59 ± 128.46^{ab}	249.67 ± 41.49^{a}	100.92 ± 86.97^{ab}	381.84 ± 27.81^{a}	132.17 ± 13.67^{a}	5.17 ± 0.42^{cd}	64.75 ± 15.77^{a}
	TMG	$238.59\pm66.23^{a-c}$	210.00 ± 49.14^{ab}	28.59 ± 17.09^{b}	298.17 ± 32.05^{b}	88.17 ± 17.09^{b}	6.43 ± 0.14^{a}	71.55 ± 26.66^{a}
	Mean	254.68	209.9	44.78	337.5	127.6	6.01	77.14

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). *$p<0.05$, **$p<0.01$, ***$p<0.001$, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari.*

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Table 3 (Cont.). Pasting properties of backslopped fermented *gari* and traditionally made *gari* from different communities.

State/communities	Sample	Peak viscosity (RVU)	Trough viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Setback viscosity (RVU)	Peak time (min.)	Pasting Temp (°C)
Imo State								
	72 hrs	264.34±9.31^{a-c}	192.34±5.18^{ab}	72.00±4.13^{ab}	346.59±2.24^{ab}	154.25±7.42^{a}	5.24±0.05^{cd}	85.53±0.04^{a}
	48 hrs BFG	377.29±2.18^{a-c}	235.67±2.24^{ab}	141.63±0.06^{ab}	373.00±5.30^{ab}	137.34±3.06^{ab}	4.94±0.09^{d}	75.95±0.00^{a}
Amatta	24 hrs BFG	332.21±74.54^{a-c}	236.25±8.24^{a}	95.96±66.29^{ab}	362.34±37.36^{ab}	126.09±29.11^{ab}	5.24±0.52^{cd}	65.73±14.39^{a}
	TMG	362.50±34.54^{ab}	210.80±20.68^{ab}	151.71±13.85^{a}	349.38±14.79^{ab}	138.59±5.89^{a}	5.07±0.09^{cd}	75.88±0.04^{a}
	Mean	334.08	218.76	115.32	357.82	139.06	5.12	75.77
Osun State								
	96 hrs BFG	532.25±27.58^{ab}	250.46±12.55^{a-d}	281.80±15.03^{a}	357.75±15.09^{bc}	107.29±2.53^{bc}	4.04±0.05^{d}	73.53±0.04^{fg}
	72 hrs BFG	334.63±2.76^{d}	175.30±15.73^{f}	159.34±12.96^{e}	302.59±11.43^{de}	127.29±4.30^{ab}	4.50±0.04^{b}	74.68±0.60^{ef}
Araromi-Ifon	48 hrs BFG	394.88±20.92^{cd}	198.55±13.97^{ef}	196.34±6.95^{c-e}	326.29±2.53^{c-e}	127.75±11.43^{ab}	4.33±0.00^{bc}	74.28±0.04^{e-g}
	TMG	441.08±45.61^{c}	237.88±29.88^{b-e}	203.21±15.73^{b-e}	339.88±13.50^{cd}	102.00±16.38^{bc}	4.94±0.09^{a}	75.88±0.04^{cd}
	Mean	425.71	215.54	210.17	331.63	116.08	4.45	74.59
	96 hrs BFG	535.84±43.25^{ab}	282.09±17.91^{a}	253.75±25.34^{ab}	435.25±15.09^{a}	153.17±2.83^{a}	4.30±0.14^{c}	75.80±0.07^{cd}
	72 hrs BFG	545.13±71.71^{a}	256.38±15.73^{a-c}	288.75±25.34^{a}	390.05±10.08^{b}	133.67±5.66^{ab}	4.27±0.09^{c}	76.65±0.07^{bc}
Obaagun	48 hrs BFG	470.63±38.12^{a-c}	228.55±23.51^{c-e}	242.09±14.62^{a-d}	359.58± 16.97^{bc}	131.05±6.54^{ab}	4.50±0.04^{b}	77.03±0.67^{b}
	TMG	446.55±16.79^{c}	236.88±4.42^{b-e}	209.67±12.37^{b-e}	363.50±11.07^{bc}	126.63±6.65^{ab}	4.77±0.05^{a}	78.25±0.07^{a}
	Mean	499.53	250.97	248.56	387.09	136.13	4.18	76.93
	96 hrs BFG	545.75±24.86^{a}	259.75±10.72^{a-c}	286.00±14.14^{a}	364.25±8.84^{bc}	104.50±1.88^{bc}	3.97±0.05^{d}	73.48±0.04^{g}
	72 hrs BFG	457.04±19.86^{bc}	209.25±1.65^{ef}	247.80±18.21^{a-c}	294.00±43.49^{e}	84.75±41.83^{c}	4.00±0.10^{d}	73.85±0.57^{fg}
Ajaagba	48 hrs BFG	454.59±26.75^{bc}	213.05±18.92^{d-f}	241.54±7.83^{a-d}	337.21±3.13^{cd}	124.17±15.79^{ab}	3.97±0.05^{d}	73.80±0.64^{fg}
	TMG	466.17±25.58^{a-c}	275.30±11.14^{ab}	190.88±14.43^{de}	382.96±6.77^{b}	107.67±4.36^{bc}	4.80±0.10^{a}	75.05±1.13^{de}
	Mean	480.89	239.34	241.55	344.61	105.27	4.36	74.04
p states		***	***	***	***	***	***	NS
p communities		***	***	***	***	NS	***	NS
p samples		***	***	**	***	NS	***	*
p states × communities		***	*	***	***	***	***	NS
p states × samples		**	**	**	***	NS	*	**
p communities × samples		***	***	**	***	**	***	NS
p states × communities × samples		*	**	*	***	**	**	NS

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). *$p<0.05$, **$p<0.01$, ***$p<0.001$, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari*.

113.90 RVU, with samples from the Abenga community having the lowest and Tyo-Mu community the highest (Table 3). In the Abenga community, the setback viscosity of the TMG was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs and 72 hrs BFG. In the Tyo-Mu community, the setback viscosity of the TMG was significantly different ($p < 0.05$) from that of the 72 hrs BFG. However, there was no significant difference ($p > 0.05$) in the setback viscosity of the TMG and that of the 24 hrs and 48 hrs BFG in the Tyo-Mu community of Benue state. In the Imo state, the setback viscosity of the *gari* samples was lower in the Ubomiri community (127.60 RVU) and higher in the Amatta community (139.06 RVU) (Table 3). The setback viscosity of the TMG was not significantly ($p > 0.05$) different from that of the 24 hrs, 48 hrs and 72 hrs BFG in the Amatta community. However, the setback viscosity of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs and 72 hrs BFG in the Ubomiri community of Imo state. In the Osun state, the setback viscosity of the *gari* samples was higher in the Obaagun community (136.13 RVU) and lowered in the Ajaagba community (105.27 RVU) (Table 3). In the Obaagun and Ajaagba communities of Osun state, the setback viscosity of the TMG was not significantly different ($p > 0.05$) from that of the 48 hrs, 72 hrs and 96 hrs BFG. Adebowale *et al.* (2008) stated that the low setback viscosity during the cooling of the starchy paste indicates more excellent resistance to syneresis. This indicates that the BFG from Abenga community of Benue state, Ubomiri community of Imo state, and Ajaagba community of Osun state may not weep easily when prepared to *eba* because of their low setback viscosities. Also, the setback viscosity implies digestibility; a low setback value indicates low retrogradation tendency and consequently improved dough digestibility (Arinola, 2016). This is because retrogradation is known to increase the resistance of starchy foods to enzymatic hydrolysis. Consequently, BFG from the Abenga community of Benue state, Ubomiri community of Imo state, and Ajaagba community of Osun state may be digested and assimilated by the human body easily due to their low setback viscosity. The range of values (111 – 191 RVU) reported for the setback viscosity of the BFG from different cassava varieties (Awoyale *et al.*, 2022) agrees with that of the BFG from the Imo and Osun states.

The pasting temperature is the measure of the smallest temperature expected to cook a given food sample, which has implications for other components' stability and also indicates energy costs (Sanni *et al.*, 2008). *Gari* samples from the Abenga community of Benue state had the highest pasting temperature (86.49°C) and the Tyo-Mu community had the lowest pasting temperature (74.80°C) (Table 3). There was no significant difference ($p > 0.05$) in the pasting temperature of the TMG and that of the 24 hrs, 48 hrs, and 72 hrs BFG in the Abenga community of Benue state. Nevertheless, in the Tyo-Mu community, it was only the 72 hrs BFG that was significantly different ($p < 0.05$) from the TMG in terms of the pasting temperature. In the Imo state, the pasting temperature of the *gari* samples ranged from 75.77 to 80.23, with the samples from the Amatta community having the lowest and that of the Egbelu Obibiezena community the highest (Table 3). There was no significant difference ($p > 0.05$) in the pasting temperatures of the TMG and that of all the BFG samples in all the communities of Imo state. *Gari* samples from the Obaagun community of Osun state had the highest pasting temperature (76.93°C), and that of the Ajaagba community had the lowest (74.04°C) (Table 3). The pasting temperature of the TMG in Obaagun and Ajaagba communities of Osun state was significantly different ($p < 0.05$) from that of the 48 hrs, 72 hrs and 96 hrs BFG. So, all the BFG from Benue, Imo, and Osun states may be reconstituted in hot water to *eba* below the boiling point of water and in less than 7 min, reducing energy costs (Adebowale *et al*., 2008). The average pasting temperature reported in this study was below the range of values (88.75 – 94.50°C) reported for *gari* samples by Arinola (2016) but agrees with the values (80.85°C) reported by Oluwamukomi and Jolayemi (2012).

3.3 Chemical composition of the backslopped fermented gari and traditionally made gari from different communities

The pH value of the *gari* samples in the Benue state ranged from 4.63 to 4.95; *gari* from the Abenga community had the highest pH value and that of the Tse-Hom community had the lowest (Table 4). The pH value of the TMG was significantly different ($p < 0.05$) from the 24 hrs, the 48 hrs, and the 72 hrs BFG in Tse-Hom and Abenga communities. The pH value of the TMGs in all the locations in Benue state was lower and significantly different ($p < 0.05$) from that of the 24 hrs, 48 hrs and 72 hrs BFG. The pH value of the *gari* samples in the Imo state was higher in the Ubomiri community (5.25) and lower in the Amatta community (5.05) (Table 4). The TMG pH value was significantly different ($p < 0.05$) from that of the 24 hrs BFG but not significantly different ($p > 0.05$) from that of the 48 hrs and 72 hrs BFG in the Amatta community of Imo state. Conversely, the pH value of the TMG was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs, and 72 hrs BFG in the Ubomiri community of Imo state. The pH value of the TMG in all the communities (excluding Amatta 24 hrs BFG) was not significantly different (p <

Table 4. Chemical composition of backslopped fermented *gari* and traditionally made *gari* from different communities.

State/communities	Sample	pH-value	Sugar content (%)	Starch content (%)	CNP (mg HCN/kg)
Benue State					
	72 hrs BFG	4.90±0.01^{e}	2.65±0.02^{de}	81.94±0.58^{a}	2.10±0.04^{b}
	48 hrs BFG	4.80±0.01^{g}	3.02±0.07^{c}	82.16±0.57^{a}	2.90±0.01^{ab}
Tse-Hom	24 hrs BFG	4.83±0.01^{f}	3.26±0.01^{a}	79.01±0.55^{ef}	3.10±0.01^{ab}
	TMG	3.99±0.01^{j}	3.10±0.02^{bc}	79.36±0.13^{d-f}	2.60±0.04^{ab}
	Mean	4.63	3.01	80.62	2.68
	72 hrs BFG	5.12±0.01^{b}	2.49±0.01^{f}	80.38±0.16^{b-e}	3.25±0.01^{ab}
	48 hrs BFG	5.23±0.01^{a}	2.74±0.06^{d}	81.34±1.44^{a-c}	2.90±0.13^{ab}
Abenga	24 hrs BFG	5.00±0.03^{c}	3.00±0.10^{c}	81.55±0.29^{ab}	3.15±0.04^{ab}
	TMG	4.46±0.00^{h}	2.69±0.04^{d}	79.75±0.72^{d-f}	3.05±0.04^{ab}
	Mean	4.95	2.73	80.75	3.09
	72 hrs BFG	4.95±0.01^{d}	3.16±0.11^{ab}	81.63±0.14^{ab}	2.10±0.01^{b}
	48 hrs BFG	5.02±0.01^{c}	2.34±0.04^{g}	78.68±0.72^{f}	3.70±0.01^{a}
Tyo-Mu	24 hrs BFG	5.12±0.02^{b}	2.54±0.07^{ef}	79.95±0.45^{c-f}	2.20±0.11^{b}
	TMG	4.12±0.01^{i}	2.79±0.06^{d}	80.77±0.15^{a-d}	1.95±0.04^{b}
	Mean	4.8	2.71	80.26	2.49
Imo State					
	72 hrs BFG	5.74±0.37^{a}	2.14±0.08^{de}	80.94±0.85^{b-d}	1.60±0.01^{f}
	48 hrs BFG	4.50±0.00^{ab}	2.47±0.04^{a-c}	80.55±0.29^{b-d}	3.10±0.07^{c-f}
Egbelu Obibiezena	24 hrs BFG	5.00±0.28^{ab}	2.37±0.04^{a-d}	79.65±0.57^{d}	2.35±0.02^{ef}
	TMG	5.00±0.28^{ab}	2.55±0.08^{a-c}	80.15±0.73^{cd}	1.95±0.01^{f}
	Mean	5.13	2.38	80.32	2.25
	72 hrs BFG	5.20±0.56^{a}	2.10±0.09^{e}	82.88±0.16^{a}	2.60±0.03^{d-f}
	48 hrs BFG	5.80±0.85^{a}	2.50±0.06^{a-c}	80.04±0.58^{d}	4.35±0.05^{b-d}
Ubomiri	24 hrs BFG	5.00±0.85^{ab}	2.32±0.04^{b-e}	81.74±0.01^{ab}	4.05±0.08^{b-e}
	TMG	5.00±0.28^{ab}	2.08±0.10^{e}	81.60±0.29^{a-c}	8.55±0.02^{a}
	Mean	5.25	2.25	81.56	4.89
	72 hrs BFG	5.60±0.57^{a}	2.17±0.07^{de}	80.36±0.73^{b-d}	4.45±0.16^{bc}
	48 hrs BFG	5.20±0.00^{ab}	2.83±0.06^{ab}	80.73±0.58^{cd}	4.30±0.07^{b-d}
Amatta	24 hrs BFG	4.00±0.00^{b}	2.59±0.08^{a}	80.47±0.27^{b-d}	7.55±0.01^{a}
	TMG	5.40±0.28^{a}	2.30±0.01^{c-e}	81.04±0.40^{b-d}	5.05±0.13^{b}
	Mean	5.05	2.47	80.65	5.34
Osun State					
	96 hrs BFG	5.34±0.04^{a}	3.85±0.06^{c}	82.88±0.15^{ab}	0.40±0.01^{c}
	72 hrs BFG	5.30±0.01^{a}	3.47±0.13^{e}	83.41±0.58^{a}	3.30±0.08^{a}
Araromi-Ifon	48 hrs BFG	5.25±0.01^{b}	4.02±0.05^{b}	80.88±0.58^{c}	0.50±0.01^{bc}
	TMG	4.30±0.00^{e}	2.61±0.02^{g}	80.69±0.01^{c}	3.85±0.05^{a}
	Mean	5.54	3.48	81.96	2.01
	96 hrs BFG	5.07±0.01^{c}	4.29±0.08^{a}	80.37±0.01^{c}	0.50±0.1^{bc}
	72 hrs BFG	5.02±0.02^{d}	3.41±0.10^{ef}	78.54±0.44^{d}	0.40±0.01^{c}
Obaagun	48 hrs BFG	4.98±0.00^{d}	3.30±0.07^{f}	76.04±0.59^{e}	1.25±0.02^{b}
	TMG	4.15±0.04^{g}	3.82±0.01^{c}	80.74±0.57^{c}	0.50±0.00^{bc}
	Mean	4.8	3.7	78.92	0.66
	96 hrs BFG	5.16±0.14^{c}	3.63±0.01^{d}	82.16±0.57^{b}	0.65±0.02^{bc}
	72 hrs BFG	4.98±0.01^{d}	4.03±0.09^{b}	79.38±0.25^{d}	3.50±0.04^{a}
Ajaagba	48 hrs BFG	5.08±0.13^{d}	3.94±0.04^{bc}	80.47±0.27^{c}	1.10±0.01^{bc}
	TMG	4.21±0.07^{f}	2.29±0.06^{h}	81.15±0.55^{c}	0.80±0.00^{bc}
	Mean	4.89	3.47	80.79	1.51
p states		***	***	NS	***
p communities		NS	**	**	***
p samples		***	***	***	*
p states × communities		*	***	***	***
p states × samples		***	***	***	***
p communities × samples		NS	***	***	***
p states × communities × samples		*	***	***	***

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). *p<0.05, **p<0.01, ***p<0.001, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari*.

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0.05) from that of the 24 hrs, 48 hrs and 72 hrs BFG. The *gari* samples produced in the Araromi-Ifon community of Osun state had the highest pH value (5.54) and that of the Obaagun community had the lowest (4.80) (Table 4). The pH value of the TMG in all the communities in Osun state was lower and significantly different ($p < 0.05$) from that of the 48 hrs, 72 hrs and 96 hrs BFG. The pH value measures the degree of acidity or alkalinity of fermented products (Sanni *et al.*, 2005). This implies that all the BFG falls within the acidic pH range, meaning that there was a proper breakdown of starch in the fresh cassava roots by *Corynebacterium manihot* during fermentation to simple sugars, leading to the production of lactic and formic acids. However, the mean pH values of the *gari* samples in this study were higher compared to the values (3.40 – 4.50) reported for *gari* by Komolafe and Arawande (2010) and the recommended pH range (3.50 – 4.50) for acid-fermented products (Arionla, 2016). The relatively high pH values of the *gari* samples in this study may be because of the vaporization of lactic acid and other volatile organic acids which might have reduced the acidity of the product (Arinola, 2016). It is important to add that the length of fermentation also reduces the pH value of the *gari*, thus making it acidic. This acidic nature particularly contributes to the sourness of *gari* which is preferable to some *gari* consumers (Arinola, 2016).

Starch content is one of the vital quality indices of *gari* which determines the texture of *eba*. In the Benue state, the starch content of the *gari* samples ranged between 80.26% and 80.75%, with *gari* from the Abenga community having the highest value and that of the Tyo-Mu community the least (Table 4). The starch content of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs and the 48 hrs BFG in the Abenga community. There was a significant difference ($p < 0.05$) in the starch content of the TMG and that of the 48 hrs BFG in the Tyo-Mu community of Benue state. The conversion of the starch to sugar during the production of the *gari* samples was higher in the Tse-Hom community (3.01%) and lower in the Tyo-Mu community (2.71%) (Table 4). The sugar content of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs, 48 hrs, and 72 hrs BFG in the Tyo-Mu community, while in the Tse-Hom community, the sugar content of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs and 72 hrs BFG. The *gari* samples from the Ubomiri community had the highest starch content (81.56%) and that of the Egbelu Obibiezena community had the least (80.32%) (Table 4) in the Imo state. The starch content of the TMG was not significantly different ($p > 0.05$) from the 24 hrs, 48 hrs and 72 hrs BFG in the Egbelu Obibiezena community of Imo state. However, the TMG starch content was significantly different ($p < 0.05$) from the 48 hrs BFG in the Ubomiri community. The sugar content of the *gari* samples in the Imo state was higher in the Amatta community (2.47%) and lower in that of the Ubomiri community (2.25%) (Table 4). The sugar content of the TMG was significantly different ($p < 0.05$) from that of the 24 hrs and 48 hrs BFG in the Amatta community, while a significant difference ($p < 0.05$) exists between the TMG and only the 48 hrs BFG in the Ubomiri community of Imo state. In the Osun state, the starch content of the *gari* samples ranged from 78.92 to 81.96%, with *gari* produced from the Obaagun community having the lowest value and that of the Araromi-Ifon community the highest (Table 4). The starch content of the TMG was significantly different ($p < 0.05$) from that of the 72 hrs and 96 hrs BFG in the Araromi-Ifon community, while in the Obaagun community, the TMG starch content was significantly different ($p < 0.05$) from that of the 48 hrs and 72 hrs BFG. *Gari* produced in the Obaagun community had the highest sugar content (3.70%) and that of the Ajaagba community had the least (3.47%) (Table 4). A significant difference ($p < 0.05$) was observed in the sugar content between the TMG and the 48 hrs, 72 hrs and 96 hrs BFG in all the communities of Osun state. The range of values (72–82%) (Awoyale *et al.*, 2021b) reported for the starch content of the BFG produced from different ratios of fresh and backslopped cassava mash agrees with that of the present study but is higher compared to the starch content of *gari* samples (59.92–61.63%) from different locations reported by Abass *et al*. (2018).

The total cyanogenic potential (CNP) content of the *gari* samples in the Benue state ranged from 2.49 – 3.09 mg HCN/kg. *Gari* from the Abenga community had the highest CNP content, and *gari* from the Tyo-Mu community had the lowest (Table 4). The CNP content of the TMG in the Abenga community was not significantly different ($p > 0.05$) from that of the 24 hrs, the 48 hrs, and the 72 hrs BFG, while in the Tyo-Mu community, the TMG was significantly different ($p < 0.05$) from that of the 48 hrs BFG. Amatta community *gari* samples had the highest CNP content (5.34 mg HCN/kg) while that of the Egbelu Obibiezena community had the lowest CNP content (2.25 mg HCN/kg) in the Imo state (Table 4). The CNP content of the TMG was not significantly different ($p > 0.05$) from that of the 24 hrs, 48 hrs, and 72 hrs BFG in the Egbelu Obibiezena community. However, a significant difference ($p < 0.05$) was observed between the TMG and the 24 hrs BFG in the Amatta community of Imo state. In the Osun state, the CNP content of the *gari* samples was higher in the Araromi-Ifon community (2.01 mg HCN/kg) and lower in the Obaagun community (0.66 mg HCN/kg) (Table 4). There was no significant difference (p > 0.05) in the CNP content of the TMG and that of the 48 hrs, 72 hrs, and 96 hrs BFG in the Obaagun community, while a significant difference (p < 0.05) exists in the CNP content of the TMG and that of the 48 hrs and 96 hrs BFG in Araromi-Ifon community of Osun state. The CNP content of all the BFG was very low compared to the Codex Alimentarius Commission standard of 10 mg HCN/kg (Joint FAO/WHO Codex Alimentarius Commission, 1985). The CNP content of the *gari* samples (14.08 – 23.43 mg/kg HCN) reported by Arinola (2016) was higher compared to that of the present study. This may be attributed to differences in the cassava varieties, length of fermentation, and roasting duration.

3.4 Consumer acceptability of the backslopped fermented gari in different communities

About 48% of consumers accepted the 72 hrs BFG in the Tyo-Mu community, and 38% accepted the 72 hrs BFG in the Abenga and Tse-Hom communities of Benue state. The 72 hrs BFG was more accepted compared to the TMG (p < 0.05) in the Tyo-Mu, Abenga, and Tse-Hom communities of Benue state. However, the consumer acceptability of the 48 hrs BFG was not significantly different (p > 0.05) from the TMG in the Tyo-Mu and Abenga communities, while in the Tse-Hom community, the consumer acceptability of the TMG was significantly different (p < 0.05) from all the BFG (Table 5). The Principal Component Analysis (PCA) biplot, as shown in Figure 1, allowed us to know the drivers of the consumer acceptability of the BFG in different communities of Benue state, based on the quality attributes. The result showed a data variance of about 52.58%, with the principal component-1 (PC1) contributing 34.65% and principal component-2 (PC2) 17.94%. The 72 hrs BFG from Tyo-Mu and the TMG from Tyo-Mu and Tse-Hom communities were in the same quadrant with the setback, trough, and final viscosities, and the WAC. Similarly, the 24 hrs and 48 hrs BFG from the Tyo-Mu community were in the same quadrant with peak and breakdown viscosities and pasting temperatures. Also, the 24 hrs, 48 hrs, and 72 hrs BFG and the TMG from the Abenga community were in the same quadrant with the pH value, dispersibility, and CNP content. Furthermore, the 24 hrs, 48 hrs, and 72 hrs BFG from the Tse-Hom community were in the same quadrant with the starch and sugar contents, bulk density, peak time, and consumer acceptability (Figure 1). This implies that the drivers of the consumer acceptability of the BFG in the Tse-Hom community of Benue state are the starch and sugar content, bulk density, and peak time of the product.

The *gari* consumer preferred the 72 hrs BFG in Ubomiri (34%) and Egbelu Obibiezena (36%) communities and the 48 hrs BFG was preferred by the consumers in the Amatta community (50%) of Imo state. The consumer acceptability of the 72 hrs BFG was not significantly different (p > 0.05) from that of the TMG in Ubomiri and Egbelu Obibiezena communities of Imo state, while in the Amatta community, the consumer acceptability of the 48 hrs BFG was significantly different (p < 0.05) from that of the TMG (Table 6). The

Table 5. Analysis of variance and the percentage frequency of the consumer acceptability of the backslopped fermented *gari* in Benue State.

Communities	N	Samples	Consumer acceptability
Tyo-Mu	50	24 hrs BFG	2.50±1.39^c (14%)
	50	48 hrs BFG	3.20±1.29^b (10%)
	50	72 hrs BFG	4.02±1.24^a (48%)
	50	TMG	3.28±1.41^b (28%)
		Mean	3.25
		p level	***
Abenga	50	24 hrs BFG	3.08±1.41^b (20%)
	50	48 hrs BFG	3.26±1.51^b (20%)
	50	72 hrs BFG	3.84±1.30^a (38%)
	50	TMG	2.80±1.25^b (22%)
		Mean	3.25
		p level	**
Tse-Hom	50	24 hrs BFG	3.42±1.30^a (20%)
	50	48 hrs BFG	3.66±1.29^a (22%)
	50	72 hrs BFG	3.84±1.18^a (38%)
	50	TMG	2.86±1.54^b (20%)
		Mean	3.45
		p level	**

Values are presented as mean±SD (frequency %). Values with different superscripts within the same column are statistically significantly different (p<0.05). **p<0.01, ***p<0.001, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari*.

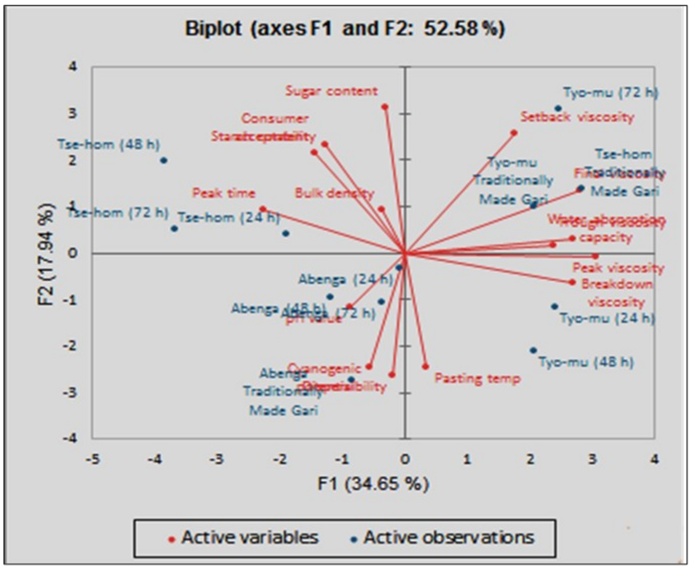

Figure 1. Principal component analysis biplot of the quality attributes and consumer acceptability of the backslopped fermented *gari* in Benue state.

result of the PCA (Figure 2) showed a data variance of about 56.11%, with PC1 contributing 35.42% and PC2 20.69%. The 72 hrs BFG and the TMG from the Ubomiri community were in the same quadrant with the starch contents, peak time, and CNP content. Similarly, the 24 hrs and 48 hrs BFG and the TMG from the Egbelu Obibiezena community were in the same quadrant with dispersibility, BD, and peak, breakdown, and setback viscosities. Also, the 48 hrs BFG from the Ubomiri community and the 72 hrs BFG from Amatta and Egbelu Obibiezena communities were in the same quadrant with the pH value, WAC, and pasting temperature.

Table 6. Analysis of variance and the percentage frequency of the consumer acceptability of the backslopped fermented *gari* in Imo State.

Communities	N	Samples	Consumer acceptability
Ubomiri	50	24 hrs BFG	3.54±1.16[ab] (20%)
	50	48 hrs BFG	3.04±1.41[b] (18%)
	50	72 hrs BFG	3.62±1.26[a] (34%)
	50	TMG	3.16±1.42[ab] (28%)
		Mean	3.34
		p level	NS
Amatta	50	24 hrs BFG	3.62±1.10[a] (26%)
	50	48 hrs BFG	3.68±1.33[a] (50%)
	50	72 hrs BFG	2.78±1.39[b] (20%)
	50	TMG	2.06±0.84[c] (4%)
		Mean	3.04
		p level	***
Egbelu Obibiezena	50	24 hrs BFG	2.78±1.32[a] (8%)
	50	48 hrs BFG	3.14±1.37[a] (22%)
	50	72 hrs BFG	3.24±1.44[a] (36%)
	50	TMG	3.20±1.58[a] (34%)
		Mean	3.25
		p level	NS

Values are presented as mean±SD (frequency %). Values with different superscripts within the same column are statistically significantly different (p<0.05). ***p<0.001, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari.*

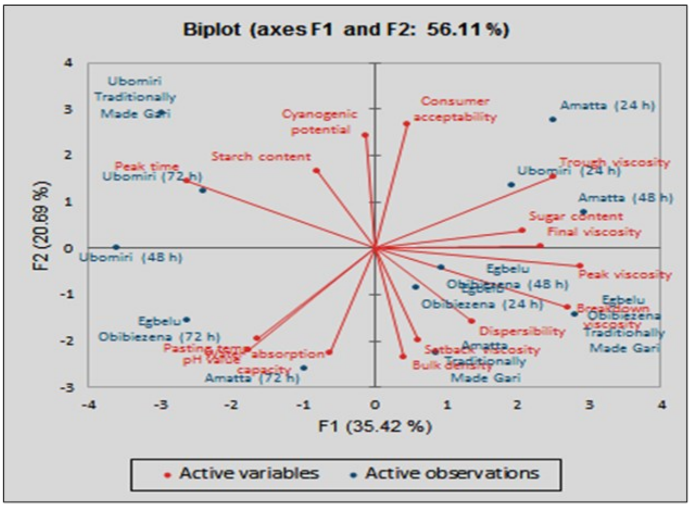

Figure 2. Principal component analysis biplot of the quality attributes and consumer acceptability of *gari* in Imo state.

Furthermore, the 24 hrs and 48 hrs BFG from Amatta and the 24 hrs BFG from Ubomiri communities were in the same quadrant with the trough and final viscosities, sugar content, and the consumer acceptability (Figure 2). This means that the consumer acceptability of the BFG in the Amatta and Ubomiri communities of the Imo state is linked to the trough and final viscosities and sugar content of the product.

About 58%, 60%, and 68% of *gari* consumers preferred the TMG in Obaagun, Ajaagba, and Araromi-Ifon communities of Osun state respectively compared to all the BFG. The acceptability of the TMG in Obaagun, Ajaagba, and Araromi-Ifon communities of Osun state was significantly different ($p < 0.05$) from that of all the BFG (Table 7). However, the PCA biplot, as shown in Figure 3, allowed us to separate between the BFG samples based on the quality attributes and the consumer acceptability in Osun state. The result showed a data variance of about 55.72%, with PC1 contributing 29.72% and PC2 26.00%. The 72 hrs and 96 hrs BFG from the Obaagun community and the 96 hrs BFG from the Ajaagba community were in the same quadrant with the final, trough, peak, breakdown, and setback viscosities. Similarly, the 48 hrs and 72 hrs BFG and the TMG from the Araromi Ifon community were in the same quadrant with dispersibility, starch content, and CNP content. Also, the 48 hrs and 72 hrs BFG from Ajaagba and the

Table 7. Analysis of variance and the percentage frequency of the consumer acceptability of the backslopped fermented *gari* in Osun State.

Communities	N	Samples	Consumer acceptability
Araromi-Ifon	50	24 hrs BFG	2.28±1.20[c] (4%)
	50	48 hrs BFG	3.10±1.42[b] (24%)
	50	72 hrs BFG	2.42±1.14[c] (4%)
	50	TMG	4.10±1.21[a] (68%)
		Mean	2.98
		p level	***
Ajaagba	50	24 hrs BFG	3.10±1.25[b] (4%)
	50	48 hrs BFG	2.46±1.25[c] (20%)
	50	72 hrs BFG	3.20±1.41[b] (16%)
	50	TMG	4.08±1.18[a] (60%)
		Mean	3.21
		p level	***
Obaagun	50	24 hrs BFG	2.82±1.16[b] (14%)
	50	48 hrs BFG	2.74±1.44[b] (18%)
	50	72 hrs BFG	3.06±1.22[b] (10%)
	50	TMG	4.16±1.00[a] (58%)
		Mean	3.20
		p level	***

Values are presented as mean±SD (frequency %). Values with different superscripts within the same column are statistically significantly different (p<0.05). ***p<0.001, NS: Not significant, BFG: Backslopped Fermented *Gari*, TMG: Traditionally Made *Gari.*

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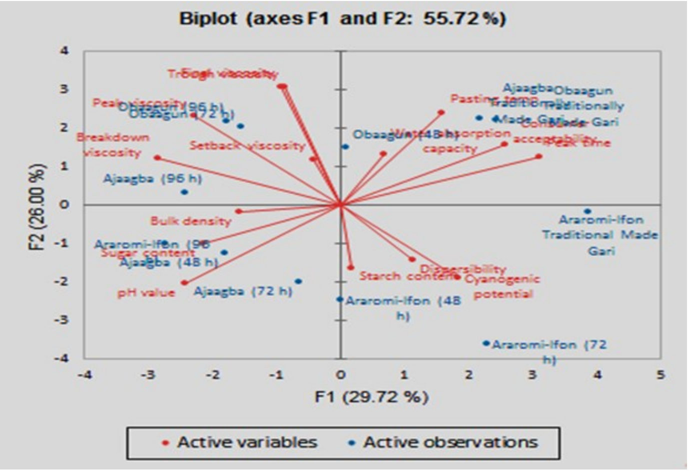

Figure 3. Principal component analysis biplot of the quality attributes and consumer acceptability of *gari* in Osun state.

96 hrs BFG from Araromi Ifon communities were in the same quadrant with BD, pH value, and sugar content. Furthermore, the 48 hrs BFG from the Obaagun and the TMG from the Obaagun and the Ajaagba communities were in the same quadrant with the WAC, pasting temperature, peak time, and consumer acceptability (Figure 3). Therefore, the consumer's acceptability of the BFG in the Obaagun community of Osun state was based on the WAC, pasting temperature, and the peak time of the product.

4. Conclusion

The results of this study showed that the drivers of the consumer acceptability of the 24 hrs, 48 hrs, and 72 hrs BFG in the Tse-Hom community of Benue state were the starch and sugar contents, bulk density, and peak time. *Gari* consumers in Amatta and Ubomiri communities of Imo state prefer the 24 hrs and 48 hrs BFG because of the trough and final viscosities and the sugar content. The consumer acceptability of 48 hrs BFG in the Obaagun community of Osun state was attributed to the WAC, pasting temperature, and peak time. Hence, the consumer acceptability of the BFG is a function of their biophysical attributes and location specific.

Conflicts of interest

The authors declare no conflict of interest, and the funders had no role in the study's design, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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