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Quality assessment of vended steamed Bambara groundnut (*Voandzeia subterranean*) paste in Ifite, Awka, Nigeria

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Abstract
The steamed Bambara groundnut paste from designated vendors in Ifite, Awka, were assessed on four different days to ascertain the qualities and quality consistency of the products. Samples of the steamed paste were collected from four designated vendors labeled A, B, C and D on four different days. The proximate and mineral compositions were analyzed using official methods. Sensorily samples were evaluated on 7-point Hedonic scale. The moisture content of the samples ranged from 27.30 to 33.13%; protein, 4.17 – 6.44%; fat, 18.20 – 23.00%; ash, 1.00 - 2.50%; and carbohydrate, 39.64 – 44.91%. The energy content ranged between 353.56 and 398.00 Kcal/100 g. Magnesium was the predominating macro-mineral with the value range of 14.489 – 20.034 ppm. This was followed by calcium (10.335 – 12.929 ppm), potassium (5.885 – 6.725 ppm) and sodium (2.003 – 4.323 ppm). Among the micro or trace minerals, aluminum ((1.694 – 4.094 ppm) had highest value, followed by iron (1.355 – 1.667 ppm), manganese (0.429 – 3.085 ppm) while molybdenum (0.00 – 0.092 ppm) was the least. Steamed Bambara groundnut paste from vendor A was most preferred as it had the highest scores in all the sensory parameters. This was consistent for the four days of evaluation. There were significant ($p<0.05$) differences in the proximate and mineral compositions and sensory quality of the steamed Bambara groundnut pastes within (from the same) and among (from different) vendors. There was consistency in the preference of Vendor A steamed paste though mineral and proximate composition values did not attest to its superiority.

Keywords: Bambara steamed paste, vendor, proximate composition, mineral content, and sensory quality

1. Introduction

Bambara groundnut (*Voandzeia subterranean*), a leguminous plant belonging to Fabaceae family (Mazahib *et al*., 2013) [18], is of tropical African origin (Linnemann, 1990; Collision *et al*., 2000; Omoikhole *et al*., 2006) [17, 13] and widely cultivated in West and Central Africa mainly for its edible seeds (Abdulsalami and Sheriff, 2010; Mazahib *et al*., 2013) [1, 18]. It is locally called 'okpa' in Igbo speaking tribe of Eastern Nigeria and kwaruru in Sokoto of North Western Nigeria (Abdulsalami and Sheriff, 2010) [1]. Bambara groundnut can yield in soils with little rainfall and substantial yield under better condition (Linnemann, 1990; Collision *et al*., 2000; Omoikhole *et al*., 2006) [13].

Many and varying reports have been given on the chemical and nutritional composition of Bambara groundnut probably due to specie differences, soil condition of areas of cultivation and analytical methods employed. According to Rachie and Roberts (1974) [28], ripe seeds contain 20% crude protein, 4-7% fat, 50-60% carbohydrate. Abdulsalami and Sheriff (2010) [1] reported that per 100 g dry matter, Bambara groundnut contains 6.85 g fat, 5.37 g ash, 6.85 g crude fiber, 8.70 g moisture and 51.96 carbohydrate. On the average, Mune *et al*. (2011) [20] reported that the seeds of Bambara groundnut contain 49.72% carbohydrate, 21.18% protein and 6.38% fat; whereas Mazahib *et al*. (2013) [18] who observed the ash content to be 3.25%, protein 20.60%, fat 6.60%, carbohydrate 56.51% and fiber 6.34%, stated that the high carbohydrate (65%) and relatively high protein (18%) and sufficient fat (6.5%) makes Bambara groundnut rank highly as a complete food; collaborating Brough and Azam-Ali (1992) [12] who earlier reported that Bambara groundnut seeds are complete food as they contain sufficient quantities of proteins, carbohydrate and lipid.

Bambara groundnut contains micronutrients such as zinc (Zn), iron (Fe), calcium (Ca) and potassium (K) but is poor in phosphorus (P) and magnesium (Mg) (Murevanhema and Jideani, 2013; Mubaiwa *et al*., 2017) [21, 13]. According to Amarteifio *et al*. (2006) [4], the range of minerals in mg/ 100 g dry matter obtained for macro minerals ranged from 37-123 Ca, 1545-2200 K, 159-335 Mg, 16-25 Na, 313-363 P; and the micro minerals ranged from 3.0-13.2 Cu, 23.0-150 Fe and 13.0-77 Zn.

Although Bambara groundnut has lower protein content in comparison to other legumes, its seeds contain relatively high proportion of sulphur containing methionine and cystein as a percentage of protein (Bamshaiye, 2011; Brough and Azam-Ali, 1992) [9, 12] and all essential and non-essential amino acids meet FAO requirements (Akroyd *et al*., 1982; Brough and Azam-Ali 1992) [12]. The amino acid score of most limiting amino acid, is 80% for Bambara groundnut as compared to 74% for soybean, 65% for groundnut and 64% for cowpea showing that Bambara groundnut has a high protein quality (Mubaiwa *et al*., 2017) [19]. Bambara groundnut contains higher levels of fatty acids (palmitic and linoleic acids) in comparison to groundnut (Basu *et al*., 2007; Mubaiwa *et al*., 2017) [11, 19] and a substantial quantity of vitamin A, thiamine, riboflavin, niacin, carotene and trace quantities of ascorbic acid (Adeyeye *et al*., 2013; Oyenuga, 1968) [3, 26].

Though Bambara groundnut has been classified as an under-utilized crop due to lack of industrial use, it has many traditional uses. Freshly harvested pods are eaten as snacks after boiling for approximately an hour (Hillock *et al.*, 2011; Ani *et al.*, 2013) [14, 6]. According to Obizoba (1983) [22], and Amarteifio *et al.* (2006) [4], the immature seeds are boiled and eaten as part of main meal and can also be ground into flour and used in making porridge. The dried seeds can be dehulled and ground into paste for making different steamed or fried products. It may be roasted and eaten as snacks (Mubaiwa *et al.*, 2017) [19]. The seeds may be milled into flour, baked to make small flat cake and bread (Linnemann, 1987). Additionally, thin porridge and stiff porridge have been made from the flour (Amarteifio and Moholo, 1998) [4]. In East Africa, Bambara groundnut are roasted, milled and the flour used to make soup, a relish, and also used as substitute for coffee (Mubaiwa *et al.*, 2017) [19]. Milk, a water extract produced from milled Bambara groundnut was reported to compare favourably in flavor and mineral composition to cowpea and soybean milk (Poulter, 1981; Mubaiwa *et al.*, 2017) [27, 19].

Steamed Bambara groundnut paste called 'okpa' in local parlance is a highly cherished food/ dish among the Igbo tribes of South Eastern Nigeria. Because of its nutritional quality and relish, students in various higher Institutions in the region who mostly used it alone or with cereal gruel/ porridge for breakfast so much patronize the dealers that readily made it available. The preparation of the steamed paste by the vendors does not follow any standard recipe. Moreover, recipes are formulated by guessing rather than measurements by weight or volume; and Bambara groundnut flours are occasionally adulterated with less costly maize flour. This work evaluates the chemical and organoleptic qualities of some vended steamed Bambara groundnut pastes with the objective of ascertaining the quality consistency among and within vendors at various times in Ifite Area, Awka, Nigeria.

2. Materials and methods

2.1 Steamed paste collections

Steamed pastes of Bambara groundnut ('Okpa') were purchased from four different vendors at Ifite-Awka village of Awka in Awka South Local Government Area of Anambra State. The vendors were tagged A, B, C, and D; and the 'okpa' samples correspondingly labeled as such. Purchases were made four times from the same vendors with the same tags at seven days interval. The sensory evaluation and proximate analyses were immediately carried out on the samples. Portions of the samples were, however, dried to preserve for minerals analyses.

2.2 Chemical analyses

Moisture content of samples was determined using air-oven method; ash by incineration in a Muffle furnace at 550^{O}C; fat using Soxhlet Extraction Apparatus with petroleum ether (BP 40-60^{o}C) as solvent; protein by Kjeldahl method (N x 6.25) as described by AOAC (2010) [7]. Carbohydrate was estimated by difference, that is, subtracting the sum of % moisture, % ash, % protein and % fat from 100.

2.3 Energy estimation

This was carried out using Atwater factor. That is multiplying carbohydrate and protein contents by 4 and fat by 9 since 1g of protein and carbohydrate each yield 4 Kcal and 1g of fat 9 Kcal. The summation was expressed as Kcal/ 100 g.

2.4 Mineral determinations

Atomic absorption spectroscopy as described by Lawal *et al*. (2015) [15] was used except that ash was produced by dry-ashing method. Three grams of powdered sample was weighed into ashing crucible, pre-ashed over a hot plate in a fume cupboard till smoke production ceases. It was then transferred into a muffle furnace and incinerated at 550^{o}C for 4 h, cooled to room temperature and the volume made up to 50 ml with de-ionized water and filtered. The filtrate in a 5 ml volumetric flask was loaded to a flame atomic absorption spectrophotometer (VARIAN 240FS, Sweden). Calibration standard for each element was prepared using these stock solutions by employing serial dilution technique. The mineral element composition in each sample was deduced from the calibration curves. For each sample three determinations were performed and average results were reported in three decimal places.

2.5 Sensory evaluation

The sensory evaluation conducted was the preference test on 7-point Hedonic Scale where 1 represents very much disliked; 4 neither liked nor disliked; and 7 very much liked. The panelists were drawn from among students and staff of Faculty of Agriculture of Nnamdi Azikiwe University, Awka. The evaluation was conducted in a room well illuminated with sun light. Samples were simultaneously served using white plates between the hours of 11.00 am and 12 noon. Portable water was provided and panelists instructed to rinse mouth in-between tests to remove after taste.

2.6 Statistical Analysis

The data generated were analyzed using Analysis of Variance (Steel and Torrie, 1990). Significant means (values) were discriminated using Least Significant Difference (LSD) test at 95% level of confidence.

3. Results and discussion

3.1 Proximate compositions of steamed Bambara groundnut pastes

The proximate compositions of steamed Bambara groundnut paste collected from four designated vendors over four days are presented in Tables 1. The results revealed that there were significant ($p < 0.05$) differences in the compositions or amounts of various nutrients of the steamed paste samples from the same (within) and different (among) vendors. Generally, the moisture content of the entire collections ranged from 27.30 to 33.13%; protein, 4.17 to 6.44%; fat, 18.20 to 23.00%; ash, 1.00 to 2.50%; and carbohydrate, 39.64 to 44.91%. The energy content ranged between 353.56 and 398.00 Kcal/100 g. This overview of the proximate composition and energy content of the vended steamed Bambara groundnut paste reveals lower protein, ash and carbohydrate contents in comparison with the mature Bambara groundnut seeds. The reason could be as a result of the amount of water and oil added during the steamed paste preparation. A survey revealed that more than 200% of water is usually added to Bambara groundnut flour to make a very watery slurry if a product with good texture, a desired quality parameter, could be obtained. Bramalea *et al*. (2005) [10] prepared the steamed paste using 150 ml of water per 50 g of Bambara groundnut flour (300% water) to obtain desired texture. Of course, much oil, preferably palm oil, is needed to improve the colour (another quality parameter) of the steamed paste; otherwise, a food colourant should be added to improve acceptability. Barimalaa *et al*. (2005) [10] added 8% of oil. Hence, the lower protein, ash and carbohydrate contents of the steamed pastes than in seeds were due to dilution effect with oil and water. The protein, fat, ash and carbohydrate contents of 20.60%, 6.60%, 3.25% and 56.51%, respectively, have been reported (Mazahib *et al*., 2013) [18] for Bambara groundnut seeds. The differences in composition of steamed paste samples among the vendors could arise from specie and variety differences in addition to the levels of water and oil dilutions.

Table 1a: Among Vendors comparison of proximate composition of steamed Bambara groundnut paste

Parameters (%)	Vendors				
	A	B	C	D	LSD
DAY 1					
Moisture	31.0^{b}	31.2^{b}	32.21^{ab}	32.84^{a}	1.31
Protein	6.44^{a}	4.62^{c}	5.52^{b}	4.58^{c}	0.72
Fat	20.4^{b}	21.6^{a}	19.6^{b}	18.2^{c}	1.04
Ash	1.53^{ab}	1.00^{b}	1.55^{a}	1.52^{ab}	0.54
Carbohydrate	40.63^{b}	41.58^{b}	41.12^{b}	42.86^{a}	1.13
Energy (Kcal %)	371.88^{b}	379.20^{a}	362.92^{c}	353.56^{d}	3.04
DAY 2					
Moisture	33.04^{a}	30.20^{b}	28.13^{b}	29.92^{b}	2.10
Protein	4.56^{a}	4.80^{a}	4.60^{a}	4.64^{a}	0.53
Fat	20.2^{b}	20.10^{b}	23.0^{a}	19.2^{b}	1.22
Ash	1.5^{c}	2.0^{b}	2.03^{a}	2.50^{a}	0.47
Carbohydrate	40.7^{b}	42.90^{a}	42.24^{ab}	43.74^{a}	1.63
Energy (Kcal %)	362.84^{d}	371.70^{b}	394.36^{a}	366.32^{c}	2.83
DAY 3					
Moisture	30.23^{b}	33.13^{a}	27.20^{ab}	32.0^{ab}	1.85
Protein	5.25^{a}	5.50^{a}	4.34^{b}	4.17^{b}	0.56
Fat	18.60^{b}	20.20^{b}	22.4^{a}	19.8^{b}	2.06
Ash	1.01^{b}	1.53^{a}	1.30^{ab}	1.51^{a}	0.34
Carbohydrate	44.91^{a}	39.64^{c}	44.76^{a}	42.52^{b}	1.96
Energy (Kcal %)	368.04^{b}	362.36^{c}	398.00^{a}	364.96^{c}	2.67
DAY 4					
Moisture	28.10^{c}	32.57^{a}	30.25^{b}	32.44^{a}	2.11
Protein	5.76^{a}	5.05^{b}	4.80^{b}	4.43^{b}	0.63
Fat	21.23^{ab}	20.46^{b}	21.75^{a}	20.11^{b}	1.15
Ash	1.30^{b}	1.74^{a}	1.52^{ab}	1.62ab	0.41
Carbohydrate	43.61^{a}	40.18^{b}	41.68^{ab}	41.40^{b}	1.16
Energy (Kcal %)	388.55^{a}	365.06^{c}	381.67^{b}	364.31^{c}	2.91

Values are means of triplicate determinations and values with different superscripts within a row are different at 5% confident level.

The proximate parameter values of steamed Bambara groundnut paste from different (among) vendors (Table 1a) and different days from the same (within) vendors (Table 1b) varied significantly ($p < 0.05$). The differences between the highest and lowest values (the range) of each parameter from same vendor revealed that sample A had the highest range (4.86) and D the lowest (2.92) as regards moisture content. The protein content range was highest in sample A (1.88) and lowest in sample D (0.36). Consideration of fat, ash, carbohydrate and caloric ranges indicated that C (3.40), D (0.99), A (4.28) and C (35.04), respectively, had the highest ranges whereas B (1.50), A (0.52), D (2.34) and D (11.40) had the lowest ranges. The mean values (Table 2) of moisture, protein, fat, ash, carbohydrate, and calorie were highest in samples D (31.80%), A (5.50%), C (21.69%), D (1.79%), D 42.63%) and C (384.49 Kcal), respectively, whereas the lowest mean values of moisture (29.45%), protein (4.46%), fat (19.33%), ash (1.34), carbohydrate (41.08%) and calorie (362.33 Kcal) were observed in samples C, D, D, A, B and D, respectively. The samples with the highest protein, fat, ash and caloric value ranges had the highest mean values whereas sample D with lowest moisture range had the highest moisture mean value. Hence, except for carbohydrate, it could be inferred that solid matter parameters with highest ranges had the highest mean values whereas liquid matter parameter with the lowest range had the highest mean value. However, the difference in mean of carbohydrate content of sample D (42.63%) that was the highest and that of sample A (42.46%) with the highest range was insignificant ($p > 0.05$).

Table 1b: Individual (within) Vendors comparative proximate composition of steamed Bambara groundnut paste

Parameters (%)	Days				
	1	2	3	4	LSD
Vendor A					
Moisture	31.00^{bc}	33.04^{a}	30.23^{b}	28.10^{c}	2.03
Protein	6.44^{a}	4.56^{c}	5.25^{b}	5.76^{b}	0.67
Fat	20.4^{a}	20.20^{a}	18.60^{b}	21.23^{a}	1.31
Ash	1.53^{a}	1.50^{a}	1.01^{b}	1.30^{ab}	0.38
Carbohydrate	40.63^{b}	40.70^{b}	44.91^{a}	43.61^{a}	2.42
Energy (Kcal %)	371.88^{c}	362.84^{b}	369.12^{c}	388.55^{a}	2.77
Vendor B					
Moisture	31.20^{bc}	30.2^{c}	33.13^{a}	32.57^{ab}	1.88
Protein	5.52^{a}	4.80^{b}	5.50^{a}	5.05^{ab}	0.61
Fat	21.60^{a}	20.10^{a}	20.20^{a}	20.46^{a}	1.75
Ash	1.00^{a}	2.00^{a}	1.53a^{b}	1.74^{a}	0.53
Carbohydrate	41.58^{ab}	42.90^{a}	39.64^{c}	40.18^{bc}	1.56
Energy (Kcal %)	382.80^{a}	371.60^{b}	362.36^{c}	365.06^{c}	3.11
Vendor C					
Moisture	32.21^{a}	28.13^{b}	27.20^{b}	30.25^{a}	1.81
Protein	5.52^{a}	4.60^{bc}	4.34^{c}	4.80^{b}	0.35
Fat	19.6^{b}	23.00^{a}	22.4^{a}	21.75^{a}	1.49
Ash	1.55^{ab}	2.03^{a}	1.30^{b}	1.52^{b}	0.60
Carbohydrate	41.12^{b}	42.24^{b}	44.76^{a}	41.68^{b}	2.06
Energy (Kcal %)	362.96^{d}	394.36^{b}	398.00^{a}	381.67^{c}	3.08
Vendor D					
Moisture	32.84^{a}	29.92^{b}	32.00^{c}	32.44^{a}	1.68
Protein	4.58^{a}	4.64^{a}	4.17^{b}	4.43^{ab}	0.37
Fat	18.20^{b}	19.20^{a}	19.80^{a}	20.11^{a}	1.21
Ash	1.52^{a}	2.50^{a}	1.51^{a}	1.62^{a}	0.41
Carbohydrate	42.86^{ab}	43.74^{a}	42.52^{ab}	41.40^{b}	2.09
Energy (Kcal %)	353.56^{c}	366.32^{a}	364.96^{ab}	364.31^{b}	2.85

Values are means of triplicate determinations and values with different superscripts within a row are different at 5% confident level.

Table 2: Within and Among Vendor Mean Proximate Compositions of Steamed Bambara Groundnut Pastes

Within Vendors Mean					
	Vendors				
Parameters	A	B	C	D	LSD
Moisture	30.59^{ab}	31.78^{a}	29.45^{b}	31.80^{a}	1.25
Protein	5.50^{a}	4.99^{ab}	4.82^{ab}	4.46^{b}	0.81
Fat	20.11^{bc}	20.59^{a}	21.69^{a}	19.33^{c}	1.19
Ash	1.34^{b}	1.57^{ab}	1.60^{ab}	1.79^{a}	0.43
Carbohydrate	42.46^{a}	41.08^{b}	42.45^{a}	42.63^{a}	1.35
Energy (Kcal %)	372.83^{b}	369.59^{c}	384.49^{a}	362.33^{d}	2.05
Among Vendors Mean					
	Days of Sample collections				
Parameters	1	2	3	4	LSD
Moisture	31.81^{a}	30.32^{b}	30.64^{b}	30.84^{ab}	1.10
Protein	5.52^{a}	4.65^{b}	4.82^{b}	5.01^{ab}	0.69
Fat	19.95^{a}	20.63^{a}	20.25^{a}	20.89^{a}	1.14
Ash	1.40^{b}	2.01^{a}	1.34^{b}	1.55^{ab}	0.55
Carbohydrate	41.55^{b}	42.40^{ab}	42.96^{a}	41.72^{b}	1.02
Energy (Kcal %)	367.83^{b}	373.87^{a}	373.37^{a}	374.93^{a}	2.86

Values with different superscripts within a row are significantly different ($p < 0.05$)

3.2 Mineral elements of vended steamed Bambara groundnut paste

The values of the nineteen minerals analyzed on bone-dry steamed Bambara groundnut paste on two different days from the four vendors are presented in Table 3. Magnesium was the predominating major or macro minerals with the value range of 14.489 – 20.034 ppm. This was followed by calcium (10.335 – 12.929 ppm), potassium (5.885 – 6.725 ppm) and then sodium (2.003 – 4.323 ppm). Among the micro or trace minerals, alumimum ((1.694 – 4.094 ppm) predominated and was followed by iron (1.355 – 1.667 ppm), then manganese (0.429 – 3.085 ppm) while molybdenum (0.00 – 0.092 ppm) was the least. Investigation revealed that the vendors produced the steamed Bambara groundnut paste by dry milling the seeds and sieving out the testa/ hulls; and not by soaking and wet milling. Hence, it is likely that the mineral composition, no matter the amount lost will be a reflection of that of raw seeds. However, some minerals may be higher in concentration in the testa/ hulls and can make a difference. Abiodun and Adepeju (2011) [2] analysed the proximate composition of Bambara groundnut fractions and reported 1.52% ash for seed coat, 2.28% for dehulled flour and 3.26% for whole raw flour. They also reported that the mineral composition of raw Bambara nut flour were higher than the dehulled possibly due to the removal of the hull. There were varying reports (Oluwole and Taiwo, 2009; Abdulsalami and Sheriff, 2010; Mazahib *et al*., 2013; Olaleye *et al*., 2013; Yao *et al*., 2015) [8, 3, 30] on the amount and preponderance of these minerals of raw and unprocessed Bambara groundnut. Only Yao *et al.* (2015) [30] reported magnesium (136 mg/ 100 g), aside phosphorous, as the predominant macro mineral element and followed by calcium (30.2 mg/ 100g). Oluloye *et al.* (2013) and Mazahib *et al.* (2013) [18] reported calcium as the predominant mineral of raw Bambara groundnut followed by potassium and then sodium; Aboiodun and Adepeju (2011) [2] observed magnesium as second to calcium while potassium (92.43 mg/ 100g) was observed by Abdulsalami and Sheriff (2017) [1] as the predominant mineral.

Table 3: Mineral composition of vended steamed Bambara groundnut paste (‘Okpa’)

Parameters (ppm)	**Vendors Day 1**				**Vendors Day 4**			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Iron	1.355^{c}	1.631^{a}	1.365^{c}	1.559^{b}	1.359^{c}	1.667^{a}	1.485^{b}	1.359^{c}
Zinc	0.839^{c}	0.782^{c}	1.981^{b}	2.876^{a}	0.531^{c}	0.643^{bc}	1.411^{ab}	1.468^{a}
Magnesium	15.894^{d}	16.102^{c}	20.034^{a}	18.647^{b}	14.489^{b}	15.125^{b}	18.750^{a}	18.351^{a}
Nickel	0.472^{a}	0.346^{b}	0.285^{c}	0.183^{d}	0.318^{b}	0.448^{a}	0.125^{c}	0.207^{c}
Cadmium	1.304^{b}	1.521^{a}	0.169^{c}	0.042d	1.543^{a}	1.356^{b}	0.496^{c}	0.606^{bc}
Calcium	12.929^{a}	10.335^{c}	11.568^{b}	11.727^{b}	11.982^{a}	11.035^{b}	12.087^{a}	11.820^{ab}
Manganese	3.085^{a}	1.859^{b}	2.241^{ab}	0.429^{c}	1.832^{a}	1.443^{ab}	2.045^{a}	0.749^{b}
Cobalt	0.236^{ab}	0.173^{b}	0.325^{a}	0.00^{c}	0.273^{a}	0.156^{b}	0.185^{b}	0.046^{c}
Silver	1.694^{b}	1.836^{a}	0.781^{b}	0.524^{c}	1.298^{a}	1.306^{a}	0.880^{a}	1.284^{a}
Selenium	0.067^{c}	1.043^{a}	0.347^{b}	0.929^{ab}	0.026^{c}	0.041^{c}	0.356^{b}	0.523^{a}
Lead	0.196^{a}	0.265^{a}	0.178^{a}	0.00^{b}	0.036^{b}	0.172^{a}	0.178^{a}	0.053^{b}
Copper	0.00^{c}	0.248^{a}	0.056^{c}	0.112^{b}	0.103^{b}	0.112^{a}	0.083^{b}	0.148^{b}
Arsenic	0.154^{c}	0.207^{c}	0.432^{a}	0.313^{b}	0.216^{b}	0.235^{ab}	0.302^{a}	0.321^{a}
Mercury	0.277^{b}	0.167^{c}	0.231^{bc}	0.368^{a}	0.256^{ab}	0.141^{b}	0.260^{a}	0.315^{a}
Sodium	4.323^{a}	3.174^{ab}	2.316^{b}	2.003^{b}	3.873^{a}	2.734^{b}	3.106^{b}	2.450^{b}
Potassium	6.682^{a}	5.888a	6.725^{a}	6.682^{a}	6.125^{a}	6.108^{a}	6.371^{a}	5.948^{a}
Aluminum	1.694^{b}	3.112^{a}	3.722^{a}	4.094^{a}	2.642^{b}	3.823^{a}	3.472^{ab}	3.814^{a}
Molybdenum	0.021^{a}	0.00^{b}	0.035^{a}	0.00^{b}	0.00^{c}	0.063^{b}	0.073^{ab}	0.092^{a}
Chromium	0.053^{a}	0.064^{a}	0.095^{a}	0.064^{a}	0.048^{b}	0.042^{b}	0.105^{a}	0.036^{b}

Values are means of triplicate determinations and values with different superscripts within a row are different at 5% confident level.

3.3 Sensory quality

Table 4 revealed that among vendors, steamed Bambara groundnut from vendor A received the highest scores in all the sensory parameters evaluated and so should be the most preferred sample. This is consistent for the four days of evaluation. Samples from other vendors are in close competition for the four days of evaluation and significantly differ from that of Vendor A. Unlike those of Vendors B, C and D, the sensory parameters of samples from Vendor A are consistent for the four days. This may be indicating that Vendor A applies scientific procedure in her preparations. The results of the proximate and mineral compositions (Tables 1 and 3) did not attest to this. However, Vendor A may be good in condiment management especially as taste score, being highest, is likely the most determinant of sensory acceptability. Furthermore, Vendor A may have made preparations from bulk purchased Bambara nut consisting of the same specie or blends of species which could have aided in the consistent quality of the product while other vendors may have prepared the steamed paste from retail purchases of any available specie. Moreover, the possibility of adulteration with other flours may have contributed in inconsistency in quality of the steamed Bambara nut paste products.

Table 4: Mean sensory scores of steamed Bambara nut paste from different vendors on different days

Parameters	Vendors					Days				
	A	B	C	D	LSD	1	2	3	4	LSD
	Day 1					**Vendor A**				
Taste	6.10^{a}	4.20^{b}	4.05^{b}	3.95^{b}	0.72	6.10^{a}	6.00^{a}	6.30^{a}	5.95^{a}	0.61
Flavor	5.60^{a}	4.40^{b}	3.95^{b}	4.05^{b}	0.70	5.60^{a}	6.05^{a}	5.50^{a}	5.65^{a}	0.64
Colour	5.30^{a}	5.40^{a}	4.20^{b}	4.15^{b}	0.59	5.30^{a}	5.30^{a}	5.05^{a}	4.85^{a}	0.70
Texture	5.50^{a}	4.10^{b}	4.75^{b}	4.70^{b}	0.69	5.50^{a}	5.75^{a}	5.45^{a}	5.85^{a}	0.70
Overall acceptability	5.85^{a}	4.40^{b}	4.05^{b}	4.00^{b}	0.62	5.85^{a}	5.90^{a}	5.95^{a}	5.85^{a}	0.57
	Day 2					**Vendor B**				
Taste	6.00^{a}	5.15^{b}	4.80^{b}	4.00^{c}	0.60	4.20^{a}	5.15^{a}	$4,30^{ab}$	3.60^{b}	0.91
Flavor	6.05^{a}	4.90^{b}	4.95^{b}	3.95^{c}	0.55	4.40^{a}	4.90^{a}	3.40^{b}	3.45^{b}	0.86
Colour	5.30^{a}	5.30^{a}	4.55^{b}	4.80^{c}	0.33	5.40^{a}	5.30^{a}	4.75^{ab}	4.10^{b}	0.76
Texture	5.75^{a}	4.55^{b}	4.40^{b}	4.85^{b}	0.61	4.10^{b}	4.55^{ab}	5.20^{a}	3.85^{b}	
Overall acceptability	5.90^{a}	5.00^{b}	4.75^{b}	3.80^{c}	0.54	4.40^{bc}	5.60^{a}	4.55^{b}	3.70^{c}	0.71
	Day 3					**Vendor C**				
Taste	6.30^{a}	4.30^{c}	5.15^{b}	4.10^{c}	0.58	4.05^{b}	4.80^{ab}	5.15^{a}	3.95^{b}	0.95
Flavor	5.50^{a}	3.40^{c}	4.25^{b}	3.05^{c}	0.59	3.95^{b}	4.95^{a}	4.25^{ab}	3.85^{b}	0.80
Colour	5.05^{a}	4.75^{a}	4.45^{a}	3.80^{b}	0.63	4.20^{a}	4.55^{a}	4.45^{a}	4.60^{a}	0.55
Texture	5.45^{a}	5.20^{a}	4.90^{a}	4.85^{a}	0.69	4.75^{a}	4.40^{a}	4.90^{a}	4.55a	0.79
Overall acceptability	5.95^{a}	4.55^{b}	4.95^{b}	3.65^{c}	0.49	4.05^{a}	4.75^{a}	4.95a	4.20^{b}	0.75
	Day 4					**Vendor D**				
Taste	5.95^{a}	3.60^{b}	3.95^{b}	4.05^{b}	0.65	3.95^{a}	4.00^{a}	4.10^{a}	4.05^{a}	0.63
Flavor	5.65^{a}	3.45^{b}	3.85^{b}	3.65^{b}	0.67	4.05^{a}	3.75^{ab}	3.05^{b}	3.65^{ab}	0.70
Colour	4.85^{a}	4.10^{a}	4.60^{a}	3.80^{b}	0.85	4.15^{a}	3.80^{a}	3.80^{a}	3.80^{a}	0.73
Texture	5.85^{a}	3.85^{c}	4.55^{a}	4.70^{b}	0.69	4.70^{a}	4.85^{a}	4.85^{a}	4.70^{a}	0.86
Overall acceptability	5.85^{a}	3.70^{b}	4.20^{b}	3.75^{b}	0.60	4.00^{a}	3.80^{a}	3.65^{a}	3.75^{a}	0.56

Values are means of 20 replications. Values with different superscripts within a row are different at 5% confident level.

4. Conclusion

The proximate and mineral compositions and sensory quality of steamed Bambara groundnut paste from different vendors and the same vendor at different time varied significantly ($p < 0.05$). The preference for samples from Vendor A was consistently preferred to others. This indicates that generally, the quality consistency is lacking. Giving the place of steamed Bambara groundnut paste in the diet of people, attempt shall be made to provide standard for this food.

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