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Production and Evaluation of Porridge-Type Breakfast Product from *Treculia africana* and Sorghum Bicolor Flours

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Abstract: Porridge-type breakfast products were prepared by blending boiled and fermented (24 h) *Treculia africana* and fermented (24 and 48 h) sorghum flours in 80:20, 70:30, 60:40 and 50:50 ratios. Products were evaluated for composition, functional properties and sensory acceptability. A commercial indigenous porridge-type product (Ogi dawa), served as the control. Products contained 14.24%-15.75% crude protein, 4.09%-6.00% ether extract and an average metabolizable energy of 1.8 KJ. Fermented *Treculia africana* products had higher ($p \leq 0.05$) soluble carbohydrate and water uptake than other products. The formulated products exhibited lower ($p \leq 0.05$) apparent viscosity than equal concentration of the control. Residual anti-nutrients, tannin, phytate, cyanide and lectin were generally low in the products. Blend of 50:50 boiled *Treculia africana* and fermented (24 h) sorghum product was least preferred. All blends of fermented *Treculia africana* products except 50:50 ratio had high ($p \leq 0.05$) scores for mouthfeel, colour and appearance. All formulated products had higher nutrient density than the control.

Key words: Porridge-type breakfast product, *Treculia africana*, sorghum bicolor, functional properties, fermentation, nutrient density, cereal-legume composites, "Ogi-dawa"

INTRODUCTION

There is increased interest in African breadfruit (*Treculia africana*, Decne) seed because of its potential as a protein supplement (Nwokolo, 1996). The seed has been reported to contain 17-23% crude protein, 11% crude fat and other essential vitamins and minerals (Akubor *et al*., 2000). African breadfruit is widely cultivated in the southern states of Nigeria where it serves as low cost meat substitute for poor families in some communities (Badifu and Akubor, 2001; Ugwu *et al*., 2001). However despite the elucidation of the nutritional qualities of African breadfruit by Ekpenyoung (1985) the use of the seed has been limited to only local traditional culinary practices which makes the seed under exploited. There is therefore a need to diversify the use of the seed by developing non-traditional foods with the seeds.

The enrichment of cereal based foods with legumes and oilseeds has received considerable attention. High protein breakfast meals and weaning foods have been developed from composites of cereal and legumes like soybean, cowpea and pigeon pea but *Treculia africana* seed has not been used for such product even though it can serve that purpose considering its nutritional qualities.

In Nigeria, the high cost of commercial industrially produced high protein energy rich breakfast products make them out of reach of low income earners consequently people in this wage category who constitute an appreciable percentage of the population depend for their breakfast on left over super or at best on sole cereal porridge that is of low nutritional value. Meanwhile indigenous legumes like *Treculia africana* seeds if properly complemented with carbohydrate sources will provide affordable breakfast products that will help to alleviate protein-energy malnutrition particularly among school age children. There is therefore the need to develop affordable low cost high protein energy breakfast product whose production would not require high technology. This study therefore aims at formulating breakfast product using *Treculia africana* seeds and evaluating the composition and sensory acceptability of the formulated product.

MATERIALS AND METHODS

Sorghum (Sorghum bicolor) seeds (white variety) and African breadfruit (*Treculia africana*, Decne) seeds were procured from Nsukka main market, Enugu State, Nigeria.

Preparation of *Treculia africana* seed samples

Parboiling: Seeds (5 kg) of *Treculia africana*, were washed to remove extraneous materials and immature seeds in excess volume of water, drained and parboiled in excess volume of water at 95°C for 15 min with constant stirring. The boiling time was recorded from the point the water started to boil. The parboiled seeds were drained, air-dried and dehulled in a Bental mill whose teeth gap was adjusted to crack the seeds without crushing. The dehulled cotyledons were recovered by winnowing. One kilogram of the parboiled seeds was dried in an air oven at 100°C for 48 h and designated as Parboiled African Breadfruit (PAB).

Boiling: Parboiled *Treculia africana,* seeds (2 kg) were washed and cooked at 100°C for 40 min (based on the result of a preliminary study) in its volume of water (w/v) to dryness. Cooked seeds were dried at 100°C for 48 h and designated as Boiled African Breadfruit (BAB).

Fermentation: Parboiled *Treculia africana* seeds (2 kg) were washed and put into a plastic bucket containing its volume of water (w/v). The seeds were allowed to ferment for 24 h by natural microflora. After fermentation the seeds were steamed for 5min dried at 100°C and designated as Fermented African Breadfruit (FAB).

Preparation of sorghum Seeds: Sorghum seeds (4 kg) were cleaned to remove extraneous materials, washed and allowed to soak in excess water for 12 h. After soaking, the rehydrated seeds were divided into 2 batches, soaked in water and allowed to ferment by natural microflora for 24 and 48 h respectively. After fermentation the samples were washed steamed for 5min dried (100°C) and designated as FSO_{24} and FSO_{48} for sorghum fermented for 24 and 48 h respectively.

Preparation of seed flours: All the dried *Treculia africana* seeds (PAB, BAB and FAB) and the dried fermented sorghum (FSO_{24} and FSO_{48}) seeds were milled into flour and screened through a 40 mesh (British standard sieve) sieve. The flours were stored in closed screw-capped plastic bottles kept at -4±2°C until used for product formulation and analysis. The commercial sample (Ogi dawa) that served as control was also dried, milled and packaged as other samples.

Production of *Treculia africana*-Sorghum Composites The composites BAB: FSO_{24}, BAB: FSO_{48}, FAB: FSO_{24}, and FAB: FSO_{48} were blended in ratios of 80:20, 70:30, 60:40 and 50:50 *Treculia africana* flour to sorghum flour. The blends were mixed in a Kenwood food processor at full speed for 5 min, screened twice through a 40-mesh sieve to ensure adequate mixing. The composites were packaged and stored until analyzed.

Chemical analysis of individual flours and blends: Crude protein (Nx6.25), crude fat and total ash were determined on the flours and blends by the AOAC (1990) methods. Residual moisture was determined by the hot air oven method. Total carbohydrate was estimated by difference. Energy (caloric) values were estimated from Atwater factors.

Antinutrients: Tannin was determined by the method of Price and Butler (1977). Phytate was determined by the method of Thompson and Erdman (1982). The methods of Cooke (1977) was used in determining cyanide while lectin was determined as percent agglutination by the method of Kaneko *et al*., (1974).

Functional properties: Selected functional properties of the blends were determined using standard methods.

Water uptake: Water uptake was determined by the method of Johnson *et al.* (1980). Each product blend (1 g) was dispersed in 10 ml of distilled water, centrifuged for 15 min at 500 rpm and the supernatant decanted. The flour precipitate was weighed and water uptake expressed as percent was calculated using the expression

$$\%\ \text{water uptake} = \frac{\text{weight difference}}{\text{original weight}} \times 100$$

pH and titratable acidity: pH and titratable acidity values were determined using standard AOAC (1990) methods. Acidity was expressed as percent lactic acid.

Apparent viscosity: Apparent viscosity was determined on 10% dispersion of each product blend using Ferranti Viscometer. Each dispersion was converted into porridge by heating at 100°C for 10 min. Viscosity was measured at 40°C.

Soluble carbohydrate: Soluble carbohydrate was determined on the product blend using the standard AOAC (1990) method.

Sensory analysis: Porridge was prepared with each product blend by boiling 1:4 (v/v) flour to water dispersion at 100°C for 10 min. The products were evaluated for flavour, taste, colour and appearance, mouthfeel, consistency and overall acceptability by a 20 member panel on a 7 point hedonic scale with 1 representing the lowest rating and 7 the highest rating (Ihekoronye and Ngoddy, 1985).

Data analysis: Determinations were done in 3 replicates. The Least Significant Difference (LSD) test was used to test differences between means. Statistical analysis was done by using the Genstat 5 release 3.2 (PC/windows 95) copyright, 1995, Lawes Agricultural Trust (Rothamsted Experimental Station).

RESULTS AND DISCUSSION

Table 1 shows the composition of the flours and flour blends. There were significant ($p \leq 0.05$) differences between the composition of the individual flours and blends. The proximate values obtained for the parboiled *Treculia africana* seed flour compares with the values reported by Akubor and Badifu (2004) for parboiled *Treculia africana* seed flour.

Composition of individual flours: The fermented *Treculia africana* seed flour (FAB) had higher ($p \leq 0.05$)

crude ether extract than the parboiled (PAB) samples. The difference was attributed to the activities of lipolytic enzymes during fermentation. Akpapunam and Achinewhu (1985) made similar observation in fermented cowpea while Achinewhu and Isichei (1990) reported similar increases in ether extract in the fermentation of fluted pumkin seeds. Marginal increase ($p>0.05$) was observed in the ether extract of the sorghum flour as fermentation extended to 48 h. Fermenting *Treculia africana* seeds for 24 h caused 11% increase ($p \le 0.05$) in the crude protein content when compared to the parboiled seeds. The micro-organisms involved in the fermentation may have found the sample a conducive medium for growth and activity. The highly significant ($p \le 0.05$) increase observed in the protein content of the Boiled African Breadfruit (BAB) when compared to the PAB was attributed to heat induced hydrolysis of the protein and its complexes to lower molecular weight components with the release of amino acids.

Significant ($p \le 0.05$) decreases were observed in the carbohydrate content of FAB when compared to PAB and the carbohydrate content of FSO_{48} when compared to FSO_{24}. The decreases were attributed to the activities of amylases which hydrolyzed the carbohydrate to simpler sugars to provide energy for the fermenting micro-organisms. Similar decrease was reported by Isichei and Achinewhu (1988) in the fermentation of African oil bean seeds (*Pentaclethra macrophylla*).

Tannin level decreased significantly ($p \le 0.05$) in the 48 h fermented sorghum (FSO_{28}) when compared to the 24 h fermented (FSO_{24}) sorghum. The decrease was attributed to the enzymic hydrolysis of the polyphenolic compounds with increased fermentation time. Obizoba and Amaechi (1992) made similar observations on fermented baobab seed. Fermentation was observed to be more effective in reducing phytate in *Treculia africana* seed flour than boiling treatment. However Fardiaz and Markakis (1981) had earlier noted the effectiveness of fermentation in reducing phytate and attributed it to the activities of phytase. According to Fardiaz and Markakis (1981) the enzyme phytase dephosphorylates phytate in successive steps terminating with the formation of inositol and phosphoric acid.

Composition of the formulated products and control: The formulated products had higher ($p \le 0.05$) ether extract, crude protein and metabolizable energy than the control. Differences in composition among the different treatments of the formulated products were not statistically significant but the products containing boiled *Treculia africana* (BAB) had marginally higher ($p>0.05$) crude protein than those blends containing fermented *Treculia africana* (FAB). The differences were attributed to possible effect of the higher ($p \le 0.05$) protein level in the BAB flour. Similarly product blends containing FAB flour exhibited marginally ($p>0.05$) higher ether extract than the blends containing BAB flour due probably to the fermentation induced higher ether extract in FAB flour because of the activity of lipolytic enzyme during fermentation. However, the observed marginal differences in ether extract did not exert any significant effect on the metabolizable energy value of FAB blends compared to other blends.

Antinutrients tannin and phytate were significantly higher ($p \le 0.05$) in the control than in the formulated products. The lower ($p \le 0.05$) tannin in the formulated product relative to the control was particularly noteworthy because of the nutritional implication. Tannins are known to reduce the availability of proteins, carbohydrates and minerals by forming indigestible complexes with the nutrients (Obizoba and Atti, 1991). Invariably therefore decreased tannin will be associated with increased availability of proteins and mineral (Nnam, 1999). Significant differences ($p \le 0.05$) were observed in the phytate levels of products containing BAB flour and FAB flour. The difference was attributed to the activities of phytase during the fermentation of FAB.

Products containing FAB flour had higher ($p \le 0.05$) soluble carbohydrates than the control and products containing BAB flour (Table 2). This higher level of soluble carbohydrate was attributed to the activities of amylolytic enzymes which breakdown complex carbohydrate to simpler and more soluble monomers during fermentation. Steaming of the samples after fermentation may also have enhanced starch gelatinization and hence solubilization of the native starch contained in both the sorghum and *Treculia africana* seed flours. However, the low ($p \le 0.05$) soluble carbohydrate observed in the control cannot be readily explained considering the fact that the control is also a fermented sorghum product.

Functional properties of the formulated products and control: Selected functional properties of the formulated products and the control is shown in Table 2.

Apparent viscosity: At equal porridge concentration (10%), the control exhibited higher ($p \le 0.05$) apparent viscosity than the formulated products. Among the formulated products, blends of BAB and FSO_{24} had higher ($p>0.05$) apparent viscosity than other blends. The lower apparent viscosity of the formulations containing FAB was attributed to the enzymic breakdown of higher molecular weight polysaccharide and polypeptides to lower molecular weight dextrins and peptides during fermentation. Similar enzymic breakdown was supposed to have occurred in the control being a fermented sorghum product as well. Apparently, the inherent native starch in the control exhibited its normal viscofying properties since it was not modified unlike the starch in the product blend that

Table 1: Composition of flours of fermented sorghum seed, parboiled, boiled and fermented *Treculia africana* seeds and their blends (Dry weight basis)

Sample	Ether extract (%)	Protein (Nx6.25) %	Total ash (%)	N-free extract (%)	Metabolizable energy (KJ)	Tannin (mg/100 g)	Phytate (mg/100 g)	Cyanide (mg/100 g)	Lectin (%)
BAB+FSO$_{24}$ 80:20	5.6^{b}	15.02^{c}	1.37^{a}	78.01^{c}	1.77^{bc}	68.81^{b}	124.03^{f}	0.02	0.54^{a}
BAB+FSO$_{24}$ 70:30	5.43^{b}	15.08^{c}	1.45^{a}	78.06^{c}	1.79^{bc}	71.02^{c}	122.27^{ef}	0.02	0.52^{a}
BAB+FSO$_{24}$ 60:40	4.30^{b}	15.60^{c}	1.91^{a}	78.09^{c}	1.75^{bc}	73.28^{cd}	121.36^{ef}	0.02	0.49^{a}
BAB+FSO$_{24}$ 50:50	4.09^{b}	15.06^{c}	2.64^{b}	78.21^{c}	1.72^{bc}	81.34^{c}	124.45^{ef}	0.01	0.45^{a}
BAB+FSO$_{48}$ 80:20	4.52^{b}	15.74^{c}	1.42^{a}	78.22^{c}	1.74^{bc}	66.40^{a}	122.56^{ef}	0.02	0.64^{ab}
BAB+FSO$_{48}$ 70:30	4.43^{b}	15.28^{c}	1.39^{a}	78.90^{c}	1.74^{bc}	67.44^{b}	121.14^{ef}	0.01	0.59^{a}
BAB+FSO$_{48}$ 60:40	4.45^{b}	15.32^{c}	1.36^{a}	78.87^{c}	1.74^{bc}	68.48^{bc}	120.31^{ef}	0.01	0.44^{a}
BAB+FSO$_{48}$ 50:50	4.39^{b}	15.37^{c}	1.37^{a}	78.87^{c}	1.74^{bc}	69.48^{bc}	118.91^{dc}	0.02	0.39^{a}
FAB+FSO$_{24}$ 80:20	5.65^{b}	14.52^{c}	2.20^{b}	77.63^{c}	1.76^{bc}	68.90^{bc}	87.28^{d}	0.01	0.42^{a}
FAB+FSO$_{24}$ 80:20	6.01^{bc}	14.44^{c}	1.74^{a}	77.81^{c}	1.77^{bc}	71.06^{c}	90.86^{d}	0.01	0.44^{a}
FAB+FSO$_{24}$ 70:30	5.73^{b}	14.29^{c}	1.64^{a}	78.34^{c}	1.77^{bc}	73.02^{cd}	94.44^{c}	0.01	0.39^{a}
FAB+FSO$_{24}$ 60:40	5.62^{b}	14.24^{c}	1.62^{a}	78.52^{c}	1.76^{bc}	81.40^{c}	98.02^{c}	0.01	0.43^{a}
FAB+FSO$_{48}$ 50:50	6.00^{bc}	15.38^{c}	1.48^{a}	77.14^{c}	1.77^{bc}	66.50^{ab}	86.66^{d}	0.02	0.43^{a}
FAB+FSO$_{48}$ 80:20	5.71^{b}	14.72^{c}	1.48^{a}	78.09^{c}	1.77^{bc}	67.52^{b}	89.94^{bc}	0.01	0.43^{a}
FAB+FSO$_{48}$ 70:30	5.74^{b}	14.64^{c}	1.53^{a}	78.09^{c}	1.77^{bc}	68.50^{b}	93.24^{c}	0.02	0.54^{a}
FAB+FSO$_{48}$ 50:50	5.06^{b}	14.53^{c}	1.76^{a}	78.65^{c}	1.75^{bc}	69.34^{bc}	96.48^{c}	0.01	0.58^{a}
Control	1.07^{a}	7.51^{a}	2.08^{b}	89.34^{f}	1.63^{a}	1604.37^{g}	221.9^{h}	0.02	0.96^{bc}
PAB	9.65^{d}	18.65^{d}	2.14^{b}	69.56^{b}	1.84^{bc}	75.01^{d}	143.3^{g}	0.03	0.79^{b}
BAB	7.83^{c}	24.18^{f}	2.82^{b}	65.17^{a}	1.79^{bc}	64.48^{a}	125.0^{f}	0.02	0.65^{ab}
FAB	11.60^{c}	20.78^{c}	1.27^{a}	66.35^{a}	1.90^{c}	64.51^{a}	80.13^{a}	0.02	0.57^{a}
FSO$_{24}$	1.70^{a}	11.61^{b}	1.67^{a}	85.02^{c}	1.68^{ab}	86.48^{f}	115.9^{dc}	0.04	0.94^{bc}
FSO$_{48}$	2.16^{a}	12.56^{b}	2.65^{b}	82.63^{d}	1.67^{ab}	74.48^{a}	112.82^{d}	0.03	0.93^{bc}
LSD	1.67	1.85	0.61	2.04	0.41	2.56	4.43	0.004	0.32

Mean on the same column with different superscript differ significantly ($p \leq 0.05$), n = 3

BAB = Boiled African breadfruit flour FSO$_{24}$ = 24 h fermented sorghum PAB = Parboiled African breadfruit flour

FSO$_{48}$ = 48 h fermented sorghum FAB = Fermented African breadfruit flour

Table 2: Selected functional properties of *Treculia africana* based porridge-type breakfast product

Sample	Apparent viscosity (cps,40°C)	Water uptake (%)	Titrable (% lactic acid)	pH	Soluble Carbohydrates (mg/100 g)
BAB+FSO$_{24}$ 80:20	35^{d}	80^{b}	0.70^{ab}	6.46^{d}	22.08^{a}
BAB+FSO$_{24}$ 70:30	30^{c}	80^{b}	0.08^{ab}	6.28^{cd}	22.42^{ab}
BAB+FSO$_{24}$ 60:40	30^{c}	84^{c}	0.06^{ab}	6.20^{cd}	23.39^{ab}
BAB+FSO$_{24}$ 50:50	36^{d}	88^{d}	0.09^{ab}	6.0^{bc}	24.13^{b}
BAB+FSO$_{48}$ 80:20	29^{c}	82^{b}	0.07^{ab}	6.27^{cd}	22.48^{ab}
BAB+FSO$_{48}$ 70:30	29^{c}	84^{c}	0.05^{b}	6.10^{c}	22.52^{ab}
BAB+FSO$_{48}$ 60:40	27^{bc}	84^{c}	0.08^{b}	6.06^{c}	22.59^{ab}
BAB+FSO$_{48}$ 50:50	28^{c}	86^{cd}	0.09^{bc}	5.84^{bc}	22.99^{ab}
FAB+FSO$_{24}$ 80:20	25^{b}	96^{c}	0.07^{ab}	6.34^{cd}	37.70^{c}
FAB+FSO$_{24}$ 70:30	26^{bc}	98^{e}	0.08^{b}	6.16^{c}	33.54^{c}
FAB+FSO$_{24}$ 60:44	26^{bc}	98^{e}	0.07^{ab}	5.87^{bc}	33.42^{c}
FAB+FSO$_{24}$ 50:50	24^{ab}	99^{e}	0.08^{b}	5.75^{b}	35.75^{d}
FAB+FSO$_{48}$ 80:20	20^{a}	99^{e}	0.06^{ab}	6.27^{cd}	34.04^{cd}
FAB+FSO$_{48}$ 70:30	22^{a}	99^{e}	0.07^{ab}	6.16^{c}	35.41^{d}
FAB+FSO$_{48}$ 60:40	24^{ab}	99^{e}	0.07^{ab}	6.54^{d}	35.44^{d}
FAB+FSO$_{48}$ 50:50	26^{bc}	99^{e}	0.07^{ab}	6.17^{c}	34.69^{cd}
Control	81^{c}	70^{a}	0.18^{d}	4.39^{a}	22.02^{a}
LSD	2.1	4.0	0.02	0.3	1.74

Mean on the same column with different superscript differ significantly ($p \leq 0.05$), n = 3

BAB = Boiled African breadfruit flour FSO$_{24}$ = 24 h fermented sorghum PAB = Parboiled African breadfruit flour

FSO$_{48}$ = 48 h fermented sorghum FAB = Fermented African breadfruit flour

was pregelatinized during steaming of the individual seed samples. The nutritional implication of this observed property is that the formulations containing FAB would permit the addition of higher quantities of the product solid for equal volumes of the porridge compared to the other products. In other words FAB containing products have higher nutrient density than the control and other formulations (Ariahu *et al*., 1999).

Water uptake: The formulated products had higher ($p \leq 0.05$) water uptake than the control. High water uptake is related to the extent of gelatinization. Steaming of the wet fermented seeds prior to drying may have partially or completely gelatinized the starch granules such that they imbibed water more readily. Conversely the control probably had a greater proportion of its starch granules in the native form and so had lower tendency to

Table 3: Sensory scores of *Treculia africana* based porridge-type breakfast product

Product blend	Flavour	Taste	Colour and appearance	Mouthfeel	Consistency	General acceptability
BAB+FSO$_{24}$ 80:20	4.8^{ab}	4.8^{ab}	4.7^{a}	4.8^{b}	5.6^{bc}	5.3^{ab}
BAB+FSO$_{24}$ 70:30	4.8^{ab}	4.8^{ab}	5.1^{ab}	4.9^{b}	5.6^{bc}	5.1^{ab}
BAB+FSO$_{24}$ 60:40	4.5^{ab}	4.6^{ab}	5.5^{b}	4.1^{a}	5.3^{ab}	4.7^{a}
BAB+FSO$_{24}$ 50:50	4.2^{a}	4.4^{a}	4.7^{a}	4.4^{a}	3.9^{a}	4.5^{a}
BAB+FSO$_{48}$ 80:20	5.1^{ab}	4.6^{ab}	5.4^{b}	4.7^{ab}	5.4^{ab}	5.2^{ab}
BAB+FSO$_{48}$ 70:30	5.2^{b}	4.7^{ab}	5.4^{b}	4.9^{b}	5.1^{ab}	5.0^{ab}
BAB+FSO$_{48}$ 60:40	4.8^{ab}	4.5^{ab}	4.7^{b}	5.3^{bc}	4.7^{ab}	4.8^{a}
BAB+FSO$_{48}$ 50:50	5.2^{b}	4.2^{a}	.5.0^{ab}	4.9^{b}	5.4^{ab}	5.3^{ab}
FAB+FSO$_{24}$ 80:20	5.2^{b}	5.1^{b}	5.6^{b}	5.6^{cd}	5.8^{c}	5.2^{ab}
FAB+FSO$_{24}$ 70:30	5.1^{ab}	4.5^{ab}	5.6^{b}	5.3^{bc}	5.8^{c}	5.3^{ab}
FAB+FSO$_{24}$ 60:40	4.4^{a}	5.0^{b}	5.5^{b}	4.8^{b}	5.8^{c}	4.8^{a}
FAB+FSO$_{24}$ 50:50	4.7^{ab}	4.5^{a}	5.4^{b}	5.3^{bc}	5.3^{ab}	5.0^{ab}
FAB+FSO$_{48}$ 80:20	5.0^{ab}	5.0^{b}	6.2^{c}	6.1^{d}	5.8^{c}	5.1^{ab}
FAB+FSO$_{48}$ 70:30	4.9^{ab}	4.7^{ab}	6.2^{c}	6.0^{d}	5.4^{ab}	5.0^{ab}
FAB+FSO$_{48}$ 60:40	4.4^{a}	5.4^{ab}	6.1^{c}	6.0^{d}	5.6^{bc}	4.8^{a}
FAB+FSO$_{48}$ 50:50	4.9^{ab}	4.5^{ab}	5.9^{bc}	6.3^{a}	5.6^{bc}	4.8^{a}
Control	4.5^{ab}	4.7^{ab}	5.9^{bc}	4.8^{b}	5.4^{ab}	5.3^{ab}
LSD	0.88	0.88	0.48	0.61	0.87	0.83

Mean on the same column with different superscript differ significantly ($p \leq 0.05$), n = 3

BAB = Boiled African breadfruit flour
FSO$_{24}$ = 24 h fermented sorghum
PAB = Parboiled African breadfruit flour
FSO$_{48}$ = 48 h fermented sorghum
FAB = Fermented African breadfruit flour

imbibe water readily. It also had limitation to the amount of water it can imbibe. The observed higher water uptake in FAB flour containing products than in BAB flour containing products was attributed to an additional activity of proteases during fermentation with the concomitant release of lower molecular weight peptides.

pH and titrable acidity: The control showed an acidic lower pH and higher titrable acidity that differed significantly ($p \leq 0.05$) from the pH of the formulated products (Table 2). The higher pH observed in the formulated products was attributed to a dilution effect by the *Treculia africana* flour which contain higher levels of protein and so exhibits neutral or near neutral pH. Achinewhu (1986) noted that during the fermentation of protein rich seeds there is increased activity of proteolytic enzymes which hydrolyse proteins to release free amino acids, peptides and ammonia which tends to increase pH. The higher titrable acidity and lower pH observed in the control was attributed to the activities of amylolytic enzymes which hydrolyse carbohydrates to organic acids (Odunfa, 1983). The nutritional implication of the neutral pH observed in the formulated products is that porridge prepared from the products would not be stored after preparation since it can easily encourage the growth of toxigenic micro-organisms and may constitute health hazard.

Sensory acceptability: Means sensory scores of the *Treculia africana* based products and control in shown in Table 3. The results show that all the formulated products had high sensory scores in all the sensory attributes compared to the control. The 80:20, 70:30, 60:40 blends of FAB + FSO$_{48}$ had higher ($p \leq 0.05$) mean score for colour and appearance. Comparing blends of FAB + FSO$_{48}$ with the control and all other product blends, it was seen that all the FAB + FSO$_{48}$ blends except for 50:50 ratio showed significantly higher ($p \leq 0.05$) means score for mouthfeel than other products. Similarly all the FAB + FSO$_{48}$ blends except the 50:50 ratio had significantly ($p \leq 0.05$) higher mean score for consistency than the control and other blends of the formulated products. Evidently, blends of products containing FAB were preferred by the panelist to the control and the other blends of products. However, the fact that all the products had mean scores that were above the average score of 3.5 in all attributes evaluated indicate that the products were all acceptable.

Conclusion: The study has shown that fermentation followed by steaming as methods of preparing *Treculia africana* and sorghum seed flours for use in porridge type product formulation enhances detoxification and better modifies the functional properties of the seed flours. The product formulation was based on commonly consumed plant foods in Nigeria. The technology used is also common and can easily be adopted at household level. The products compared favourably well in sensory acceptability with the commercial local breakfast product. In terms of nutrients composition the formulated products were more nutrient dense than the control. Production of *Treculia africana* based breakfast product therefore will provide a high protein-energy breakfast product than the commercial indigenous sole sorghum product and will also help in diversifying the use of *Treculia africana* seeds.

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