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Quality Evaluation of Nigerian Indigenous Based Food (*Upursah:* i.e. "Tiger nut composites flour") from Tiger Nut, Sorghum, Sweet Potato and Soybean

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Tiger nut, sorghum grain, sweet potato and soybean were processed into flours and were formulated into six indigenous foods (*Upursah*). Evaluation of their quality parameters was considered as the objective. Particle size distribution, functional properties, proximate composition, mineral elements, microbiological plate counts, and sensory properties of these blends were evaluated. Their particle size distribution generally varies. Other results are: bulk density (0.52 to 0.61 g/cm^3), water absorption capacity (1.33 to 3.00 cm^3/g), percentage dispersibility (63.50 to 75.00), moisture (3.23 to 7.81 g), ash (2.02 to 3.69 g), protein (3.85 to 13.61 g), fat (9.16 to 20.12 g), carbohydrate (57.98 to 80.06 g), Potassium (2.30 to 4.30 mg/100 g), iron (1.31 to 2.66 mg/100 g), zinc (0.01 to 0.27 mg/100 g), magnesium (0.20 to 3.20 mg/100 g), sodium (65.32 to 94.76 mg/100 g), total plate count (1.1 x 10^2 to 2.0 x 10^2 CFU/ml), presumptive coliform count (4 x 10^2 to 1.2 x 10^2 CFU/ml) and yeast-mould counts (2.3 x 10^2 to 2.7 x 10^2 CFU/ml). But four of the *Upursah* formulations (A, B, D, E) had no growth of yeasts-moulds. Microbial counts did not exceed recommended limits. All results for sensory attributes except one lie above the Hedonic scale of like slightly. Therefore, *Upursah* can be produced on large scale and incorporated into global diets.

Keywords: Formulations, blends, *Upursah*, sensory, particle, flour, tiger nut, indigenous food

INTRODUCTION

Upursah is flour made from either raw or toasted tiger nut, with resultant white, slightly brown or brown flour colour depending on the severity of heat effect used. Many researchers have reported tiger nut flour for making tiger nut milk, bakery and confectionary (Bamishaiye and Bamishaiye, 2011; Elena *et al*., 2012; Ayo *et al*., 2018) but there is scanty information on *Upursah*. However, among the tribes of *Kilba, Marghi, Chibok, Gwoza, Babur-Bura* and *Michika* in the North Eastern Nigeria, *Upursah* was said to have existed as old as the beginning of civilization. Also, there is another form of similar product obtained from tiger nut called *Dakuwa* which may serve as probably an evidence for the existence of tiger nut flour (*Upursah*) among these tribes since ancient times. While *Dakuwa* is being produced from tiger nut and groundnut as reported by Igwe *et al*. (2015), *Upursah* is produced from either tiger nut alone or in combination with any cereal grain. In production of *Dakuwa*, the quantity of tiger nut is usually higher than that of groundnut (Igwe *et al*., 2015). However, it was said that groundnut is usually incorporated into the mixing ratio at appropriate levels (Igwe *et al*., 2015) to facilitate pounding and molding of *Dakuwa* into desired shining shapes (Figures 1 and 2). Many people and researchers in Nigeria do not know these differences, but often end up calling *Upursah* as *Dakuwa* or vice versa. *Upursah* have many traditional applications among the tribes (*Kilba, Marghi, Chibok, Gwoza, Babur-Bura* and *Michika*) in North Eastern Nigeria. It can be licked directly or used for the production of other indigenous beverages such as


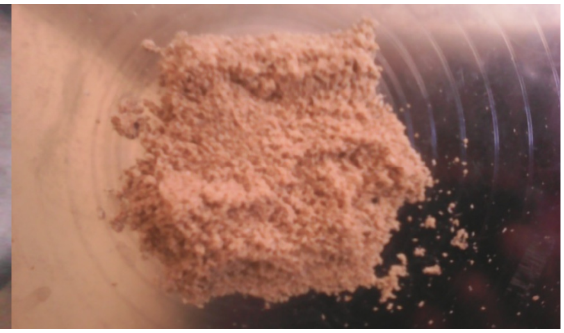

Figure 1. Home made *Dakuwa* Figure 2. Home made *Upursah*

Kunun aya (similar to *Kunun zaki*), tiger nut milk (*Madaran aya*) and also *Kunun aya* or *Kunu* (i.e. the gruel type) or it can be added as adjunt to indigenous alcoholic drinks such as *Burukutu* or *Pito* to reduce effects of alcoholic toxicity and increase satiety (Bristone *et al*., 2018). Bristone *et al*. (2018) stated that sometimes this product or its equivalent is simply called “tiger nut” and up to these days, is being used as energy given food to farmers, warriors, wrestlers and those that embark on long journey.*Upursah* is a special food presented as gifts to brides by parents and at the same time with the aim of later use to entertain their bridegrooms, visitors or guests (Bristone *et al*., 2018). Other uses of tiger nut flour as reported by Bamishaiye and Bamishaiye, (2011) and Ayo *et al*. (2018) are being used in confectionary and baking industries for the production of biscuits, candies, imitation milk and as flavouring agent for ice cream production. Those tribes in the North Eastern Nigeria believed that the consumption of *Upursah* gives them extra-ordinary strength (energy) and resistance against cold weather more than other foods they consume (Bristone *et al*., 2018). These claims are not far from what was reported by many researchers on the benefits of consumption of tiger nut and its products (Bamishaiye and Bamishaiye 2011; Adejuyitan, 2011; Ayo *et al*., 2018). It appeared; those tribes in the North Eastern Nigeria have known much about tiger nut than any other tribe in the world.

The benefits of consuming tiger nut and its product have been reported in many occasions. It is rich in essential amino acids, minerals and vitamins. It was also reported that tiger nut is high in starch and dietary fiber. It is also rich in sucrose, fat and protein as reported by many researchers. Its mineral richness includes; sodium, calcium, potassium, magnesium, zinc and traces of copper (Umerie and Enebeli 1997; Oladele and Aina, 2007; Ukwuru *et al*., 2011; Ayo *et al*., 2018). The dietary fibre content of tiger nut was reported as being effective in the treatment and prevention of diseases such as colon cancer, coronary heart diseases, obesity, diabetes and gastro – intestinal disorders. Tiger nut tubers are also known to have diuretic and stimulating effects. Their tonic natures have been reported by many researchers. Besides these, it is good for the treatment and management of flatulence, indigestion, diarrhea and dysentery (Ukwuru *et al*., 2011; Gambo and Da’u, 2014; Ayo *et al*., 2018). Nigerian tiger nut varies from black, yellow, and brown in colour (Bamishaiye and Bamishaiye, 2011; Imam *et al*., 2013). These also vary in sizes, ranging from small, medium or big. They also vary in textures. Some may be soft, while some may be stiff and tough when chewed. Their sweetness also differs. In Northern Nigeria, they have special application and uses. But mostly being use for human consumption. Some wild unidentified species and varieties which grow in swampy areas in the Northern part of Nigeria is most often being use for medicinal purposes and for making spices. Tiger nut may be eaten raw; also soaked in water and eaten raw or toasted and eaten. S´anchez-Zapata *et al*. (2012) reported that tiger nut is a crop of early domestication and was added to other crop of the Nile Valley; its dry tubers have been found in tombs from predynastic times about 6000 years ago. However, since there is the wild species growing in Nigeria and possibly in many other part of the world, nobody knows the real origin of tiger nut. Up to these days, many plants species such as tiger nut, yams, melon, rice, bambara groundnut, beans, okra, kenaf plant, sorrel, spinach, palm trees, etc. are still growing as wild plant in the Nigerian wild forest. Even though some of these plants such as bambara groundnut (*Wada-Hoba* i.e. *Kilba* groundnut) was said (through oral history) to have originated from *Kilba* tribe in North eastern Nigeria. One of this evidence was reported that bambara groundnut is indigenous to sub-Saharan Africa where it is widely cultivated and that the centre of origin is most likely North Eastern Nigeria and Northern Cameroon, in West Africa (FAO, 2018). The origin of these tribes and other history such as *Wada-Masar* (Egyptian groundnut) believed to have originated from Egypt, was reported in a Kilba magazine by the Official Publication of Kilba Students, University of Maiduguri Chapter (Gaji, 2007). Though FAO (2002) reported that groundnut is native to South America and has never been found uncultivated. On the other hand, complementation of tiger nut with sorghum grain for the production of *Upursah* is not a new technology among those tribes in North eastern part of Nigeria. Though, the major reason for the complementation is not well understood, whether is being done to increase its nutritional or sensory qualities. One possibility is to fill the gap or mask the annual deficit in tiger nut production which would yield abundance of *Upursah*. However, the benefit of consuming Sorghum bicolor has been reported by many researchers and is well understood. FAO (1995a) reported that Sorghum bicolor contain polymeric polyphenols (tannins), flavonoids, minerals and B-vitamins; the very good constituents which have therapeutic and nutritional benefits. Nonetheless, other staple foods such as sweet potatoes and soybeans have more of these potentials. Consumption of sweet potato and its products have many advantages. These include antimicrobial, antidiabetic, antiulcer, anticancer, antioxidant, anti-inflammatory, hepatoprotective wound healing ability, immunomodulatory enhancer. Sweet potatoes contain high amount of potassium needed for human relaxation and promote health being of the nervous system. It is also regarded as super food in terms of its nutrients and phytochemical constituents compared to many vegetables (Milind and Monika, 2015; Ayeleso et al., 2016). Similarly, proteins, lipids, vitamins and minerals, are major nutritionally important components of soybeans. Specifically, the B-vitamins, calcium, essential amino acids and omega-3 essential fatty acids are its significant nutritional potentials (Lokuruka, 2010). Many researchers advocated tiger nut as a vital ingredient in the ready to use therapeutic foods. The consumption of tiger nut and tiger nut related food products is increasing over the years because of its nutritional, health benefits and refreshing ability.

Therefore, in view of the above, the objective of this research is to explore the production of *Upursah* and determine its quality parameters.

MATERIALS AND METHODS

Raw material collection

The raw materials used for this study are: tiger nut (the bigger brown nut), sorghum (*Chakaleri* red), sweet potato (white varieties) and soybean were obtained from custom market in Maiduguri, Borno state, Nigeria. The materials were processed in the Department of Food Science and Technology, University of Maiduguri.

Preparation of *Upursah*

Sweet potatoes were selected and hand-peeled using a sharp stainless steel knife and were washed in potable water clean before cutting into thin slices. These sliced potatoes were dipped in water to avoid colour changes. These were further rinsed properly as reported by Akonor *et al*. (2015) before drying in a solar tent drier at 60°C for 48 h. Tiger nut also were handpicked to remove contaminants. They were washed in clean water as reported by Oladele *et al*. (2017) before drying in a solar tent drier at 60°C for 48 h. Sorghum grains were also sorted to remove contaminants. The grains were thoroughly washed and rinsed with clean as reported, before drying in a solar tent drier at 60°C for 48 h.

Soybeans were first sorted, washed and soaked for five hours in a clean water of three times its weight by volume until the coat became soaked and wet to assist in removal of some soluble anti nutrients and to facilitate dehulling. Soybeans were further washed, drained and partially sun dried. These were roasted at surface temperature of 180°C for 30 min and then cracked in a disc grinder for easy dehuling and removal of chaff. These were then milled in a disc grinder as reported by Bristone *et al*. (2015). Also, the dried tiger nut, sweet potatoes and sorghum were toasted at surface temperature of 180°C for 30 min as reported Bristone *et al*., (2015) before milling in a disc grinder. The grinding process was repeated four times so as to obtain fine flours.

Formulation of different blends of *Upursah*

After processing the raw materials into flours, they were formulated according to native formations and these were compared with researcher's formulations. These natives' formulations consist of 100% tiger nut flour; 1:1 ratio of tiger nut flour into sorghum flour or sweet potato flour and they were compared with researcher's formulations which consist of 2:1 or 1:1 ratio of carbohydrate into protein rich sources (Table 1). The various mixtures were blended (Figure 3) using Kenwood mixer (Model HM 430) as described by Bristone *et al*. (2015) and Ehimen *et al*. (2017).

Determination of percentage particle size distribution of different blends of *Upursah*

Percentage particle size distribution were evaluated by placing 100 g of each of the flours formulated on a tier of sieves (USA Standard Testing Sieve A.S.T.M E-11 Specification, USA) of decreasing apertures (1 mm, 850 um, 710 µm, 500 µm, 425 µm, 300 µm, 250 µm, 150 µm, 63 µm and base pan) and was allowed to stand on an automatic standard sieve shaker (Humboldt Mfg. Co. Testing equipment laboratory apparatus, Norridge, USA). The shaker was operated for 10 min each time and the retention on each sieve was then weighed and expressed as percentage particle size distribution as described by

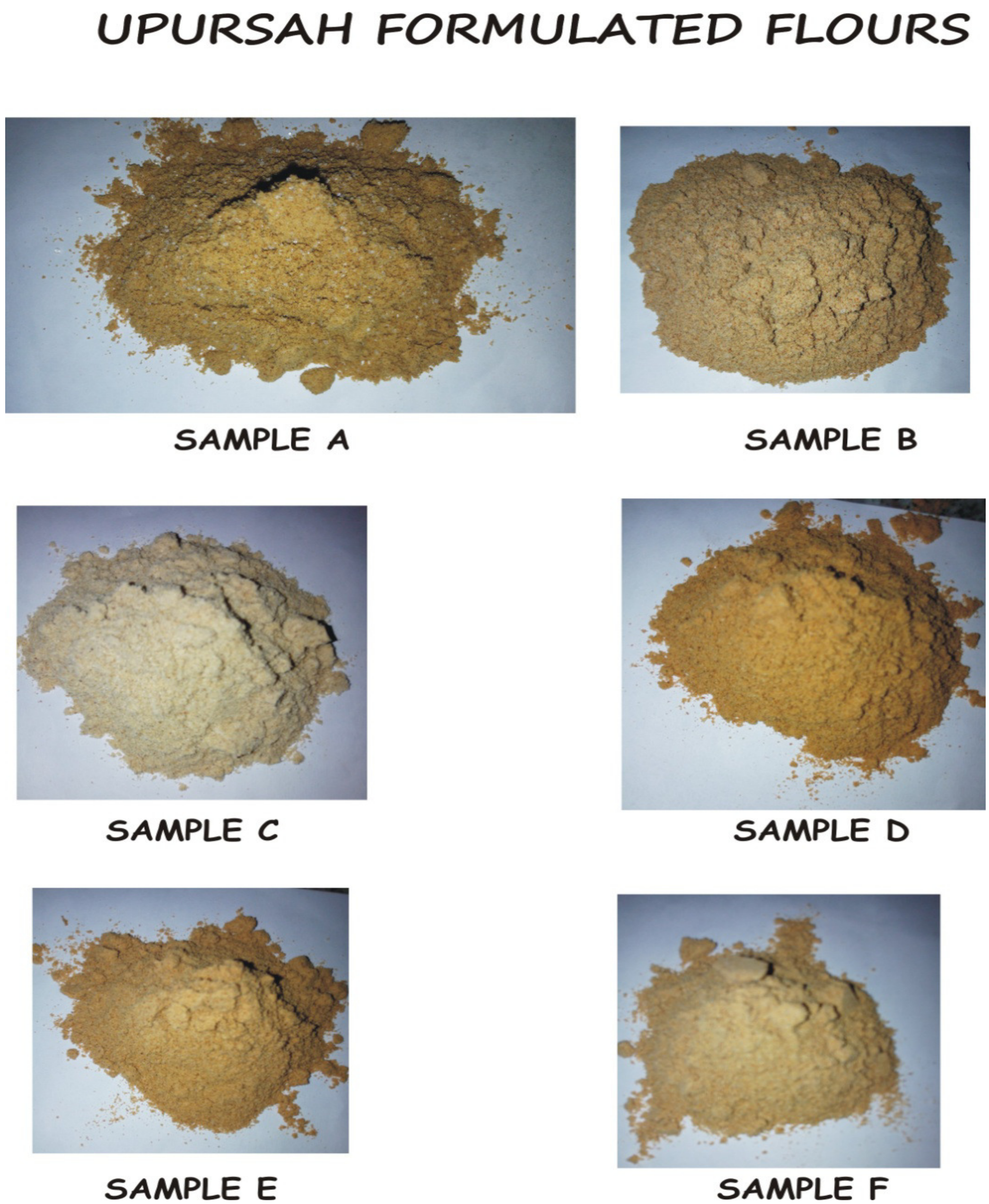

Figure 3. Blends of laboratory made *Upursah.*

Nishita and Bean, (1982).

Determination of functional properties of different blends of *Upursah*

Determination of bulk density

Bulk density of blend was determined by weighing 10 g into a clean 100 ml graduated measuring cylinder. The measuring cylinder ~~It~~ was tapped repeatedly on a padded flat table until constant volumes of flour was obtained. This was expressed as weight of flour (g) per its constant volume (cm^3) as described by Murphy *et al*. (1982) (2003) and Ojinnaka *et al*. (2013).

$$\text{Bulk density } (g/cm^3) = \frac{\text{Weight of flour (g)}}{\text{Constant volume of flour } (cm^3)}$$

Determination of percentage dispersibility

This was measured by placing 10 g each of the *Upursah* blends in a 100 ml stopper measuring cylinder. Then

Table 1. Different blends of *Upursah.*

Formulations	Tiger nut	Sorghum	Sweet potato	Soybean	Sugar	Total
Natives' formulations						
A	90.00	-	-	-	10.00	100
B	45.00	45.00	-	-	10.00	100
C	45.00	-	45.00	-	10.00	100
Researcher's formulations						
D	45.00	-	-	45.00	10.00	100
E	30.00	30.00	-	30.00	10.00	100
F	30.00	-	30.00	30.00	10.00	100

Note: A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut +45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

distilled water was added to reach 100 ml mark of the cylinder. It was vigorously stirred and was allowed to settle for 3 h. The volume of settled particles was subtracted from 100 ml mark and the difference was expressed as percentage dispersibility as reported by Malomo *et al.* (2012).

Determination of water absorption capacity

Water absorption capacity was measured by using 1 g of flour. It was mixed with 10 ml of distilled water in a centrifuge tube and allowed to stand at room temperature for 30 minute. After that it was centrifuged at 3500 rpm for 30 minutes. The volume of water in the sediment was measured. Water absorption capacity was calculated as ml of water absorbed per gram of flour (Ojinnaka *et al.*, 2013).

$$\text{Water absorption } (cm^3/g) = \frac{\text{Volume of water absorbed } (cm^3)}{\text{Weight of flour (g)}}$$

Proximate composition

The moisture, protein, fat, ash and carbohydrate content of blends were determined using the method described by AOAC (1990) and Asma *et al.* (2006).

Determination of moisture content

The moisture content of the blends was estimated by oven drying method. Each *Upursah* blends (5 g) was measured in triplicates into three different labeled Petri-dishes. Prior to this, the weight of the empty dishes were measured and recorded. The *Upursah* blends were placed in an oven at 105 ± 1°C for 3 h. After 3 h of drying, they were taken out of the oven and cooled in desiccators. They were all reweighed again. The *Upursah* blends were returned to the oven again for another 30 min of oven drying. This procedure was repeated until a constant weight was obtained (AOAC, 1990). The percentage moisture was calculated using the formula:

$$\text{Moisture content (g)} = \frac{\text{Loss of weight on drying x 100}}{\text{Initial weight of blend}}$$

Determination of ash content

The organic matter burnt at 550°C leaving only the residue behind. Therefore, the ash content of the *Upursah* was determined using 3 g placed into crucible. It was pre-ash and placed in a furnace to ash completely at 550°C for 5 h. It was then taken out from the furnace and was cooled in desiccators before weighing (AOAC, 1990). The percentage ash was determined using:

$$\text{Ash content (g)} = \frac{\text{Weight of ash x 100}}{\text{Weight of blend}}$$

Determination of crude fat

The crude fat content of the various *Upursah* formulations was determined as described by AOAC (1990). Three grammes each of the *Upursah* formulations was wrapped in cotton wool and placed into Soxhlet thimble. The fat was extracted for 5 h using petroleum ether. After extraction, the solvent was recovered and the fat remaining in the flask was dried in the oven, cooled in desiccator and weighed.

$$\text{Fat content (g)} = \frac{\text{Weight of fat x 100}}{\text{Weight of blend}}$$

Determination of protein content

Crude protein was determined by kjeldahl method (AOAC, 1990). One gramme of *Uprusah was* introduced into 100 ml digestion flask, followed by addition of 2 g anhydrous sodium sulphate, one gram hydrated cupric sulphate, a pinch of selenium powder, and 10 ml of concentrated sulpuric acid. It was digested at 420°C for 45 min until clear digest was obtained. After digestion, distilled water was added into the flask up to the 100 ml mark and then mix thoroughly.

After digestion, 5 ml of boric acid was introduced into 250 ml conical flask and 2 drops of indicator added. Then, 5 ml of the diluted digest was introduced into the distillation apparatus. The delivery tube was submerged in distilled water to prevent escape of ammonia. After 20 ml of 40% NaOH was introduced into the flask. It was then distillated into the 250 ml conical flask containing the boric acid and indicator (bromocresol and methyl red) until about 50 – 75 ml of distillate was collected (Egan *et al*., 1988; AOAC, 1990; Nielsen, 2002). The distillate in the conical flask was titrated with standard solution of hydrochloric acid (HCl) to the end point. The titre volume was recorded, i.e. volume of HCl that exchanged with the indicator and percentage crude protein was calculated using:

$$\text{Protein content (g)} = \frac{A \times C \times 100 \times 16.25}{B \times D \times 1000 \times E}$$

Where:

A = Volume of solution of standard HCl added (Titre value)
B = Volume of diluted digested *Upursah* solution taken for distillation
C = Volume of *Upursah* solution made after digestion
D = Weight of *Upursah* taken for digestion
E = Acid factor

Determination of carbohydrate content

The available percentage of carbohydrate in the *Upursah* was estimated by difference i.e. {100%-% (moisture + protein + ash + fibre + fat)} as described by Chibuzo and Ali (1995) and Asma *et al*. (2006). The carbohydrate content was calculated using:

Carbohydrate content (g) = 100 g – (moisture g + protein g + ash g + fibre g + fat g).

Determination of mineral content of blends of *Upursah*

Five grams of the blended *Upursah* were weighed into crucibles was ash at 550ºC for 5 h. Then, 5 ml each of concentrated hydrochloric acid (HCl) and trioxonitrate (v) acid (HNO3) was added to the ash and heated for dissolution. The solution was made up to 100 ml with distilled water. Similarly, blank was also prepared with same acids and was diluted to 100 ml with distilled water. Measurement of absorbance and the concentration of *Upursah* (PPM) using atomic absorption spectrophotometer were carried out on the whole portion of prepared *Upursah* solution (100 ml). Blank standard was also prepared (PPM) and absorbance of standard against concentration was also measured. Then, graph of absorbance against concentration was plotted. The absorbance of *Upursah* solution was noted and mineral content calculated (IITA, 1979; AOAC, 1990; Nielsen, 2010) using the following formula:

$$\text{Mineral content (mg/kg)} = \frac{A \times Fv \times D}{Wt}$$

Where:
A = Concentration of standard mineral solution obtained from graph
Wt = Weight of *Upursah* used
Fv = Final volume of *Upursah* extracted or digested weight of *Upursah* used
D = Dilution factor

Microbiological plate counts

Cleaning, sterilization and preparation of microbial apparatus and media

All glass wares were soaked in synthetic detergent and were allowed to stand for 30 min. They were rubbed gently with sponge and rinsed thoroughly in tap water and then in distilled water. After that, they were dried in an analytical hot air oven at 80°C. After drying and cooling of glass wares, they were assembled in canisters and sterilized in hot air oven at 160ºC for 60 min. These were allowed to cool properly inside the oven before opening (Cheesbrough, 2006; Jideani and Jideani, 2006).

Preparation of nutrient agar (basic medium)

Nutrient agar is most often regarded as multi-medium because it generally supports the growth of most bacteria. It was prepared by weighing 28 g of nutrient agar powder into 1000 ml of distilled water (i.e. 7 g of agar into 250 ml distilled water) inside conical flask. The mouth of the conical flask was stopper with sterile cotton wool and wrapped loosely with aluminum foil. This medium was heated slightly on heating mantle to get dissolved properly and was then autoclaved at temperature of 121°C for 15 min. The medium was cold to 45°C for inoculation (Cheesbrough, 2006; Jideani and Jideani, 2006).

Preparation of macConkey agar (differential medium)

MacConky agar was prepared by weighing 48.5 g of the macConkey agar powder into 1000 ml of distilled water (i.e. 12.13 g of agar into 250 ml distilled water) inside conical flask. The mouth of the conical flask was stopper with sterile cotton wool and wrapped loosely with aluminum foil. The medium was mixed thoroughly and heated slightly on a heating mantle to dissolving completely. This was then autoclaved at temperature of 121°C for 15 min. The medium was cold to a temperature of 45°C (for inoculation) and was maintained at that temperature inside water bath in order to avoid solidification of the medium (Cheesbrough, 2006; Jideani and Jideani, 2006).

Preparation of potato dextrose agar (selective medium)

Potato dextrose agar (PDA) was also prepared by weighing 39 g of potato dextrose agar into 1000 ml distilled water (i.e. 9.75 g into 250 ml) inside conical flask. It was autoclaved at a temperature of 121°C for 15 min. This medium was also cold to 45°C for inoculation (Cheesbrough, 2006; Jideani and Jideani, 2006).

Serial dilution

One gram of the blends was weighed and aseptically mixed thoroughly with 9 ml of sterile distilled water in a sterile bijou bottle. Then 1 ml out of this mixture was taken using 1 ml sterile pipette and was transferred into another 9 ml of sterile distilled water in a sterile bijou bottle. This was also mixed thoroughly for uniform suspension of test organisms to obtained serial dilution of 10^2 (Cheesbrough, 2006; Jideani and Jideani, 2006).

Plating, incubating and colony counting

Total plate count

The total plate count was determined by taken 1 ml of the diluents (i.e. 1 ml suspension of the mixture) using sterile 1 ml pipette. This was introduced into the sterile labeled microbial plate. Then about 18 ml out of the prepared nutrient agar was then poured into the sterile labeled microbial plate and was swirled gently to mix thoroughly. This was allowed to solidify. The inoculated plate was incubated at 37°C for 24 h. Colonies were counted using colony counter (Cheesbrough, 2006; Jideani and Jideani, 2006). The result was expressed using:

$$\text{Total plate count (CFU/g)} = \frac{\text{Number of colonies}}{\text{Volume transferred to plate x dilution blank factor}}$$

Coliform count

Coliform count was also determined using pour plate method. This was done by taken 1 ml of the diluents (i.e. 1 ml suspension of the mixture) using sterile 1 ml pipette. This was introduced into the sterile labeled microbial plate. Then about 18 ml out of the prepared macConkey agar was then poured into the sterile labeled microbial plate and was swirled gently to mix. The inoculated plates containing the culture medium were allowed to solidify. This was incubated at 37°C for 24 h. Colonies were counted using colony counter (Cheesbrough, 2006; Jideani and Jideani, 2006). However, eosin methylene blue (EMB) was not used to further confirm the growth colonies. Therefore, the result was expressed using:

$$\text{Presumptive coliform count (CFU/g)} = \frac{\text{Number of colonies}}{\text{Volume transferred to plate x dilution blank factor}}$$

Yeasts-moulds count

Yeasts-moulds count was also determined using pour plate method. This was done by weighing 1 ml of the diluents (i.e. 1 ml suspension of the mixture) using sterile 1 ml pipette. This was also introduced into the sterile labeled microbial plate. Then about 18 ml out of the prepared potato dextrose agar (PDA) was then poured into the sterile labeled microbial plate and was swirled gently to mix. The inoculated plates containing the culture medium were allowed to solidify. This was incubated at room temperature for 5 days and was observed daily. Colonies were counted using colony counter (Harigan and McCance, 1979). Therefore, the result was expressed using:

$$\text{Yeasts-moulds count (CFU/g)} = \frac{\text{Number of colonies}}{\text{Volume transferred to plate x dilution blank factor}}$$

Sensory analysis

Sensory attributes of blends were evaluated using nine-point Hedonic scale. *Upursah* blends were first coded with odd random digit numbers and were presented to ten panelists selected from among the students who were familiar with *Upursah*. They were asked to evaluate the *Upursah* blends, expressing their degree of like or dislike (Larmond, 1977).

Statistical analysis

Except for minerals and microbiological counts, all data generated were subjected to analysis of variance (ANONA) using IBM SPSS statistics version 20 and means were separated by Duncan’s Multiple Range Test

Table 2. Particle size distribution of different blends of *Upursah*

Mesh size	Natives' formulations			Researcher's formulations		
	A	B	C	D	E	F
1 mm	37.92	71.48	60.14	65.34	20.68	86.44
850 µm	8.20	2.40	11.36	7.56	14.32	3.38
710 µm	28.38	11.58	17.02	13.90	40.88	4.26
500 µm	21.48	9.84	6.48	8.18	16.18	0.50
425 µm	2.46	1.12	0.76	1.12	1.36	2.40
300 µm	0.98	1.72	1.00	1.06	2.14	1.30
250 µm	0.28	0.94	0.64	0.60	2.08	0.90
150 µm	0.02	0.54	0.62	0.24	1.44	0.82
63 µm	0.00	0.04	0.00	0.00	0.00	0.00
Base pan	0.28	0.34	0.00	0.00	0.92	0.00

Note: A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut +45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

Table 3. Functional properties of different blends of *Upursah*

Formulations	Water absorption (cm^3/g)	Bulk density (g/cm^3)	Percentage dispersibility
Natives' formulations			
A	1.33 ± 0.29^c	0.59 ± 0.01^b	65.00 ± 1.00^d
B	3.00 ± 1.80^a	0.57 ± 0.02^c	75.00 ± 1.00^a
C	2.00 ± 0.50^b	0.54 ± 0.02^d	71.00 ± 1.00^b
Researcher's formulations			
D	1.67 ± 0.29^c	0.59 ± 0.51^b	63.50 ± 0.50^e
E	3.00 ± 1.00^a	0.61 ± 0.02^a	67.00 ± 1.00^c
F	2.00 ± 0.50^b	0.52 ± 0.02^e	63.50 ± 1.50^e

Each value is a mean of triplicate determination. Note: ND = not detected, A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut +45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

(DMRT) at 5% significant level (Duncan, 1955).

RESULTS AND DISCUSSION

Particle size distribution of different blends of *Upursah*

The particle size distribution of different blends of *Upursah* is presented in (Table 2). The various sieve sizes used ranged from 1 mm to 63 µm. The particle size distribution of the blends recorded in sieve with size 1 mm is ranged from 20.68 to 86.44 g, sieve 850 µm ranged from 2.20 to 14.32 g, sieve 710 µm ranged from 4.26 – 40.88%, sieve 500 µm ranged from 0.50 to 21.48 g, sieve 425 µm ranged from 0.76 to 2.46 g, sieve 300 µm ranged from 0.98 to 2.14 g, sieve 250 µm ranged from 0.28 to 2.08 g, sieve 150 µm ranged from 0.02 to 1.44 g, sieve 63 µm ranged from 0.00 to 0.04 g, and base pan ranged from 0.00 to 0.92 g. Sieve with size 1 mm size was observed to have the highest particle size distribution, followed by 710 µm sieve, and 63 µm sieve is the least. In terms of their total or percentages, 1 mm (342 g) sieve had the highest, followed by 710 µm (116.02 g), 500 µm (62.66 g), 850 µm (47.22 g), 425 µm (9.22 g), 300 µm (8.20 g), 250 µm (5.44 g),150 µm (3.68 g), base pan (1.54 g), and least was µm (0.40 g). Particle size of flour plays a major role in contributing to the desired characteristics of food such as in terms of uniformity, textural, and amount of fibre. Nielsen (2010) reported that the extraction efficiency of lipids from dried foods depends on particle size; therefore, adequate grinding is very important. It was observed that high percentage of particles of flours did not pass through the mesh with smaller aperture for fine flour yield. The FAO (1995b) recommended that granularity of 98% or more of particle sizes of cereal flour or its blends must past through a 212 micron mesh (No. 70 sieve). Results of particle size distribution of formulations obtained in this study indicated very low percentage if compared with FAO recommendation. However, slightly similar researches conducted have corresponding values (Hayes *et al*., 2012).'

Functional properties of different blends of *Upursah*

The functional properties of different blends of *Upursah* are shown in (Table 3). The bulk density of the blends

Table 4. Proximate composition of different blends of *Upursah*

Formulations	Moisture	Ash	Protein	Fat	Carbohydrate
Natives' formulations					
A	4.21 ± 0.01^{bc}	2.02 ± 0.02^{e}	4.36 ± 0.06^{d}	20.12 ± 0.08^{a}	69.29 ± 0.17^{d}
B	4.20 ± 0.01^{bc}	2.05 ± 0.05^{e}	4.85 ± 0.05^{d}	10.72 ± 0.16^{e}	78.18 ± 0.16^{b}
C	4.73 ± 0.31^{b}	2.20 ± 0.20^{d}	3.85 ± 0.15^{e}	9.16 ± 0.13^{f}	80.06 ± 0.36^{a}
Researcher's formulations					
D	7.81 ± 0.06^{a}	3.20 ± 0.20^{b}	13.61 ± 0.02^{a}	17.28 ± 0.24^{b}	57.98 ± 0.31^{f}
E	4.39 ± 0.01^{bc}	2.59 ± 0.09^{c}	10.90 ± 0.01^{b}	13.27 ± 0.05^{c}	68.85 ± 0.14^{e}
F	3.23 ± 0.03^{d}	3.67 ± 0.17^{a}	9.85 ± 0.16^{c}	12.41 ± 0.05^{d}	70.84 ± 0.41^{c}

Mean values with different superscripts in each column are significantly different at $p < 0.05$
Note: A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut +45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

ranged from 0.52 to 0.61 g/cm^3, water absorption capacity ranged from 1.33 to 3.00 cm^3/g and percentage dispersibility ranged from 63.50 to 75.00. It was observed that functional properties of *Upursah* varied ($p < 0.05$) significantly. For bulk density, sample E (30 g tiger nut + 30 g sorghum + 30 g soybean +10 g sugar) had the highest bulk density while sample F (30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar) had the least bulk density. For percentage dispersibility, sample B (45 g tiger nut + 45 g sorghum + 10 g sugar) had the highest value while sample D (45 g tiger nut +45 g soybean + 10 g sugar) and F (30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar) had the least value. For water absorption capacity, sample containing sorghum (sample B and sample E) had the highest value while sample A (90 g tiger nut + 10 g sugar) and sample D (45 g tiger nut + 45 g soybean + 10 g sugar) the least value. It appeared sorghum contributed greatly for the higher level of buck density, percentage dispersibility and water absorption capacity while tiger nut, soybean and sweet potato contributed for lower level of buck density, percentage dispersibility and water absorption capacity of blends. Carbohydrates have been reported to greatly influence the water absorption capacity and this may be the reason for sorghum significant influence (Malomo *et al*., 2012; Ehimen *et al*., 2017) as observed on (Table 3).

Functional properties of foods are the physicochemical characteristics of food systems which negatively or positively affect its utilizations, operations or processing. These properties give useful information before, during or after food processing and have the ability to influence consumers' acceptability (Bristone *et al*., 2017). Food composition such as carbohydrate, proteins and fats also was reported to influence these properties (Nielsen, 2010). In this research, the bulk density (0.52 to 0.61 g/cm^3) of *Upursah* is slightly higher than the tiger nut and acha flours made for biscuits production (Ayo *et al*. 2018). But in a slightly similar study on some physicochemical properties of flour obtained from fermentation of tigernut (*Cyperus esculentus)* sourced from a market in Ogbomoso, Nigeria, indicated higher value (0.83 - 0.91 g/ml) of bulk density (Adejuyitan *et al*., 2009). For water absorption capacity (1.33 to 3.00 cm^3/g) of *Upursah,* it was still higher than water absorption capacity (1.00 ± 0.00 to 1.05 ± 0.01 g) the tiger nut and acha flours made for biscuits production (Ayo *et al*., 2018). But slightly correspond with water absorption capacity (123 to 141 g/100 g) of flour obtained from fermentation of tiger nut. Percentage dispersibility (63.50 to 75.00) of *Upursah* obtained in this study is much comparable to percentage dispersibility (65.4 ± 0.04 to 72.5 ± 0.03 g) of flour obtained from fermentation of tiger nut (*Cyperus esculentus)* sourced from a market in Ogbomoso, Nigeria (Adejuyitan *et al*., 2009). The higher the bulk density of food, the higher the needed concentration of nutrients per unit volume of that food if it is well dried or contain less moisture. But higher water absorption capacity and percentage dispersibility may require higher amount of water for constitution and wetting ability or hydration and is a disadvantage where there is limited water supply.

Proximate composition of different blends of *Upursah*

Table 4 shows the proximate composition of different blends of *Upursah*. The moisture content of blends ranged from 3.23 to 7.81 g, ash content ranged from 2.02 to 3.69 g, protein content ranged from 3.85 to 13.61 g, fat content ranged from 9.16 to 20.12 g and carbohydrate content ranged from 57.98 to 80.06 g. It was observed that proximate composition of *Upursah* varied ($p < 0.05$) significant. For moisture content of blends, only *Upursah* blend D (45 g tiger nut + 45 g soybean + 10 g sugar) and F (30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar) had the highest and least moisture respectively. Natives' formulations were observed to have least values in ash and protein than the researcher's formulations. Probably due to soybean addition since it was reported that soybean is rich in ash and protein. All the *Upursah* blends were also observed to be rich in fat and carbohydrate especially *Upursah* blend A (90 g tiger nut + 10 g sugar), D (45 g tiger nut + 45 g soybean + 10 g sugar); and C (45 g tiger nut + 45 g sweet potato + 10 g sugar). In all the formulations the increased in tiger nut and soybean have caused significant increased in fat levels. Similarly, there was an increased in protein of formulations upon and increased in soybean. These means a particular formulation could be selected for use base on the individual nutritional requirement.

Moisture is being used as quality factor for preservation, quality factor for standard, convenience in packaging or shipping, compositional standards, and computations of the nutritional value of foods (Nielsen, 2010). Moisture content requirement of certain food may differ from one particular food to another. For example, prepared conventional cereals (4–8% moisture), liquid corn sweetener (≤ 20% moisture), glucose syrup (≤ 30% moisture), cheddar cheese (≤ 39% moisture), cereal flour or its blends (≤ 15% moisture), complementary foods (≤ 10% moisture) (CAC, 1991; FAO, 1995b; European Commission, 2003; Nestle Nutrition Institute, 2005; Nielsen, 2010; CAC, 2015). The moisture content (3.23 to 7.81 g) of *Upursah* is much less than the moisture contents of the intended food usages. *Upursah* at the local level is often being used as flour, ready-to-eat food, and complementary food. All formulations of *Upursah* are observed to be within the recommended ranges of moisture contents for flour, ready-to-eat food, and complementary food. This study also corresponded slightly with the moisture content (9.93±0.04 to 10.42±0.02 g) of flour obtained from fermentation of tiger nut (*Cyperus esculentus)* sourced from a market in Ogbomoso, Nigeria (Adejuyitan *et al*., 2009). In another study on tiger nut milk production indicated much corresponding value of moisture content (4.49 ± 0.42 g) of tiger nut flour (Bristone *et al*., 2015). Moisture contents of all *Upursah* in this study and their corresponding tiger nut flours were observed for good storage stability. Foods that have moisture level of less than 15% are expected to have shelf-life stability of more than a year under suitable storage condition (Demand, 1990).

A protein is important because cost of certain commodities may be based on the protein content, functional property, biological activity and amino acid composition (Nielsen, 2010). Protein content of food is also important in solving protein- energy malnutrition especially in the developing countries where substantial staple foods are majorly cereals and tubers. Formulations of *Upursah* with soybean (researcher's formulations) was observed to have protein content of 9.85 to 13.61 g which correspond with the protein content (8 to 12 g special need) of complementary foods (European Commission, 2003; Nestle Nutrition Institute, 2005; CAC, 2015). This also correspond with protein content (7.0 g minimum) of cereal flour or blends (FAO, 1995b) and slightly correspond with the protein content (12.00 g minimum) of flours advocated by the EU (2013). The indigenous formulations were observed to be deficient in protein (3.85 to 4.85 g). However, these are the formulations most often produced and consumed by the native of North-eastern Nigeria (*Kilba, Marghi, Chibok, Gwoza, Babur-Bura* and *Michika*). Some physicochemical properties of flour obtained from fermentation of tiger nut (*Cyperus esculentus)* sourced from a market in Ogbomoso, Nigeria is slightly lower in protein levels (7.73 to 9.23 g) (Adejuyitan *et al*., 2009) than the researcher's formulations but higher than the indigenous formulations. In a similar vein, protein content (7.80 ± 0.26) of tiger nut flour (Bristone *et al*., 2015) is also slightly lower than the researcher's formulations, but higher than the indigenous formulations.

Ash content represents the total mineral content in foods. It is a part of proximate analysis for nutritional evaluation of food (Nielsen, 2010). It means ash content of food is important for ascertaining the mineral richness or deficiency of food. The higher the ash contents of food the higher its mineral content. In this study, the ash content of *Upursah* ranged from 2.02 to 3.67 g which correspond with the recommended ash content of 0.00 to 3.00 g per 100 g of flours as advocated by the EU (2013). The ash content of *Upursah* did not vary much with other studies on tiger nut flours (Adejuyitan *et al*., 2009; Bristone *et al*., 2015). This means that ash content of tiger nut were not affected much by conditions they were processed.

Fat is important for assessing whether the food meets the standard of identity, manufacturing specifications, product of desirable quality, functionality, and nutritional labeling (Nielsen, 2010; Devis and Khatar, 2016). Irrespective of the source, fat is the most concentrated form of dietary energy; fat of any type provides 9 calories of energy per gram (www.cuchd.in/e-library/resource_library/.../Chap-14.pdf).

All the formulations were observed to be adequate in fat content (9.16 to 20.12 g) enough to provide needed energy by the body. The fat content of tiger nut was reported to contain essential fatty acid (Bamishaiye and Bamishaiye, 2011). The adequacy of *Upursah* in essential fatty acid made it an essential diet for human consumption. Other studies on tiger nut flour by Adejuyitan *et al*. (2009) and Bristone *et al*. (2015) indicated adequacy in fat content (11.24 ± 0.04 to 14.41 ± 0.04 g) and (26.26 ± 0.35) respectively. But most of these formulations were observed to be above the maximum limits of 10% fat recommended for complementary foods (CAC, 1991, Elemo *et al*., 2011) except formulation containing 45 g sorghum (*Upursah* blend B) and formulation containing 45 g sweet potato (*Upursah* blend C).

Carbohydrates are also important as other major source of energy. It contributes to textural properties, and as dietary fiber which influences physiological processes, also functional properties such as bulk density, viscosity, stability to emulsions and foams, water-holding capacity, freeze-thaw stability, browning, flavours, and a range of desirable textures from crispness to smooth, and soft gels (Nielsen, 2010). They also provide satiety and as a body for housing other nutrients. Carbohydrate content (57.98 to 80.06 g) of formulations was observed to vary. The carbohydrate content of blends of *Upursah* obtained in this study slightly corresponds to the value (58.96 ± 0.04) reported by Bristone *et al.* (2015). However, some physicochemical properties of flour obtained from fermentation of tiger nut (*Cyperus esculentus)* sourced from a market in Ogbomoso, Nigeria (Adejuyitan *et al*., 2009) showed much lower value of carbohydrate content. In this study it was observed that all the formulations of *Upursah* contained adequate amount of carbohydrate; needed to yield its function (carbohydrate) in foods especially in terms of satiety value to consumers of these products. It is recommended that all persons should limit calories from fat to not more than 30% and that most of the calories should come from soluble carbohydrate (Nielsen, 2010).

Mineral composition of different blends of *Upursah*

Table 5 shows mineral composition of different blends of *Upursah*. Potassium content of blends ranged from 2.30 to 4.30 mg/100 g, iron ranged from 1.31 to 2.66 mg/100 g, zinc ranged from 0.01 to 0.27 mg/100 g, magnesium ranged 0.20 to 3.20 mg/100 g and sodium ranged 65.32 to 94.76 mg/100 g. In most of the natives' formulations, it was observed that in most cases their mineral contents (iron, potassium and zinc) are slightly higher than the researcher's formulations except for magnesium. *Upursah* blend F (30 g tiger nut + 30 g sweet potato + 30 g soybean + 10 g sugar) was observed to be slightly higher in sodium while *Upursah* blend A (90 g tiger nut + 10 g sugar) was found to be the least in terms of sodium. The other *Upursah* blends had no much difference in their sodium content. Soetan *et al*. (2010) reported that these minerals are inorganic nutrients, usually required in small amounts from less than 1 to 2500 mg per day. Minerals are of nutritional and functional importance, and for these reasons their levels need to be known and controlled. The Nutrition Labeling and Education Act of 1990 (NLEA) mandated labeling of sodium, iron, and calcium contents largely because of their important roles in controlling hypertension, preventing anemia, and impeding the development of osteoporosis, respectively (Nielsen, 2010). In this study, most of the mineral element evaluated was observed to be deficient as compared with the general guideline for vitamins and minerals in cereal and soybean blends with the range of 0.50 to 0.60 g calcium, 0.30 to 0.45 g sodium, 5.00 to 15.00 mg iron and 2.50 to 5.00 mg zinc (Iwe, 2003). However, it was reported that some minerals are contained at high levels in natural foodstuffs while others are low (Nielsen, 2010) and also a particular mineral element of same food plant may vary due to location where the crop plant was grown (Soetan at al., 2010). Similarly, a large portion of phosphorus, zinc, manganese, chromium, and copper found in a grain kernel usually lost when the bran layer is removed during processing (Nielsen, 2010). Sometimes low level of these mineral elements is not the major problem if there is high bioavailability in foods. But if a mineral element is very low in food and there is very low bioavailability, then it is expected that consumers of such food would end up suffering the consequences of mineral deficiency. As such this calls for further research investigation of these products. It was reported that excessive intake of some of these minerals can cause toxic effects (homeostatic balance). It was known that excess sodium or iron intake, may lead to high blood pressure (hypertension), liver damage (body impairment); their deficiency may lead to drastic low blood pressure (coupled with dehydration) and anaemia associates with other metabolic disorder (Soetan *et al*., 2010). Therefore, moderately recommended levels of minerals should be maintained in foods, preferably in-between minimum and maximum levels.

Microbiological counts of different blends of *upursah*

Table 6 shows the microbiological count of different blends of *Upursah*. The total plate count of blends ranged from 1.1 x 10^2 to 20 x 10^2 CFU/g, presumptive coliform count ranged from 4 x 10^2 to 1.2 x 10^2 CFU/g and yeast-mould counts ranged 2.3 x 10^2 to 2.7 x 10^2 CFU/g. There was no growth of yeast-mould detected in *Upursah* blend A (90 g tiger nut + 10 g sugar), B (45 g tiger nut + 45 g sorghum + 10 g sugar), D (45 g tiger nut + 45 g soybean + 10 g sugar), and E (30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar). For the total plate, presumptive coliform and yeasts-moulds counts, researcher's formulations were observed to be slightly higher than the natives' formulations in terms of their microbial load.

The standard plate count (SPC), also referred to as the aerobic plate count or the total viable count, is one of the most common tests applied to indicate the microbiological quality of food (CMSF, 2001). This means that it is being use for estimating the number of microorganisms in food in order to establish its shelf-life or microbiological criteria, suitability for human consumption or spoilage (Jideani and Jideani, 2006). In this study, the total plate count of *Upursah* (1.1 x 10^2 to 2.0 x 10^2 CFU/ml) was observed to be below the limit range of $<10^4$ colony forming unit per gram (CFU/g) which is a satisfactory results and which indicated good microbiological quality that require no attention (CMSF, 2001). However, this level only applies to ready-to-eat foods in which all components of the food have been cooked in the manufacturing process or preparation of the final food product (CMSF, 2001).This may entails the

Table 5. Mineral composition of different blends of *Upursah* (mg/100 g).

Mineral Elements	Natives' formulations			Researcher's formulations		
	A	B	C	D	E	F
Potassium (K)	3.50	3.50	4.30	2.30	2.70	4.20
Iron (Fe)	2.40	2.10	2.66	1.31	1.36	2.46
Zinc (Zn)	0.01	0.14	0.27	0.11	0.19	0.24
Magnesium (Mg)	1.60	0.20	0.20	3.20	0.20	2.80
Sodium (Na)	65.32	82.80	82.80	80.04	82.80	94.76

Note: A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut + 45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

Table 6. Microbiological counts of different blends of *Upursah* (CFU/g).

Formulations	Total plate count	Presumptive coliform count	Yeast- Mould count
Natives' formulations			
A	1.1×10^2	6×10^2	NG
B	1.5×10^2	4×10^2	NG
C	1.4×10^2	8×10^2	2.3×10^2
Researcher's formulations			
D	1.6×10^2	9×10^2	NG
E	2.0×10^2	1.1×10^2	NG
F	1.8×10^2	1.2×10^2	2.7×10^2

Each value is a mean of triplicate determination. Note: NG = No growth, A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut + 45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

presence of both the spoilage and pathogenic organisms in *Upursah* but did not indicated level of being potentially hazardous to its consumers. On the other hand, if considered as flour for the preparation of other food products such as for the manufacture of confectioneries, vegetable milk, *Kunun aya* (*Kunun zaki*) or *Kunu* (gruel type), their total plate counts are already below the food safety legal basis of 100000 CFU/g (maximum limit) for flour or blends of flours (EU, 2013). Study on the microbial quality evaluation of tiger nut beverage (*Kunun aya*) processed sold in University of Maiduguri, shows high total plate count which ranged between 9.92×10^4 to 3.13×10^4 CFU/ml (Badau *et al*., 2018) and that of total staphylococcal count shows similar result which is ranged from 2.23×10^4 to 1.56×10^4 CFU/ml (Badau *et al*., 2018). This indicated serious potential hazards to its consumers. Another study on enteropathogenic bacterial contamination (5.16×10^4 to 1.17×10^5 CFU/g) of some ready to eat foods sold in Jos Metropolis, Nigeria indicated health risk (Zumes *et al*., 2014). Similarly, microbial quality assessment of commercial and home-made tiger-nut beverages in University of Valencia, Spain, showed that 73% of the products are of significant health risk (unsatisfactory) in terms of aerobic mesophilic count (Sebastin et. al, 2012). This means that tiger nut food and food products vended in Nigeria, Spain, and other parts of the world require good manufacturing practices (GMP) to safe guard the health of consumers especially if these foods are to be exported to other parts of the world. Tiger nut since it is from soil and because of the nature of its surfaces; microorganisms can adhere strongly on the seed tuber itself and can pass successfully during harvesting and postharvest handling. Manufacturing utensils and equipment are other sources of contamination that need to be checked.

The presence of these microorganisms in foods whether it is small or large may be considered significant in other areas. They may cause changes in sensory properties of food; introduce toxins into the food or causes infection to the consumer (Dubey and Maheshwari, 2014).

Coliform which was also observed in this study is any member of the Enterobacteriaceae which grows at 37°C and which possesses the enzymes β-*galactosidase* (Singleton, 1999). Typical members of this group are: Escherichia, Enterobacter, Citrobacter and Klebsiella (Jideani and Jideani, 2006). They are generally use as quality index of sanitization (faecal indicating microorganism). The presumptive coliform count (4×10^2 to 1.2×10^2 CFU/ml) of *Upursah* is slightly higher than the recommended limits of ready-to-eat food. The recommendation for most pathogen are below level of $<10^2$ per gram (CMSF, 2001). Also similar regulatory total coliform count limits of 100 CFU/g are recommended for flours by the food safety legal basis of the EU (2013).This level of unacceptability of *Upursah* which indicates

Table 7. Sensory attributes of different blends of *Upursah.*

Formulations	Colour	Texture	Flavour	Taste	Overall acceptance
Natives' formulation					
A	7.40±1.35[a]	7.30±0.95[a]	6.90±1.29[a]	8.40±0.69[a]	7.80±0.79[a]
B	6.90±1.10[ab]	7.20±1.14[a]	6.10±1.45[ab]	7.50±0.85[ab]	7.10±0.74[ab]
C	6.70±1.49[ab]	6.30±1.42[ab]	6.20±1.87[ab]	5.50±1.43[cd]	6.20±1.03[bc]
Researcher's formulation					
D	6.80±1.69[ab]	6.20±1.99[ab]	5.70±2.31[c]	4.40±2.07[e]	5.50±2.01[e]
E	7.10±1.37[a]	6.70±1.57[ab]	6.30±2.11[ab]	5.80±2.15[cd]	6.40±2.07[bc]
F	7.70±0.67[a]	6.90±1.73[ab]	6.30±1.89[ab]	6.70±2.45[c]	6.80±2.35[c]

Mean values with different superscripts in each column are significantly different at $p < 0.05$
Note: A = 90 g tiger nut + 10 g sugar, B = 45 g tiger nut + 45 g sorghum + 10 g sugar, C = 45 g tiger nut + 45 g sweet potato + 10 g sugar, D = 45 g tiger nut + 45 g soybean + 10 g sugar, E = 30 g tiger nut + 30 g sorghum +30 g soybean +10 g sugar, and F = 30 g tiger nut + 30 g sweet potato + 30 g soybean +10 g sugar

potential hazard may still be safe since some of their members are not pathogenic, but their presence is an indication of poor hygienic condition of processing which also entails the condition of the environment at which *Upursah* was processed. On the other hand, Elmahmood and Doughari,(2007) reported that coliform group is part of the normal flora of the intestine of human and vertebrates. Some strains of E. coli can cause gastroenteritis, diarrhea and urinary tract infections. In another study on the microbial quality of ready-to-eat foods made from tiger nut, indicated high total coliforms count of 1.56×10^4 to 6.0×10^4 CFU/ml (Badau *et al*., 2018). Similar study conducted on commercial and home-made tiger nut in Spain, University of Valencia indicated high level of pathogens especially E. coli. Also soil associates microorganisms were isolated. This means that all tiger nut intended to be consumed or to be processed whether in industry or at household level should be carried out under standard condition of processing to avoid all these contaminants that poses threat to its consumers. Considering the condition at which *Upursah* was processed (high temperature processing), one can conclude that these contaminants possibly contacted during milling of the raw materials into flours since it is difficult to put the entire machine free of microorganisms.

Moulds and yeasts are also evaluated in this study. It was reported that some moulds are harmful and they can produce toxic metabolite (e.g. Aspergillus flavus and Aspergiluss parasiticus). Yeasts are also undesirable because they can easily spoil food. Some yeast such as Candida albicans are pathogenic to the immuno-compromise individuals (Dubey and Maheshwari, 2014). Yeast-moulds counts determined in this study indicated four (4) out of the six (6) formulations investigated had no growth. Those that had growth showed low level of counts. Yeast-moulds counts (2.3×10^2 to 2.7×10^2 CFU/ml) of *Upursah* were observed to be much lower than the recommended limits of yeast count of 500 CFU/g or moulds count of 500 CFU/g advocated by the food safety legal basis of the EU (2013). Ready-to-eat tiger nut food consisting of 12 tiger nut beverage (Kunun aya) evaluated in the University of Maiduguri, Nigeria, indicated the following counts: total mould count ranged from 2.60×10^4 to 1.56×10^4 CFU/ml and total yeast count ranged from 2.6×10^4 to $I.56 \times 10^4$ CFU/ml (Badau *et al*., 2018) . Also ready-to-eat 22 commercial and 24 home-made tiger nut food products evaluated in University of Valencia, Spain, indicated high moulds and yeasts count (Sebastin *et al*., 2012). One of the major concerns of yeasts and moulds in foods is that some species can tolerate very low moisture (Osmophilic fungi) and grow to a very dangerous level and so spoil the foods without changing the ogarnoleptic profiles of the food. In many cases secondary metabolites (toxins) might have already been introduced into the food which may adversely affect the consumers' health after consumption (Ihekoronye and Ngoddy, 1985; Hui, 1992).

Sensory attributes of different blends of *Upursah*

Table 7 indicates sensory attributes of different blends of *Upursah*. These sensory attributes were ranged as follows: colour 6.70 to 7.70, texture 6.20 to 7.30, flavour 5.70 to 6.90, taste 4.40 to 8.40 and overall acceptance 5.50 to 7.80. It was observed that sensory attributes of *Upursah* varied significantly ($p < 0.05$). The quality attributes of *Upursah* for colour, texture and flavour did not varied significantly ($p < 0.005$), except for flavour of *Upursah* blend D (45 g tiger nut + 45 g soybean + 10 g sugar) which was observed to be rated lower. The taste and overall acceptance for *Upursah* blend D also was observed to be rated lower than the other *Upursah* blends. However, apart from *Upursah* blend D which was rated very low below the base line level of neither like nor dislike (5), all the *Upursah* blends were accepted moderately. But *Upursah* blend A (90 g tiger nut + 10 g sugar) was observed to be the most preferred formulation and *Upursah* blend D the least preferred.. *Upursah* blend D low rating compared to others may be due to the effect of higher level of soybean supplementation with soybean.

Conclusion

Nigerian indigenous food (*Upursah*) was produced from tiger nut, sorghum, sweet potato and soybean. Their quality parameters were evaluated. Percentage particle size distribution of *Upursah* differs and very low percentages were recorded in fine sieves. Functional properties of *Upursah* corresponded with many research. Proximate composition of blends vary with some had very low protein and some had adequate protein levels. The moisture contents of blends were low and could be suitable for storage. Levels of minerals in *Upursah* were observed to be lower than the standard recommended levels of minerals in foods and also in flour. The total plate count and moulds-yeasts counts were also observed to be very low within the range of value that poses no health risk to consumers except presumptive coliform count which was observed to be slightly higher. Generally, *Upursah* blends were accepted because most of the sensory scores of overall acceptability were above 6 on the 9 point hedonic scale. Incorporation of soybean into the mixtures improves the nutritional contents of *Upursah* in terms of protein, fat and ash.

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