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Physicochemical, Nutritional and Sensory Properties of " Dakuwa " From Blends of Finger Millet (Tamba), Groundnut and Moringa Seed Flour

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Abstract
"Dakuwa" a traditional Nigerian snack made from cereals and legumes was produced from finger millet (FM), groundnut (G/Nut), and moringa oleifera seed (MS) flour to form five samples A (FM 100: G/Nut 100: MS: 0), B (FM 100: G/Nut 50: MS: 50) C (FM 100: G/Nut 40: MS: 60) D (FM 100: G/Nut 30: MS: 70) E (FM 100: G/Nut 20: MS: 80). Proximate, mineral, vitamins, antinutrients and sensory properties of the products were investigated. Proximate composition of the products revealed that, moisture content ranged from 4.68 to 5.63%, ash 1.22 to 2.58%, Crude fibre 1.78 to 4.47%, Crude lipid 7.46 to 14.05%, Crude protein 17.00 to 20.14%, Carbohydrate 54.71 to 63.92% and energy (Kcal) 383.8 to 431.20%. All the samples showed higher percentage of Vit A (6.26 to 11.40IU) Vit Bl (18.50mg/100g to 21.73mg/!00g). Most of the Vitamins determined increased significantly ($P < 0.05$) as substitution with moringa seed increased. Mineral content ranged as follows: AL (33.5 to 86.9mg/100g); Ca (56.9 to 252.3mg/100g) Fe (100.5 to 128.0mg/100g), Zn (35.6 to 85.7mg/100g) Antinutrients generally increased as moringa seed substitution is increased. Sample E showed high tannin content of 253mg/100g, while sample had the least of the antinutrients ranging from 0.4% of phytate to 253mg/100g of tannin. Results of the sensory evaluation showed there was significant ($P < 0.05$) difference between the samples in terms of colour, texture and general acceptability, with the other samples being generally more acceptable than sample A (the control sample).
Keywords: Moringa Seed Flour, Moisture Content, Crude Protein, Sensory.
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INTRODUCTION

Snacks are sweet or savoury foods eaten to provide light sustenance in a quick and convenient format (Ocheme et al, 2014). They are eaten or as an alternative to main meals, International food information service (IF1S.2005). Snack foods are essential vehicles for delivery of essential nutrients because of the growing change in eating habits (Ocheme et al; 2014).

Dakuwa is a traditional Nigerian snack produced from mixture of cereal, groundnut, ground pepper, ginger, sugar and salt (Ocheme et al, 2014a; Igwe et al, 2015; Ocheme et al, 2014 b). The ingredients are thoroughly mixed, pounded and moulded into balls that can be eaten without further processing (Abdulrahman and Kolawole, 2003). Nkama and Gbenyi(2001 Reported Dakuwa is also produced from cereals (maize, millet and sorghum), tiger nuts and groundnuts. These authors also reported that in the traditional method of Dakuwa processing, the grains are cleaned, toasted and ground together to give a paste.

Dakuwa production is a major occupation for many women and young girls who can be seen hawking the product throughout the northern states of Nigeria. It is a shelf-stable product which can keep for about six (6) months at room temperature (Igwe, 2015).

Among the cereals, millet is second only to sorghum as the most important food grain and major source of calorie, proteins and vitamins for people in developing countries.

Nutritionally, finger millet (Eleusinecoracana) is a good source of nutrients especially of calcium, other minerals and fibre (Singh and Raghuvanshi, 20I2). Finger millet grains also contain essential fatty acids such as linolenic and palmitic acids which are essential for the development of brain and neutral tissue (Kunyanga et al, 2013: Mathalmilarasan et al, 2016). Low fat content together with dietary fibre and higher amounts of carbohydrate which are available in the form of non – starchy polysaccharides are essential in providing nutritional and physiological benefits such as hypocholestrolaemic and hypoglycemeic effects (Vanithasri et al, 2012; Banusha and Vasannth euba, 2013). Dietary fibre which contributes to high nutritional and functional importance is also present in FM grains. Dietary fibre which is classified into cellulose, pectin, arabinexylan, lignin and B-glucan (Prashantha and Muralikrisna 2014) assist in determing the end use quality of cereal-based food product. Moringa oleifera {Moringaceae) is a fast growing soft wood tree indigenous to sub-Himalayan tracts of north in India. Nowadays, M. oleifera is mainly found in the Middle East and in African and Asian countries. In Nigeria it is found in the northern part of the country. Moringa seed has a high protein content, on

average 31.4%, whereas carbohydrate, fibre and ash contents are 18.4%, 7.3% and 6.2% respectively (Leone et al, 2016). Thus, the defatted seeds of M. oleifera could provide an economical source of protein for use as a food supplement to traditional diets such as dakuwa to increase protein intake. Furthermore, like the protein fraction, M. oleifera seeds have a high content of high methionine and cysteine, close to that reported for milk and eggs (Leone, et al, 2016). Therefore they can be consumed together with legumes which are deficient in sulphur amino acides. Moreover, M. oleifera seeds seems to be free of trypsin inhibitor and urease activity, confirming the high protein digestibility (93%) of M. oleifera seeds (Leone et al, 2016).

Groundnut grow well in southern Mali and adjacent regions of the Ivory coast, Barkinafaso, Ghana, Nigeria and Senegal. In Nigeria and Ghana groundnut is used for candies 'Kulikuli' and 'Nkate' cake respectively, (Yelmi 2014). It's also used in Dakuwa processing in northern Nigeria.

No one legume or cereal can provide adequate amounts of all nutrients to meet the nutritional requirements of humans (FAO, 2016). However, even before knowledge on protein content, protein quality, digestibility and the nutrient requirements of human became available, it was recognized that mixing legumes with cereals in the diet could improve overall nutrition (Okpala and Chinyelu, 2011).Protein energy malnutrition (PEM) is believed to be the primary problem in most developing countries of the world (FAO, 2011). Legumes are rich sources of protein and the essential amino acid lysine which is deficient in cereals; but are deficient in the sulphur containing amino acids, methionine and cysteine. The prevalent of the present covid-19 pandemic, would necessitate for diet rich in protein, minerals and vitamins. This study is aimed at addressing the above stated problems.

''Dakuwa" production is a major occupation of many women and young girls in northern Nigeria, who can be seen hawking the products in almost all the northern states of Nigeria (Igwe et al., 2015). Dakuwa commands great economic importance among the local communities of northern Nigeria as the product features prominently in social functions such as weddings, traditional festivals as well as the installations of emirs and chiefs. The diversification of the raw materials for dakuwa production, will enhance nutritional quality of the product as well as provide consumers with variety of choice of consumption for the product. The major objective is to produce Dakuwa from mixtures of finger millet (*EleusineCoracana*) groundnut (*Arachishypogaea)* and moringa (*Oleifera Moringaceae*) seed.

Method of Collections of Raw Materials

Finger millet (*Eleusinecoracana*) was bought at a local market in Jos groundnut (*arachishypogeae), Moringacea* seeds, ginger, sugar and pepper were all purchased at Muda Lawal Market in Bauchi.

Methods Preparation of Finger Millet Flour

Preparation of finger millet flour. The finger millet "Tamba" was cleaned and winnowed manually, the cleaned seeds was then roasted in an oven at a temperature of 140°C for 30 minutes. The roasted grain was then milled using an attrition mill (Lister model). The milled grain was then sieved to obtain a particle size of 0.05mm. The sieved finger millet flour was then collected in a polythene bag and then stored at room temperature (32°C ± 2).

Preparation of Roasted Groundnut Seeds

The groundnut seeds were winnowed and cleaned manually, this was the roasted at 140°c for 30 minutes, using a laboratory oven. The roasted groundnut was then dehulled manually, the dehulled seeds was collected and stored in a polythene bag.

Moringa Seed Flour Preparation

Raw Moringa oleifera seeds were cleaned and dehulled manually, the seeds were then roasted at 140°C for 30 minutes. The roasted seeds were then dehulled manually and stored in a polythene bag at room temperature.

Preparation of Dakuwa

Five samples of Dakuwa were prepared by mixing milled roasted finger millet (FM), roasted and dehulled groundnut(G/nut), and roasted Moringa Oleifera seeds(MS). The various samples were formulated as follows: sample A (finger millet 100: Groundnut 100: Moringa seed: 0), sample B(FM 100: G/nut 50 : MS 50), sample C (FM 100: G/nut 40: MS 60) sample D (FM 100: G/nut 30: MS 70) and sample E (FM 100: G/nut 20: MS 80), other ingredients added include sugar 10%, pepper 5%, ginger 5%. and table salt 0.2 %. Each formulation of the ingredients was then transferred to a laboratory blender, and blended till a thick mast of the mixture was formed. The mast was then subdivided and rolled into a ball mass shape, which is the dakuwa end product.

Table 1: FormulationDakuwa Recipe in % Percentage

Ingredient	A	B	C	D	E
Finger millet	100	100	100	100	100
Groundnut	100	50	40	30	20
Moringa seed	-	50	60	70	80
Sugar	10	10	10	10	10
Pepper	5	5	5	5	5
Ginger	5	5	5	5	5
Salt	0.2	0.2	0.2	0.2	0.2

Key: A = (FM 100:40:60), D =100: G/NUT 100: (FM 100:30:70), E =Moringa seed: (FM 100:20:80) 0), B = (FM 100:50:50), C = (FM

Determination of Moisture Content

The method described by A.O.A.C (2005) was adopted, a clean 110°C, cooled in a desiccator and weighed (W_1). Two grams of finely ground sample was dried in an oven to constant weight (W3). The percentage moisture content was calculated thus:

%Moisture content = $\frac{W2-W3}{W2-W1}$ X 100

Where (W_2) is the weight of crucible plus sample before drying.

Determination of Ash Content

The A.O.A.C (2005) method was used. The porcelain crucible was dried in an oven at 100°C lor 10 min, cooled in a desiccator and weighed (Wi). Two grams of the finely ground sample was placed into a previously weighed porcelain crucible and reweighed (W2), it was first ignited and then transferred into a furnace which was set at 550°C. The sample was left in the furnace for eight hours to ensure proper ashing. The crucible containing the ash was then removed; cooled in a desiccator and weight (W3). The percentage ash content was calculated as follows:

%Ash content = $\frac{W2-W3}{W2-W1}$ X 100

Determination of Crude Protein

Crude protein was determined by Kjeldahl method using Kjeltec TM model 2300, as described in Foss Analytical Manual, AB, (2003). The method involved digeston of the samples at 420°C for Ihr to liberate the organically bound nitrogen in the form of ammonium sulphate. The ammonia in the digest ammonium sulphate was then distilled off into a boric and receiver solution and then titrated with standard hydrochloric acid. A conversion factor of 6.25 was used to convert from total nitrogen to parentage crude protein.

Calculations: The percent crude protein (%CP) in the sample was calculated as

%CP = $\frac{(a)(b)(14)(6.25)(100)}{C}$

Where a = normality of the acid

b = volume of standard acid used (ml) corrected for the blank titre (i.e the sample titre - the blank titre).

C = sample weight (g) and 6.25 is the conversion factor for percentage protein.

Determination of Crude Lipid Content by Soxhlet Method

A clean, dried 500 cm^3round bottom Bask containing few anti-bumping granules was weighed (Wi) with 300 cm' petroleum ether (40 - 60°C) for extraction poured into the flask tilled with soxhlet extraction unit. The extractor thimble weighing twenty grams was fixed into the Soxhlet unit. The round bottom flask and a condenser were connected to the Soxhlet extractor and cold water circulation was connected/put on. The heating mantle was switched on and the heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for 6 h. The solvent was recovered and the oil dried in an oven set at 70°C for 1 h. The round bottom flask and oil was then weighed (W2). The Lipid content was calculated thus:

%Crude Lipid content = $\frac{w2-w1}{weight\ of\ Sample}$x 100 Weight of Sample

Determination of Crude Fibre

The sample (2 g) was weighed into a round bottom flask, 100 cm3 0.25 M sulfuric acid solution was added and the mixture boiled under reflux for 30 min. The hot solution was quickly filtered under suction. The insoluble matter was washed several times with hot water until it was acid free. It was quantitatively transferred into the flask and 100 cm3 of hot 0.31 M, Sodium Hydroxide solution was added, the mixture boiled under reflux for 30 min and filtered under suction. The residue was washed with boiling water until it was base free, dried to constant weight in an oven at 100°C, cooled in a desiccator and weighed (Ci). The weighed sample (C1) was

then incinerated in a muffle furnace at 550°C for 2 h, cooled in a desiccator and reweighed (C2).
Calculation: The loss in weight on incineration = Ci - C2
% Crude Fibre $\frac{C1-C2}{Weight\ of\ original\ sample}$ x 100

Determination of the Mineral Elements and Heavy Metals
I he ground sample (5.0 g) was put in a crucible and placed into a muffle furnace, ashed at 500°C and then cooled. Three mL concentrated HCI was added and evaporated to dryness. Twenty cm325% HCI was then added to the residue to extract the mineral. The extract was qualitatively transferred to 100 cm3 volumetric flask and volume made up to the mark with distilled water with the digest used directly for the elemental determination using the Atomic Absorption Spectrophotometer

Preparation of Standard
For each mineral standard ranging from 1-16 ppm were prepared from the stock solution and were used to calibrate the equipment in concentration mode.

Determination of Oxalate
Oxalate was determined by using the method ofEjikeme*et al*., (2014). Exactly one gram of the sample was placed in 250 cm^3 volumetric flask, 190 mL of distilled water and 10 $cm^3$of 6MHCI were added. The mixture was then warmed in a water bath at 90°C and the oxalate was precipitated with 5% Cacl solution was allowed to stand overnight and then centrifuged, precipitate was washed with hot 25% H2SO4.

Calculations:
1 mL 0.05 M KMnO4 = 2.2 mg Oxalate

Determination of Phytic Acid
Phytic acid was determined by the procedure of Essien and Akpan (2014). 2.0 g of the sample was weighed into a 250 mL conical flask. One hundred mL 2% concentrated HC1 was used to soak sample for 3 h and then filtered with a whatman No. 1 filter paper. Fifty cm^3 of the filtrate and 10 $cm^3$of distilled water were added into the solution as indicated and titrated with standard Iron II Chloride solution containing 0.00195 g Iron/mL. end point observed to be yellow which persisted for 5 min. The percentage phytic acid was calculated thus:

%Phytic acid = y x 19 x 100

Where
Y= titre value x 0.00195 g

Quantitative Determination of Phytochemical Constituents.
Tannin
Analytical method for quantitative determination of tannin was according to Amadi*et al*., (2004) and Ejikeme*et al.,*(2014). By dissolving 50 g of Sodium tungstate (Na2WC>4) in 37cm3of distilled water, Folin-Denis reagent was made. To the reagent prepared above, 10g of phosphomolybdic acid (H3PM012O40) and 25cm3 of orthophosphoric acid (H3PO4) were added. Two-hour reflux of the mixture was carriedout, cooled, and diluted to 500 cm3 with distilled water. One gram of ach wood powder (sample) in a conical flask was added to 100 cm3 of distilled water. This was boiled gently for I hour on an electric hot plat and filtered using number 42 (125 mm) Whatman filter paper in a 100cm3 volumetric flask, Addition of 5.0 cm3 Folin-Denis reagent and 10cm3 of saturated Na2C03 solution into 50 cm3 of distilled water and 10 cm-l of diluted extract (aliquot volume) was carried out after being pipetted into a 100cm3 conical flask for color development. The solution was allowed to stand for 30 minutes in a water bath at a temperature of 250C after thorough agitation. With the aid of a Spectrum Lab 23A spectrophotometer optical density was measured at 700 nm and compared on a standard tannic acid curve. Dissolution of 0.20 g of tannic acid in distilled water and dilution to 200 cm-3 mark (1 mg/cm3) were used to obtain tannic standard curve. Varying concentrations (0.21.0 mg/cm3) of the standard tannic acid solution were pipetted into five different test tubes to which Folin-Denis reagent (5 cm3) and saturated Na2C03 (10cm3) solution were added and made up to the 100 cm3 mark with distilled water. The solution was left to stand for 30 minutes in a water bath at 250C. Optical density was ascertained at 700 nm with the aid of a Spectrum Lab 23A spectrophotometer. Optical density (absorbance) versus tannic acid concentration was plotted.
The following formula was used in the calculation:
Tannic acid $[\frac{mg}{100g}] = \frac{c\ X\ extract\ volume\ X\ 100}{Aliqout\ volume\ X\ weight\ of\ sample}$
Where C is concentration of tannic acid read off the graph $\frac{c\ X\ extract\ volume\ X\ 100}{Aliqout\ volume\ X\ weight\ of\ sample}$

Determination of Alkaloids

Quantitative determination of alkaloid was according to the methodology by Sofowara, (2006). Exactly 200 cm3 of 10% acetic acid in ethanol was each wood powder sample (2.50g) in a 250 cm3 beaker and al owed to stand for 4 hours. The extract was concentrated on a water bath to one quarter of the original volume followed by addition of 15 drops of concentrated ammonium hydroxide drop wise to the extract until the precipitates was complete immediately after filtration. After 3 hours of mixture sedimentation, the supernatant was discarded and the precipitates were washed with 20cm3 of 0.1 M of ammonium hydroxide and then filtered using Gem filter paper (12.5cm). Using electronic weighing balance Model B-218, the residue was dried in an oven and the percentage of alkaloid is expressed mathematically.

$$\% \text{ Alkaloid} = \frac{weight\ of\ alkaloid}{weight\ of\ sample} \text{ X } 100$$

$$\% \text{ Alkaloid} = \frac{weight\ of\ alkaloid}{weight\ of\ sample} \text{ X } 100$$

weight of samples

Determination of Flavonoid

Flavonoid determination was by the method reported by Ejikeme et al. (2014) and Chukwuma and Ejikeme (2016). Exactly 50 cm3 of 80% aqueous methanol was added to 2.50g of sample in a 250cm^3 beaker, covered and allowed to stand for 24 hours at room temperature. After discarding the supernatant, the residue was reextracted (three times) with the same volume of ethanol. Whatman filter paper number 42 (125mm) was used to filter whole solution of each wood sample. Each wood sample filtrate was later transferred into a crucible and evaporated to dryness over a water bath. The content in the crucible was cooled in a desiccator and weighed until constant weight was obtained. The percentage of flavonoid was calculated as,

$$\% \text{ Saponin} = \frac{weight\ of\ saponin}{weight\ of\ sample} \text{X } 100$$

Determination of Saponin

Saponin quantitative determination was carried out using the method reported by Ejikeme*et al.,*(2014) and Obadoni and Ochuko(2001). Exactly 100 cm3of 20% aqueous ethanol was added to 5 grams of each wood powder sample in a 250 cm3 conical flask. The mixture was heated over a hot water bath for 4 hours with continuous stirring at a temperature of 55°C. The residue of the mixture was reextracted with another 100 cm3 of 20% aqueous ethanol after filtration and heated for 4 hours at a constant temperature of 55°C with constant stirring. The combined extract was evaporated to 40 cm3 over water bath at 90°C. 20 cm3 of diethyl ether was added to the concentrate in a 250 cm3 separator funnel and vigorously agitated from which the aqueous layer was recovered while the ether layer was discarded. This purification process was repeated twice. 60cm3 of n-butanol was added and extracted twice with 10 cm3 of 5% sodium chloride. After discarding the sodium chloride layer the remaining solution was heated in a water bath for 30 minutes, after which the solution was transferred into a crucible and was dried in an oven with constant weight. The saponin content was calculated as a percentage:

$$\% \text{ Flavanoid} = \frac{weight\ of\ flavanoid}{weight\ of\ samples} \text{ X } 100$$

Determination of Oxalate

Oxalate quantitative determination was carried out using the method reported by Ejikeme*et al.,*(2014) . Exactly 20 cm3 of 0.3M HCL in each wood powder sample (2.50 g) was extracted three (3) times by warming at a temperature of 50°C for 1 hour with constant stirring using a magnetic stirrer. For oxalate estimation, 1.0 cm3 of 5 M ammonium hydroxide was added to 5.0 cm3 of extract to ensure alkalinity. Addition of 2 drops of phenolphthalein indicator, 3 drops of glacial acetic acid, and 1.0 cm3 of 5% calcium chloride to make the mixture acidic before standing for 3 hours was followed by centrifugation at 3000 rpm for 15 minutes. After discarding the supernatant, the precipitate was washed three times using hot water by mixing thoroughly each time centrifugation. Then, to each tube, 2.0 cm3 of 3 M tetraoxosulphate (VI) acid was added and the precipitate dissolved by wanning in a water bath at 70°C. Freshly prepared 0.01 M potassium permanganate (K.MnO4) was titrated against the content of each tube at room temperature until the first pink colour appears throughout the solution. The solution was allowed to stand until it returned colorless, after which it was warmed on an electric hot plate at 70°c for 3 minutes. Titration reaction of oxalate in sample was calculated as

$$C2O2\text{-}4 + 8H+ + MnO24 = 2CO2 + 4H2O + Mn2+$$

Ratio of reacting ions =1:1

From MiVi = M2V2

Where Mi is molarity of KMnO4, M2 is molarity of extract (oxalate), Vi is volume of extract (oxalate), and V2 is volume of KMnO4 (Titre value).

Molecular weight of $CaCO_3$ = 100
Weight of oxalate in titre = M2x molecular weight = Xg
Weight of oxalate in titrand $2CM_3$
$= \frac{XG}{1000} X\ 2 = Y$
1000 Cm3 of oxalate extract will contain = $\frac{Y}{2.5}$x 100g = W
% oxalate composition g/100 g = $\frac{W}{2.5} X \frac{100}{1}$

Mineral Determination
AOAC (2005) methods were used to determine the mineral composition of the samples. One gram of sample was digested with nitric/perchloric/sulfuric acid mixture in the ratio of 9:2:1, respectively, and filtered. The filtrate was made up to mark in a 5ml volumetric flask. The filtered solution was loaded to an Atomic Absorption Spectro photometer (AA320N Wincom)

The standard curve for each mineral, that is calcium, magnesium, iron, aluminum, lead, copper, and zinc, was prepared from known standards and the minerals.

Values of samples estimated against that of the standard curve AOAC (2005).

Vitamins Determination
The level of vitamin A, vitamin E, riboflavin, pyridoxine and cobalamin was carried out by UV-visible spectrophotometric method for multivitamins determination Karthrima, (2015). The protocol described by Jadoonetal, (2013) for the determination of vitamin A, and E was followed. Exactly 1g of each sample was extracted in 5ml methanol in a test tube which was protected from light with dark towel. They were saponified with 2ml KOH, and 2ml ethanol was added. It was incubated in a water bath at 45°C for 2h with intermitted mixing to expel nitrogen gas. Two Milliliter of water. The layer formed was recovered and dried in a water bath at 37°C for 2hours. It was re-dissolved in 5ml methanol and diluted in a mixture of 5% methanol containing triton x-100. The absorbance were read in UV2500 Shimadzu spectrophotometer. For vit A, sample was measured at 325m, while for Vitamin E, it was measured at 292nm. The concentration of the vitamins were extrapolated from the standard curve for each vitamin.

The levels of thiamin, raiboflavin, niacin, pyridoxine and cobalamin were also determined by UV-visible spectrophotometric method. The protocol of Bartzatt and Wol (2014) wasfollowed. Exactly 1g of each sample was extracted in 5ml water. Alkaline borate butter was added to adjust the pH to 7.52. The absorbance was read in UV/Vis spectrophotometer (752N). The absorbance of thiamin was measured at 269nm. riboflavin at 266nm, niacin at 261nm, pyridoxine at 324nm and cobalamin at 530nm. The concentration of each vitamin was extrapolated from the standard curve for each vitamin.

Sensory Evaluation
Sensory evaluation of the " Dakuwa" products from blends of finger millet " Tamba: groundnut and moringa seed flour was carried out using the method described by Giami and Barber (2004). The " Dakuwa" samples were presented to 20 semi-trained panelists which comprises staff and students of the Department of Food Science and Technology, Federal Polytechnic Bauchi, on a white disposable flat plates, and bottled water was also served for cleansing of the mouth in – between each sample to prevent the transfer of sensory attributes from one sample to the other. Sensory attributes evaluated include colour, flavor, texture, taste and general acceptability using 9- point hedonic scale preference test ranging from 1-9 where 1 represented dislike extremely and 9 represented like extremely.

Statistical Analysis
The results obtained from the various analyses were subjected to Analysis of Variance (ANOVA) using the statistical package GenStat 64-bit Release 17.1(2014). Means were separated with Duncan Multiple Range Test (DMRT) at 95% Confidence level ($P<0.05$).

RESULTS
Proximate Composition of "Dakuwa" Samples
The results of the proximate composition of the Dakuwa samples are shown in Table 2. Results showed wide variation in all the constituents determined. The moisture content, ash, crude fibre, crude lipid (fat), crude protein, carbohydrate and energy ranged from (4.68 to 5.63%, 1.22 to 2.58%, 1.78 to 4.47%, 7.46 to 14.05%, 1700 to 20.14%, 54.71 to 63.92%, 383.8 to 431.20 Kcal, respectively. Moisture content decreased with increase in moringa seed flour. The ash content increase with increase in moringa seed flour. There was no significant ($P < 0.05$) difference in crude fibre. The protein tends to decrease with increased moringa seed substitution.

Table 2. Proximate Composition of Dakuwa Products

Me (%)	Ash (%)	Crude fiber (%)	Crude lipid (%)	Crude Protein (%)	CHO (%)	Energy (Kcal)
A 5.43^{ab}±0.42	1.22^{b}± 0.25	1.78^{c}±0.08	7.46^{d}±0.13	20.14^{a}±0.40	54.71^{e}± 0.05	383.80^{d} ± 0.00
B 5.63a ±0.32	1.37^{b}± 0.42	2.49^{b}±0.16	8.46^{c}±0.19	19.20^{b}± 0.28	63.92^{a}±0.62	412.00^{c} + 0.02
C 5.1 l^{bc}± 0.27	2.17^{a}±0.20	4.36^{a}±0.06	13.40^{ab} ± 0.36	18.67^{e}± 0.30	56.09^{d}±0.11	421.10^{b}±0.13
D 4.68^{c} ± 0.09	2.52^{a}±0.14	4.47^{a}±0.15	12.93^{b}± 0.55	17.86^{d}± 0.14	56.65^{c}±0.17	4l8.40^{b}±0.02
E 4.85^{c}±0.!l	2.58^{a}± 0.25	2.60^{b}±0.10	14.05^{a}±0.48	17.00^{c}±0.09	58.42^{b}±0.01	431.20^{a}±0.02

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscript are significantly (P < 0.05) different.
Key: A = (FM 100: G/NUT 100: Moringa seed: 0), B = (FM 100:50:50), C = (FM 100:40:60), D = (FM 100:30:70), E = (FM 100:20:80)

Vitamins

The results of vitamins in the products are shown in Table 3. Vitamin A content range from 6.26 to 11.40 (IU), Vitamin Bi (Thianin) 18.46 to 21.73 (mg/l00g), B2 (Riboflavin) 17.04 to 20.77 (mg/l00g) B3 (Niacin) 16.54 to 20.80 (mg/l00g) B6 (Pyridoxine) 44.28 to 46.19 (mg/100g) B12 (Cobalamin) 140.50 to 374.60 (mg/100g) and lastly Vitamin E (Retinol) is from 15.98 to 17.66 (mg/l00g). With regards to the Vitamins there was a general decrease in most of the vitamins as moringa substitution is increased, with the exception of Vitamin E, which increases as moringa substitution is increased.

Table 3. Determination of Vitamins (mg/100g) in Dakuwa Products

Samples	Vit A(I U)	Vit Bi	Vit B_2	Vit B_3	Vit B_6	Vit Bi 2	Vit E
A	6.26'±0.01	21.73* ± 0.01	20.77^{d} ± 0.11	20.83^{a}±0.01	46.19^{a} ± 0.00	374.65^{a} ± 0.35	15.98^{d}± 0.02
B	6.39^{d} ± 0.01	18.46^{b}±0.02	20.10^{b}±0.00	19.24^{b}±0.00	44.88^{b} ±0.14	182.90^{b} ± 0.81	17.19^{c}± 0.00
C	8.60'±0.01	18.54^{b} ± 0.09	19.01' ± 0.01	18.08'±0.00	44.67^{b}'±0.00	142.00'±0.06	17.28'± 0.17
D	9.88^{b}±0.00	18.49^{b} ± 0.00	18.38^{d} ± 0.00	17.99^{d} ± 0.01	44.52^{bc}±0.00	141.40'±0.23	17.44^{b}± 0.01
E	11.40^{a}±0.00	18.50^{b} ± 0.01	17.04'±0.00	16.54'±0.00	44.28'±0.00	140.50^{d}±0.06	17.66^{a}±0.00

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscript are significantly (P < 0.05) different.
Key: A = (FM 100: G/NUT 100: Moringa seed: 0), B = (FM 100:50:50), C = (FM 100:40:60). D = (FM 100:30:70), E = (FM 100:20:80)

Minerals

The results of the mineral content of the products are shown in Table 4. The results showed aluminum (Al) ranged 33.5 to 86.9 (mg//100g), Calcium (Ca) 56.9 to 253.3 (mg/l00g), Copper (Cu) 9.2 to 16.5 (mg/l00g), Iron (Fe) 100.5 to 128.0 (mg/l00g) Magnesium (Mg) 7.64 to 9.5 (mg/l00g), Lead (Pb) 1.2 to 3.0 (mg/l00g) while Zinc (Zn) ranged from 35.6 to 85.7 (mg/l00g). Also with the minerals, Al, Cu, Fe, Zn and Mg increased with increase in moringa seed in the formulation. However, Ca decreased as moringa seed is increased.

Table 4. Mineral Content of Dakuwa products (mg/100g)

Samples	Al	Ca	Cu	Fe	Mg	Pb	Zn
A	33.5^{e}±0.04	252.3^{a}±0.03	9.2^{d} ± 0.00	109.0^{c}±0.05	7.63^{d} ±0.12	2.2^{c}±0.00	35.6^{d} ± 0.03
B	66.6^{d} ± 0.05	81.5^{d}±O.O2	10.2^{e} ± 0.00	100.5^{d} ± 0.03	8.18^{c} ± 0.00	1.3^{d} ±0.00	76.6^{C}± 0.02
C	82.7^{c}±0.03	89.3^{c}±0.00	10.4^{c}±0.00	115.2^{C} ± 0.02	9.56^{a} ± 0.01	1.2^{d} ± 0.00	77.5^{C} ± 0.01
D	86.9^{a} ± 0.02	97.4^{b} ± 0.01	12.5^{b} ± 0.00	118.0^{b} ± 0.02	9.29^{b}±0.01	2.2^{b} ± 0.00	84.4^{b} ± 0.06
E	81.8^{b}±0.02	56.9^{e}±0.02	16.5^{a} ± 0.00	128.0^{a} ± 0.02	804.5^{C} ± 0.01	3.0^{a}±0.00	85.7^{a}±0.02

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscript are significantly (P < 0.05) different.
Key: A = (FM 100: G/NUT 100: Moringa seed: 0), B = (FM 100:50:50), C = (FM 100:40:60), D = (FM 100:30:70), E = (FM 100:20:80)

Antinutrients

The results for the antinutrients, alkaloids, flavonoids, saponin. Tannin, oxalate and phytate are shown in Table 5. The result range as follows alkaloids (0.37 to 28.37%), Flavonoids (0.37 to 44.7%), Saponin (0.20 to 2.03%), Tannin (7.90 to 25.33mg/100g), Oxalate (0.5 to 11.00%) and Phytate (0.04 to 0.06%). There was generally an increase in the antinutritional compounds as moringa seed is increased in the formulation.

Table 5. Antinutrients of Dakuwa products (%)

Samples	Alkaloids	Flavonoi	Saponins	Tannin (mg/100g)	Oxalate	Phytate
A	$0.37^{e} \pm 0.06$	$0.37^{e} \pm 0.06$	$0.20^{e} \pm 0.06$	$7.90^{e} \pm 1.44$	$0.53^{d} \pm 0.06$	$0.04^{ab} \pm 0.02$
B	$4.00^{d} \pm 0.00$	$3.57^{d} \pm 0.06$	$1.00^{d} \pm 0.00$	$28.00^{d} \pm 0.58$	$3.27^{c} \pm 0.02$	$0.02^{b} \pm 0.00$
C	$12.37^{c} \pm 0.06$	$9.57^{c} \pm 0.06$	$1.17^{c} \pm 0.06$	$132.50^{c} \pm 0.58$	$5.75^{b} \pm 0.55$	$0.05^{a} \pm 0.02$
D	$19.67^{b} \pm 0.58$	$32.37^{b} \pm 0.06$	$1,60^{b} \pm 0.00$	$182.80^{b} \pm 1.44$	$11.00^{\text{“}} \pm 0.00$	$0.06^{a} \pm 0.01$
E	$28.37^{a} \pm 0.06$	$44.77^{a} \pm 0.06$	$2.03^{a} \pm 0.06$	$253.00^{a} \pm 0.00$	$11.00^{a} \pm 0.00$	$0.06^{a} \pm 0.01$

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscript are significantly ($P < 0.05$) different.
Key: A = (FM 100: G/NUT 100: Moringa seed: 0), B = (FM 100:50:50), C = (FM 100:40:60). D = (FM 100:30:70), E = (FM 100:20:80)

Sensory Evaluation

The results of the sensory evaluation based on 9-poing hedonic scale preference test are shown in Table 6. The samples were evaluated on the parameters of colour, flavor, texture, taste and general acceptability. There was significant ($P < 0.05$) difference in colour between the control sample (A) and the other samples. However there was no significant ($P < 0.05$) difference in colour between samples B, C, D and E. There was also no significant ($P < 0.05$) difference in taste between sample A, B and D. In terms of general acceptability, all the other samples were generally more preferred than the control sample (A).

Table 6. Sensory Evaluation of Dakuwa Products.

Samples	Colour	Flavor	Texture	Taste	General Acceptability
A	$8.6^{e} \pm 0.02$	$7.1^{c} \pm 0.06$	$8.6^{a} \pm 0.14$	$7.7^{b} \pm 0.14$	$7.9^{b} \pm 0.09$
B	$7.8^{b} \pm 0.11$	$8.4^{a} \pm 0.21$	$7.8^{b} \pm 0.21$	$7.8^{b} \pm 0.19$	$8.0^{a} \pm 1.11$
C	$7.2^{c} \pm 0.12$	$7.7^{b} \pm 0.24a$	$7.4^{C} \pm 1.01$	$8.3^{a} \pm 1.11$	$8.6^{a} \pm 1.12$
D	$7.2^{C} \pm 0.04$	$7.4^{c} \pm 0.01a$	$7.1^{c} \pm 0.06$	$7.7^{b} \pm 0.04$	$8.0^{a} \pm 0.16$
E	$7.8^{c} \pm 0.12$	$7.4^{C} \pm 0.1$ la	$7.6^{b} \pm 0.12$	$7.9^{b} \pm 0.12$	$8.0^{a} \pm 0.12$

Samples whose means carried same superscript along a column are not significantly ($P < 0.05$) different.Key: A = (FM 100: G/NUT 100: Moringa seed: 0), B = (FM 100:50:50), C = (FM 100:40:60), D = (FM 100: 30:70) E=(FM 100:20:80)

DISCUSSION

Proximate composition. The results for proximate composition of the samples showed wide variation in composition in terms of moisture content, ash, crude fibre, crude lipid, crude protein, carbohydrate and energy. The moisture content range from 4.68 to 5.63%, this agreed with the moisture content of Dakuwa reported by Ocheme et al., (2014). Moisture has been correlated to the roasting temperature and time for dakuwa ingredients (finger millet, groundnut and moringa seeds). Low moisture content is an advantage in respect to keeping quality of the products as well as transportation cost. The ash content of the samples varied significantly. The increase in ash content with increase in moringa seed is a welcome development, as this could be an indicator of increase in mineral content. There was also a significant increase in the crude fibre content with substitution of moringa seed in the formula. The increase in crude fibre which a fraction of it constitute dietary fibre could also come from the moringa seed flour. The dietary fibre has been found to have significant effect in lowering blood cholesterol and relieving constipation (Ayo and Kajo, 2016; Ocheme et al., 2014). Though the protein content showed a slight decrease with increased substitution of moringa seed. The percentage protein is much higher than any of the cereals. The protein also could be of higher quality than that obtain from any individual cereal or legume, as compositing is known to upgrade the quality of proteins from cereal and legumes (Ayo and Kajo, 2016). The significant increase in fat and protein will help build the body and provide energy (Jimah et al., 2021). Table 3 showed the results for the Vitamin content of the products. It generally showed a sharp increase in all the Vitamins determined with Vit A, E showing the most increase, however, Vit Bl, B2, and B12 were seen to decrease as moringa seed was increased. The presence of Vitamin E in high quantity is a welcome development as Vit E is known to possess a high antioxidant property. Table 4 showed the mineral content of the sample A, B. C, D and E. The highest concentration of mineral was calcium (252.3 mg/l00g), while the least was lead (Pb) observed in sample B. high calcium is of nutritional benefit, particularly for children and the aged who need higher intakes of calcium and phosphorus for bone formation and maintenance. It is well known that diets with high value Ca/P ratio are considered “good”, particularly for growing children who require high intake of calcium and phosphorus for bone and teeth formation (Oluwole et al., 2013). Also the high percentage of Fe is of great importance. Iron deficiency is a serious problem worldwide, particularly for women and children. The low phytate in the diet is welcome development, as this has shown to chelate Fe and Zn and therefore rendering them

unavailable for digestion (Ayo &Kajo, 2016).

The antinutrients content of Dakuwa samples are shown in Table 5. Antinutrients of recent are known to have both beneficial and detrimental effects in human nutrition. Antinutrients such as oxalate, tannin and phytates have been implicated in the chelation of certain minerals such as iron and zinc, which rendered them unavailable during digestion. Flavonoids ranged from 0.37 to 28.37%. flavonoids are large group of compounds widely distributed in plant foods. They posses strong antioxidant properties to protect the body against cardiovascular diseases and cancer (Ukom et al., 2014). The oxalate ranged from 0.53 to 11%. High oxalates content have a negative effect on human nutrition and health by forming insoluble complex with calcium ions and limits calcium utilisation, absorption and bioavailability (Ukom et al., 2017). The saponin ranged from 0.20 to 2.03% with sample E having the highest 2.03%. This value are lower than that reported by Offor et al., 2011. Phytate content ranged from 0.04 to 0.06%. The tannin content in the range of 7.9 to 253mg/100g was lower than that reported by Wabali et al., 2020.

The results of the sensory evaluation is shown in Table 6. In terms of colour there was significant ($P < 0.05$) between the samples, with the control sample A having the most preferred colour with a mean score of 8.60 ± 0.02 while the least score was with samples C and D having 7.20 ±0.12 and 7.20 ± 0.04 respectively. There was no significant difference among the samples in terms of texture, flavor and taste. In terms of general acceptability all the substituted samples B, C, D and E were more accepted than the control sample. This is a welcome development bearing in mind, the more accepted samples have high antinutritional factors which are effective in treating or preventing some health risks such as cancer, cardiovascular disease and diabetes.

Conclusion

This study investigated the proximate composition, mineral content and antinutrients of "Dakuwa" a traditional Nigerian snack produced and hawked majorly in the northern part of Nigeria. The ingredients used to produce the snack were finger millet, groundnut, moringa seed, sugar, pepper and salt. Five samples were formulated on the basis of the major ingredients (finger millet, groundnut and moringa seed and designated as samples A, B, C, D and E. With sample A being the control sample. Results of the proximate composition showed increase in ash, fat, carbohydrate and Energy (Kcal) levels.

The Vitamins in the product such as Vit A, and Vit E increased with increase in moringa seed substitution. There was a high percentage of minerals such as iron (Fe), Aluminum (Al) and Calcium. The product also content high antinutrients such as Oxalate and tannins. In terms of product acceptability, the results of the sensory evaluation showed that the moringa seed substituted samples were more preferred than the control sample.

RECOMMENDATION

From the results of this study, it can be recommended that, this snack food ''Dakuwa" be consumed by civil servants at work in all part of the country, as the product is dense in nutrients and antinutritional factors beneficial to health.

Suggestions for Further Study

i. We are suggesting that investigation of the effectof processing conditions such as soaking, germination, roasting and process time be carried out on the physicochemical, nutrient and antinutritional factors of this product.

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