EAS Journal of Nutrition and Food Sciences
Abbreviated Key Title: EAS J Nutr Food Sci
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya

Volume-6 | Issue-6 | Nov-Dec; 2024 | DOI: https://doi.org/10.36349/easjnfs.2024.v06i06.006

OPEN ACCESS

Original Research Article

Nutritional Composition, Functional, Mineral, Microbial Count and Acceptability of Two Different Types *Dakuwa* (Local Snack) Produced from the Blends of Pearl Millet, Sorghum and Groundnut Paste

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Article History
Received: 17.11.2024
Accepted: 23.12.2024
Published: 28.12.2024

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: Dakuwa is a leguminous based snack prominent throughout northern Nigeria. It consists basically of roasted tiger nut and groundnut paste, It is produced mixtures of legumes such as tiger nut and groundnut, ground pepper, ginger, sugar and salt, pounded and molded into balls that can be eaten without further processing. The aim was to produce dakuwa from the blends of roasted millet and sorghum with groundnut and determine the nutritional, functional, mineral, microbiology and sensory qualities. Dakuwa produced from the blend of pearl millet flour and groundnut paste, sorghum and groundnut paste were evaluated according to different formulations (Mtrl 100, MG 80:20, MG 60:40, MG 50:50) and (Strl 100, SG 80:20, SG 60:40, SG 50:50). Dakuwa at 100% pearl millet and sorghum flour had 8.25 and 8.17% protein, higher protein content was found in samples MG 50:50 and SG 50:50 and carbohydrate contents (74.29 - 71.79%) fat content valued from 2.88 to 1.83%, ash valued from 2.44 to 2.38%, crude fibre from 2.62 to 1.93% that corresponds to the levels of substitution with groundnut paste. The microbial count was within the acceptable limits, with TBC ranging from 2.4×10^3 to 4.8×10^3 and the TFC was 6.2×10^3 to 3.3×10^3. Colour value from 6.8 to 5.3, mouth feel from 7.3 to 4.7, texture valued from 7.3 to 5.2, taste from 7.8 to 5.7 and overall acceptability valued form 7.3 o 5.3 respectively. The dakuwa produced from different blends of millet and groundnut was observed to have increased in protein and ash with variations in the fat content and a decrease in carbohydrate content which was as a result of varying substitution rates with groundnut paste.

Keyword: Dakuwa, Proximate, Mineral, Acceptabilitys.

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1.0 INTRODUCTION

Dakuwa as a leguminous based snack popularly produced throughout northern western Nigeria. It basically consists of roasted tiger nut and groundnut paste, while roasted sorghum flour is optional depending on cultural provision (Abdulrahman and Kolawole, 2003). It is mainly produced and consumed across all ages in the northern parts of Nigeria. Dakuwa is prepared from mixtures of legumes such as tiger nut and groundnut, ground pepper, ginger, sugar and salt. The main ingredients and the spicies are thoroughly mixed, pounded and molded into balls that can be eaten without further processing (Abdulrahman and Kolawole, 2003). With this there is need to substitute with roasted millet and sorghum with groundnut to make use of the local available cereal grain. The production of dakuwa from tiger nut is usually higher than that of groundnut which is due to the high fat content of the groundnut that may render the product unacceptable. To this effect, defatted groundnut paste to reduce the oil content of the final product. The use of millet and sorghum flour with groundnut is to promote and utilize the use of cereal grain flour into leguminous flour, in other to reduce the cost and minimized the used of groundnut so as to achieve the value addition of the product, by utilizing the available cereal which is millet. Pearl millet is believed to have originated from sub-Saharan Africa, and finger millet from the sub-humid uplands of East Africa (Gari *et al.*, 2020). Tiger nut (Cyperus esculentus lativum) is an underutilized tuber of the family Cyperaceae, which produces rhizomes from the base of the tuber that is

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somewhat spherical (Devries and Feuke, 2000). It is a tuber that grow freely and is consumed widely in Nigeria, other parts of west Africa, east Africa, and parts of Europe particularly Spain as well as in the Arabian Peninsula. Thus, there is a need to substitute roasted millet and sorghum flour with groundnut to produce dakuwa.

2.0 MATERIALS AND METHODS

2.1 Materials

Millet, groundnut, ginger, sugar, cloves, and pepper were purchased from Wudil Central Market and kept in the food processing laboratory at Department of Food Science and Technology Aliko Dangote University of Science and Technology.

2.2.0 Sample preparation

Samples were sorted, weight, dried, roasted, winnowed, milled into flour, pounded, and molded into dakuwa.

2.2.1 Proximate composition

Moisture, crude fat, crude protein, crude fat, ash and carbohydrate contents were determined as described by (AOAC, 2000). The energy was evaluated using a Atwater.

2.2.2 Functional Properties

Bulk Density Determination

The method described by Onwuka (2005) was used. An empty 10 ml capacity graduated measuring cylinder was weighed. The cylinder was gently filled with the sample, and then the bottom of the cylinder was gently tapped on the laboratory bench several times until there is no further diminution of the sample level after filling to the 10ml mark. The bulk density was calculated as weight of sample (g) per volume of the sample (ml).

$$\text{Bulk density (g/ml)} = \frac{W1}{W2}$$

W1 = the already weighed measuring cylinder
W2 = the weight of the sample and weight of the cylinder

Determination of Water Absorption

Water absorption capacity was determined using the method described by Onwuka (2005). Ten milliliters of distilled water was mixed with 1g of flour each and blended for 30 seconds. The samples were allowed to stand for 30 minutes and centrifuged at 1300 rpm for another 30 min at room temperature (27 ± 2ºC). The supernatant was decanted. The weight of water absorbed by the flour was calculated and expressed as percentage water absorption capacity.

Swelling Capacity and Solubility

Swelling capacity and solubility index determination The method described by (Hirsch & Kokini, 2002) was used for swelling power and solubility index determination. One gram of the flours was poured into pre-weighed graduated centrifuge tube appropriately labeled. Then, 10 ml of distilled water was added to the weighed sample in the centrifuge tube and the solution was stirred and placed in a water bath heated at different temperature of 85°C for one hour while shaking the sample gently to ensure that the starch granules remained in suspension until gelatinization occurred. The samples were cooled to room temperature under running water and centrifuged for 15 min at 3000 rpm. After centrifuging, the supernatant was decanted from the sediment into a pre-weighed petri-dish; the supernatant in the petridish was weighed and dried at 105°C for 1 h. The sediment in the tube was weighed and the reading recorded. The starch swelling power and solubility was determined according to the equations below;

$$\text{Swelling capacity} = \frac{Weight\ of\ swollen\ sediment}{Weight\ of\ sample}$$

$$\text{Solubility capacity} = \frac{Weight\ of\ dry\ supernatant}{Weight\ 0f\ sample} \times 100$$

Dispersibility

Dispersibility of flour was determined by method adopted by Balami *et al*., (2004). Sample of 10g was dispersed in distilled water in a 100 ml measuring cylinder and distilled water was added up to 50 ml mark. The mixture was stirred vigorously and allowed to settle for 3 h. The volume of settled particles was noted and percentage dispersibility was calculated as follows:

$$\text{Dispersibility (\%)} = \frac{50 - Volume\ of\ settled\ particle}{Weight\ of\ sample} \times 100$$

2.2.3 Determination of Mineral

Minerals content were determined using (AOAC 2005) 0.3 g of each of the powdered sample in a 50 ml beaker was wet digested using 30 ml of HNO3-HClO4 acid solution (2:1 volume) on a hot digestion system, heated until the samples turn colourless solution. After digestion was complete, the solution of each sample was transferred into a 50 ml calibrated sample bottle and the solution was diluted to the mark with distilled water. Ca, Mg, Fe, and Zn in wheat samples were determined by Atomic Absorption Spectrophotometer (VARIAN model AA240FS, United States). Na and K in the samples were determined by flame photometer (pfp7, United States) using a working standard of 10 ppm for each of the species.

2.2.4 Microbiological Analysis

Determination of Total Plate Count

Enumeration of aerobic micro-organism was carried out using nutrient agar. For the enumeration of mesophillic bacteria, the serial dilution method as described by Kawo *et al*., (2006) was employed. One gramme of the sample was mixed with 0.2% peptone water. The sample was shaken and thoroughly comminuted to make a homogenate solution; this gave the dilution of 10^1. One millilitre of the prepared solution was transferred in to one milliliter of the diluents (0.1% peptone water), this gave the dilution of 10^1. This procedure was repeated up to the third dilution which gave the dilution of 10^3.

The dilution bottles was agitated. One millilitre of each dilution was pipetted into a separate corresponding petri-dish in duplicates. About 15 ml of the nutrient agar (NA) cooled to 45ºC was poured into each plate. The sample and the agar medium were mixed by rotating the plate on a flat surface and allowed to solidify. The petri-dishes was inverted and incubated at 35ºC for 48 hours. Plates containing between 30-300 colonies was selected and counted. The number obtained was multiplied by the dilution factor this gave the number of colony forming units per gramme of the sample (cfu/g).

Determination of Fungal Count

Enumeration of aerobic mesophillic fungi and mould was carried out using Potato dextrose agar. For the enumeration of mesophillic fungal and mould, the serial dilution method as described by Kawo *et al.*, (2006) was employed. One gramme of the flours or the *gurasa* sample was mixed with 99 ml of 0.1% peptone water. The sample was shaken and thoroughly comminuted to make a homogenate solution; this gave the dilution of 10^1. One milliliter of this prepared solution was transferred in to 9 millilitre of the diluents (0.1% peptone water); this gave the dilution factor of 10^2. This procedure was repeated up to the third dilution which gave the dilution of 10^3. The dilution bottles were agitated. One ml of each dilution was pipetted into separate corresponding petri-dishes in duplicates. About 15 ml antibiotic supplemented agar (cooled to 45ºC) was poured into each plate. The sample and the agar medium were mixed by rotating the plate on a flat surface and allowed to solidify. The petri-dishes was then inverted and incubated at 25 ºC for 3-5days (APHA, 1992). Plates containing less than 50 colonies was selected and counted at 3-5 days incubation periods. The count was reported as fungi and mould colony forming unit per gramme of the sample (cfu/g). A set of control plate for each sample containing agar and diluents were incubated to ascertain the sterility of the media.

This formula was used to calculate the number of bacteria/fungi colony forming units per gram of the sample.

$N = \frac{n}{Vd}$,

Where,

N= the number of bacterial colony per gramme of sample

N=n/vd

n= Number of colonies counted

v= volume of sample used

d= dilution factor

2.2.5 Sensory evaluation

Sensory evaluation samples and the controls were assessed using students and staff (15) drawn from the department (Food Science and Technology). Sensory evaluation was carried out as described by Ihekoronye and Ngoddy (1985), A 9-point hedonic scale (where 1 represents extremely disliked, 9 extremely liked), was used evaluate the following attributes: colour, taste, aroma, texture (hand feel) and the overall acceptability. Coded samples were randomly presented to the panelists, water was provided for mouth gargling before proceeding to the next sample.

2.2.6 Statistical analysis

Statistical analysis shows that data obtained were subjected to appropriate statistical analysis (ANOVA) using a statistical package for the Social Sciences, SPSS (version 16). Mean separation was done using Duncan multiple range test and significance difference was accepted at 5% confidence level. Fig 1and 2 shows the dakuwa processing method.

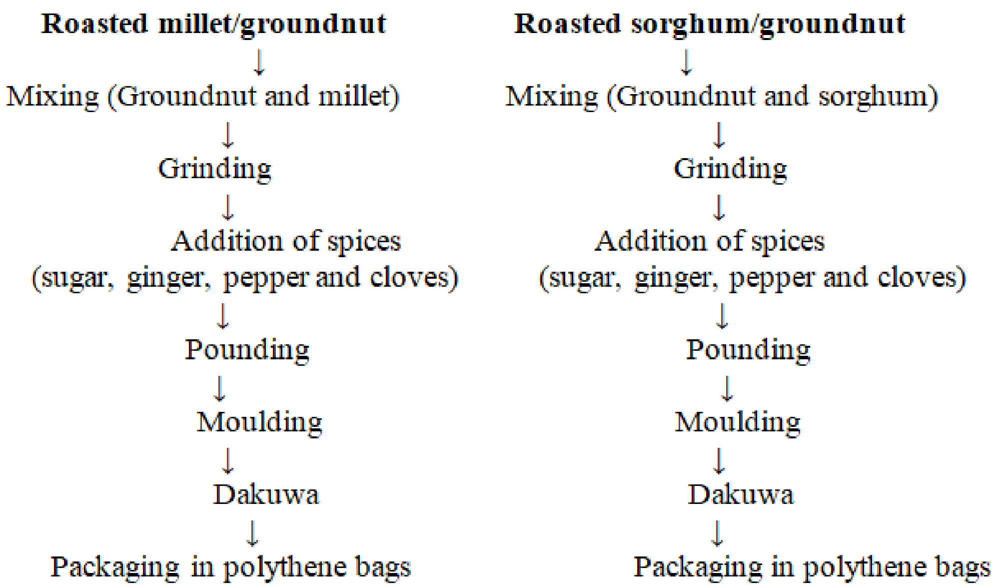

Fig 1: Production of *dakuwa* from millet/groundnut; Fig.2 Production of *dakuwa* from sorghum/groundnut
Source: Local producers

Table 2.3: Formulation table

Samples	Sample code	Millet (%)	Groundnut (%)
Millet	Mctrl (100)	100%	--------
	MG(80:20)	80%	20%
	MG(60:40)	60%	40%
	MG(50:50)	50%	50%
Sorghum	Sctrl(100)	100%	------
	SG(80:20)	80%	20%
	SG(60:40)	60%	40%
	SG(50:50)	50%	50%

Key: Mctrl (control), MG (Millet/groundnut), Sctrl (control) and SG (Sorghum/groundnut)

3.0 RESULTS AND DISCUSSION

3.1 Proximate composition of dakuwa produced from millet and sorghum with groundnut

Table 3.1 shows that the moisture content ranged from 11.86 - 10.95%, protein value from 9.26 - 8.17%, fat from 2.88 to 1.83%, ash valued from 2.44 to 2.38%, crude fibre from 2.62 to 1.93% and carbohydrate valued 74.29 – 71.79%). The ranged of moisture, protein, fat, ash, crude fibre and carbohydrate are significantly different (p≥0.05). Higher amount of moisture was attributed to sample SG (50:50) with 11.86%. The higher water absorption capacity of dakuwa could be attributed to the presence of higher amount of carbohydrates (starch) and fibre in the flour. Water absorption capacity is a critical function of protein in various food products like dough and baked products (Adeyeye and Aye, 2000). Sample MG (50:50) was high in ash 2.88% and protein 9.26%, The higher ash content in groundnut flour suggests that it contains high mineral content than millet and sorghum flour. These findings are comparable to the results reported by Fenn *et al.,* (2010) while protein increases with the rate of substitution which is in lined with McKevith (2004) that reported cereal protein is relatively low amounts and therefore, essential amino acids must be supplied from another source of the diet. Legumes are usually rich in protein as compared to cereals such as rice (5-8%), millet (7%) and sorghum (10%) (Sivasankar, 2002). Hence, it was expected that groundnut (legume flour) to have relatively higher protein content. The crude fat content was attributed higher in sample MG (50:50) and the lowest with sample Mctrl(100). This shows that the ranged of crude fat was significantly different (P≥0.05) when compared with the control Mctrl(100) and Sctrl(100). Fat increases with the rate of substitution with groundnut. While higher crude fibre 2.62% was observed in the control sample Mctrl (100). According to Schneeman (2002), crude fibre contributes to the health of the gastrointestinal system and metabolic system in man.). Decreased in carbohydrate content was due to high protein and fat contents of the dakuwa when compared with the control Mctrl and Sctrl at 100%. The addition of groundnut paste to millet or sorghum flour had increased the protein and the fat content of the final product, since legumes generally contain more proteins than cereals.

3.2 Functional Properties of dakuwa produced from millet and sorghum with groundnut

Table 3.2 showed the functional properties of dakuwa sample analyzed for bulk density (g/cm$^{3)}$, dispersibility (%), water absorption capacity (%) and oil absorption capacity (%). The result of bulk density valued from 0.94 – 0.62(g/cm^3), bulk density indicates that there was a significant difference among the samples at (P≥0.05%), where sample Mctrl and Sctrl had the highest mean value (0.94-0.91%) with the lowest mean value of sample MG(50:50) and SG(50:50) (0.62-0.71%). This shows that bulk density of dakuwa decreased with an increase rate of substitution with groundnut. The bulk density is influenced by particle size and density of the flour. It is an important requirement for determining the packaging and material handling (Karuna *et al*., 1996). Low bulk density is influenced by the loose structure of the starch polymer (Olu *et al*., 2012). The dispersibility (%) ranged value from 76.72 – 68.22% of the dakuwa samples. This shows a significant difference at (P≥0.05%), were sample Mctrl(100) was 68.55% had the lowest mean value, followed by sample SG(80:20) 72.87%, SG(50:50) (74.99%) to the highest mean value attributed to sample MG(50:50) 76.72% respectively. this implies that dispersibility increases with the rate of substitution with groundnut. The water absorption valued from 0.98 – 0.73%. thus, indicates a significant difference among the samples at (P≥0.05%) with a mean score value range, where sample Mctrl and Sctrl had the highest mean value 0.98-0.94% with the lowest mean value of sample MG(50:50) 0.73%. water absorption capacity of dakuwa decreases with an increased with the rate of substitution with groundnut. According to singh (2001) water absorption capacity is the ability of a product to associate with water under a condition where water is limited. The significance of a lower water absorption capacity in the diet is due to an increased in fat content in the food. The binding capacity that is desirable to make the dakuwa with high caloric density per unit volume. This is in agreement with the findings of El-Kahalita *et al.,* (2005). The result of oil absorption (%) valued from 1.18 – 0.88% which was significant (P≥0.05%), where sample MG(50:50) have the highest mean value 1.18% with the lowest mean value attributed to sample MG(80:20) 0.88%. with variations within the column. The water and oil binding capacity of food protein depend upon the intrinsic factors like amino acid composition, protein conformation and surface polarity or hydrophobicity.

3.3 Mineral composition of dakuwa produced from millet and sorghum with groundnut

Table 3.3 showed the result of mineral content of dakuwa produced from the blends of obtained Sorghum and Millet. The mineral content of dakuwa such as calcium, Iron, Potassium, Magnesium and Zinc were analyzed respectively. Significant difference exits between all the samples ($P \geq 0.005$). The result indicates that there was a significant difference between sample Mctrl and Sctrl 2.66 and 2.58 mg/100g, MG (80:20) 1.85 mg/100g and MG (50:50) (3.79 mg/100g) in terms of calcium content. While, sample MG (80:20) and SG(80:20) 1.85 and 1.88 mg/100g were significantly different at ($P \geq 0.05$), sample MG (50:50) 3.79 mg/100g had the highest mean value and the sample MG(80:20) 1.85 mg/100g had the lowest mean value of calcium content present in the dakuwa samples. The results of the iron concentration of dakuwa samples showed a significant difference ($P \geq 0.05$) were sample MG(50:50) 3.21mg/100g had the highest mean value, followed by sample Mctrl and Sctrl with mean value of 2.15 and 2.17 mg/100g, sample MG(80:20) and SG(80:20) had 1.59 and 1.64 mg/100g, to the lowest iron concentration was sample MG(60:40) and SG(60:40) with a mean value of 1.12 – 1.33 mg/100g) respectively. Potassium valued from 134.80 – 40.89. This indicates that there was a significant difference in terms of potassium content of the dakuwa samples analyzed at ($P \geq 0.005$), were the samples had a mean value ranged from the lowest mean value to the highest were sample Mctrl and Sctrl 41.15 and 41.08 mg/100g had the lowest mean concentration of potassium to the highest mean concentration in sample MG(50:50) and SG(50:50) of 134.80 and 128.95 mg/100g respectively. There was a significant difference observed among all the samples analyzed for magnesium content (Mg) with a mean value ranged from the lowest mean value to the highest mean value of 78.04 – 136.25 mg/100g were sample MG(80:20) and SG(80:20) had the lowest mean value of 78.04 and 81.89 mg/100g, followed by sample MG(60:40) 88.02mg/100g to sample Mctrl and Sctrl with a mean value of 116.47 and 112.33 mg/100g to the highest magnesium concentration in sample MG(50:50) 136.25mg/100g respectively, at $P \geq 0.05$ level of significance. Magnesium is essential to good health because it helps to maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system and keeps bones strong. Phosphorus works closely with calcium to build strong bones and teeth. It is stored in the bone as calcium phosphate. Similarly, Mineral content of the dakuwa samples obtained from Millet and Sorghum, were the concentration of zinc content was found higher in sample MG (50:50) 3.88mg/100g, followed by sample Mctrl and Sctrl 2.72 and 2.66mg/100g. While, sample MG (80:20) had a mean concentration of 1.66mg/100g to the least Zinc content in sample MG(60:40) 1.53mg/100g respectively. Minerals are vital to the functioning of many body processes. They are critical players in the functioning of the nervous system, other cellular processes, water balance and structural (e.g. skeletal) systems (Ameh *et al*., 2013).

3.4 Microbial count of *dakuwa* produced from millet and sorghum with groundnut

The microbial count showed that the total bacterial count valued from 4.8×10^3 to 2.4×10^3 cfu/g and the total fungal count was 6.2×10^3 to 3.3×10^3cfu/g. This was in lined with badau *et al.*, (2006) that reported population of micro-organisms was not high enough to produce an effective dose. the total bacterial count shows that the control sample Mctrl and Sctrl had the lowest growth followed by sample MG(60:40) and SG(60:40) to the highest count in sample MG(50:50) and SG(50:50) had a growth count of $3.4 – 3.3\text{x}10^3$ sample MG(80:20) and MG(80:20) had a low growth compared with the control samples which is considered within acceptable level when compared with the standard bacterial count of (100 cfu/g) set by standard organization of Nigeria. The total fungal count colony forming g/unit of growth showed that the control sample Sctrl had the lowest fungal count of $3.3\text{x}10^3$ in an increasing order followed by sample MG (60:40) $6.2\text{x}10^3$ cfu/g and sample SG(60:40) had a highest total fungal count of $5.8\text{x}10^3$ cfu/g to the count in sample control sample which had a total fungal count of $3.7\text{x}10^3$ cfu/g and the least fungal count respectively. Fungi are types of organism that can grow in a dry space therefore, due to exposure of the samples during poor handling and transportation may favour the growth and activities of the fungi which render the *Dakuwa* snack unfit for human consumption. Although the total count were still within the acceptable level. The load varied from one sample to the other which could either be due to handling and processing methods. Bacterial and Fungal growth had also been seen on all the samples of dakuwa food produced. The safe limit of 10^4 was accepted by ICMSF (International Commission on Microbiological Specification for Foods, 1996), this implies that, the population of the microorganisms does not produce an effective dose that would render the food unfit for consumption. Fungal had been seen to have the highest loads among all the organisms tested in the study this could be as a result of high moisture content present in the samples.

3.5 Acceptability of *dakuwa* produced from millet and sorghum with groundnut

Table 4.5 below shows the sensory attributes of dakuwa. Acceptability of dakuwa showed that the colour was valued from 6.8 to 5.3, mouth feel from 7.3 to 4.7, texture valued from 7.3 to 5.2, taste from 7.8 to 5.7 and the overall acceptability valued form 7.3 o 5.3 respectively. This also showed that there was a significant difference ($p \geq 0.05$) across the formulations based on the sensory attributes such as colour, mouth feel, texture, taste and overall acceptability. The colour ranged from 6.8 to 5.4 accordingly. That samples MG(50:50) and SG(50:50) had the best colour followed by sample SG(60:40) this may be likely due to the rate of substitution with groundnut. Having the least colour with the control samples at 100% Mctrl and Sctrl. Mouth-feel also ranged from 7.3 to 52. From the table shows that samples MG(50:50) and SG(50:50) were the best in terms of mouth-feel. Texture ranged from 7.3 to 5.2, samples of MG(60:40) and MG(50:50) were best in texture which was as a result of millet/groundnut blends. Taste was ranked from 7.8 to 4.3, that shows samples MG(50:50) and SG(50:50) had the best taste when substituted with groundnut. The least in tastes at 100% are Mctrl and Sctrl respectively. The overall acceptability of the eight samples showed that samples MG(50:50) and SG(50:50) was the most accepted samples in terms of colour, mouth-feel, texture, and taste ranked 7.3 and 7.1 while samples Mctrl and Sctrl (100%) were the least.

Table 3.1: Proximate composition of dakuwa produced from millet and sorghum with groundnut

Sample code	Moisture %	Protein %	Ash %	Fat %	Fibre %	Carbohydrate %	Energy (kcal)
Mctrl (100)	11.57 ± 0.29^f	8.25 ± 0.02^g	2.44 ± 0.02^a	1.83 ± 0.00^h	2.62 ± 0.67^a	73.29 ± 0.97^b	342.63 ± 2.00^g
MG(80:20)	11.68 ± 0.29^d	8.40 ± 0.01^f	2.38 ± 0.01^f	2.60 ± 0.01^e	1.94 ± 0.03^f	73.00 ± 0.01^c	349.00 ± 0.30^b
MG(60:40)	11.79 ± 0.03^b	8.84 ± 0.01^d	2.41 ± 0.02^d	2.71 ± 0.01^c	2.34 ± 0.33^b	71.91 ± 0.03^g	347.39 ± 0.01^e
MG(50:50)	11.71 ± 0.13^c	9.26 ± 0.02^a	2.43 ± 0.01^b	2.88 ± 0.01^a	1.93 ± 0.02^g	71.79 ± 0.16^h	354.12 ± 0.10^a
Sctrl(100)	10.95 ± 0.01^g	8.17 ± 0.02^h	2.41 ± 0.02^d	1.96 ± 0.01^g	2.22 ± 0.03^c	74.29 ± 2.12^a	346.94 ± 0.01^f
SG(80:20)	11.79 ± 0.03^b	8.57 ± 0.01^e	2.42 ± 0.01^c	2.58 ± 0.01^f	1.99 ± 0.01^e	72.65 ± 2.12^d	348.10 ± 0.20^d
SG(60:40)	11.66 ± 0.01^e	8.86 ± 0.02^c	2.42 ± 0.02^c	2.69 ± 0.00^d	2.01 ± 0.02^d	72.36 ± 2.12^e	349.09 ± 0.02^b
SG(50:50)	11.86 ± 0.02^a	8.95 ± 0.02^b	2.40 ± 0.01^e	2.80 ± 0.01^b	1.99 ± 0.01^e	72.00 ± 2.12^f	349.00 ± 2.00^c

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at (P≥0.05), level. *Sample designated with Mctrl (control), MG (Millet/groundnut sample), Sctrl (control) and SG (Sorghum/groundnut sample)

Table 3.2: Functional Properties of dakuwa produced from millet and sorghum with groundnut

Sample code	Bulk density(g/cm^3)	Dispersibility(%)	Water absorbtion(%)	Oil absorbtion capacity (%)
Mctrl (100)	0.94 ± 0.02^a	68.55 ± 0.02^g	0.98 ± 0.02^a	0.95 ± 0.02^c
MG(80:20)	0.82 ± 0.02^c	71.62 ± 0.02^f	0.84 ± 0.02^c	0.88 ± 0.02^g
MG(60:40)	0.74 ± 0.03^f	73.62 ± 0.02^d	0.79 ± 0.02^e	0.92 ± 0.02^e
MG(50:50)	0.62 ± 0.02^h	76.72 ± 0.02^a	0.73 ± 0.02^g	1.18 ± 0.02^a
Sctrl(100)	0.91 ± 0.02^b	68.22 ± 0.02^h	0.94 ± 0.01^b	0.94 ± 0.02^d
SG(80:20)	0.81 ± 0.02^d	72.87 ± 0.02^e	0.82 ± 0.02^d	0.90 ± 0.02^f
SG(60:40)	0.78 ± 0.02^e	74.62 ± 0.02^c	0.78 ± 0.02^f	0.94 ± 0.02^d
SG(50:50)	0.71 ± 0.01^g	74.99 ± 0.02^b	0.78 ± 0.02^f	0.96 ± 0.02^b

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at (P≥0.05), level. *Sample designated with Mctrl (control), MG (Millet/groundnut sample), Sctrl (control) and SG (Sorghum/groundnut sample)

Table 3.3: Mineral composition of dakuwa produced from millet and sorghum with groundnut

Sample code	Calcium	Iron	Potassium	Magnesium	Zinc
Mctrl (100)	2.66 ± 0.02^d	2.15 ± 0.01^d	41.15 ± 0.02^f	116.47 ± 0.06^b	2.72 ± 0.01^c
MG(80:20)	1.85 ± 0.01^h	1.59 ± 0.01^e	59.96 ± 0.05^c	78.04 ± 0.02^h	1.88 ± 0.02^g
MG(60:40)	2.89 ± 0.02^c	1.12 ± 0.01^h	42.93 ± 0.02^e	88.02 ± 0.02^e	1.53 ± 0.01^h
MG(50:50)	3.79 ± 0.01^a	3.21 ± 0.01^a	134.80 ± 0.01^a	136.25 ± 0.01^a	3.88 ± 0.02^a
Sctrl(100)	2.58 ± 0.02^e	2.17 ± 0.01^c	41.08 ± 0.02^g	112.33 ± 0.06^d	2.66 ± 0.01^d
SG(80:20)	1.88 ± 0.02^g	1.53 ± 0.01^f	52.90 ± 0.05^d	81.89 ± 0.02^g	1.94 ± 0.01^f
SG(60:40)	2.44 ± 0.02^f	1.33 ± 0.01^g	40.89 ± 0.02^h	84.06 ± 0.02^f	1.98 ± 0.01^e
SG(50:50)	2.95 ± 0.02^b	2.85 ± 0.01^b	128.95 ± 0.02^b	131.06 ± 0.2^c	3.10 ± 0.01^b

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at (P≥0.05), level. *Sample designated with Mctrl (control), MG (Millet/groundnut sample), Sctrl (control) and SG (Sorghum/groundnut sample)

Table 3.4: **Microbial count of *dakuwa* produced from millet and sorghum with groundnut**

Sample code	Total Bacterial Count (cfu/g)	Total Fungal Count (cfu/g)
Mctrl (100)	$2.4X10^3$	$3.8\ X10^3$
MG(80:20)	$2.8\ X10^3$	$4.2\ X10^3$
MG(60:40)	$4.8\ X10^3$	$6.2\ X10^3$
MG(50:50)	$3.4\ X10^3$	$3.7\ X10^3$

Sample code	Total Bacterial Count (cfu/g)	Total Fungal Count (cfu/g)
Sctrl(100)	$2.7x10^3$	$3.3x10^3$
SG(80:20)	$3.1 X10^3$	$3.6x10^3$
SG(60:40)	$4.2 X 10^4$	$5.8x10^4$
SG(50:50)	$3.3 X10^3$	$4.4x10^3$

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at (P≥0.05), level. *Sample designated with Mctrl (control), MG (Millet/groundnut sample), Sctrl (control) and SG (Sorghum/groundnut sample)

Table 3.5: **Acceptability of *dakuwa* produced from millet and sorghum with groundnut**

Sample code	Colour	Mouth-feel	Texture	Taste	Overall acceptability
Mctrl (100)	$5.4±0.03^e$	$5.2±0.04^g$	$5.3±0.01^f$	$5.7±0.01^f$	$5.3±0.03^f$
MG(80:20)	$6.5±0.02^c$	$6.3±0.03^d$	$6.3±0.04^d$	$6.3±0.06^e$	$5.8±0.02^e$
MG(60:40)	$6.5±0.02^c$	$6.8±0.02^c$	$6.7±0.02^b$	$6.9±0.02^d$	$6.4±0.04^d$
MG(50:50)	$6.8±0.04^a$	$7.2±0.02^b$	$7.3±0.03^a$	$7.8±0.05^a$	$7.3±0.03^a$
Sctrl(100)	$5.3±0.03^f$	$4.7±0.01^h$	$5.2±0.03^g$	$4.3±0.03^g$	$4.1±0.03^g$
SG(80:20)	$6.1±0.01^d$	$5.8±0.02^f$	$5.6±0.01^e$	$5.7±0.03^f$	$5.3±0.03^f$
SG(60:40)	$6.6±0.03^b$	$6.2±0.01^e$	$6.3±0.02^d$	$7.0±0.04^c$	$6.8±0.04^c$
SG(50:50)	$6.8±0.02^a$	$7.3±0.03^a$	$6.6±0.03^c$	$7.3±0.03^b$	$7.1±0.03^b$

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at (P≥0.05), level. *Sample designated with Mctrl (control), MG (Millet/groundnut sample), Sctrl (control) and SG (Sorghum/groundnut sample)

4.0 CONCLUSION

The dakuwa produced from different blends of millet and groundnut and sorghum and groundnut was observed to have increased in protein and fat content with variations in ash and crude fibre content and a decreased in carbohydrate content which was as a result of varying substitution rate with groundnut paste. The highest protein content was observed in MG (50:50) with 9.26% respectively. The safe limit of 10^4 was accepted by ICMSF (International Commission on Microbiological Specification for Foods, 1996), this implies that, the population of the microorganisms does not produce an effective dose that would render the dakuwa unfit for consumption. The overall acceptability of the four (4) samples showed that samples MG (50:50) was the most accepted sample in terms of colour, mouth-feel, texture, and taste while sample Mctrl was the least. Overall acceptability was ranked 7.3 to MG (50:50) and 7.1 to SG(50:50) which rated like very much according to the nine 9 point hedonic scale. It was concluded that samples MG(50:50) and SG(50:50) were the most accepted.

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Cite This Article: Aminu Barde & Fatima Abubakar (2024). Nutritional Composition, Functional, Mineral, Microbial Count and Acceptability of Two Different Types *Dakuwa* (Local Snack) Produced from the Blends of Pearl Millet, Sorghum and Groundnut Paste. *EAS J Nutr Food Sci*, *6*(6), 197-204.