



## QUALITY CHARACTERISTICS OF LAMBA AS AFFECTED BY DIFFERENT CEREAL AND LEGUME FLOUR BLENDS

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### ABSTRACT

Traditional foods are preserved cultural heritage passed down from generation to generation, and their recipes have remained unchanged for centuries. Lamba is a traditional food processed from the blends of maize, cowpea and karkashi (false sesame leaves). However, if prepared and consumed, lamba enriched with different flour blends will provide a healthy alternative to consumers. This study aimed to prepare and evaluate the quality of lamba produced from wheat – cowpea – karkashi (Wck), wheat–soybeans – karkashi (Wsk) and lastly, wheat –bambara groundnut– karkashi (wbk) flour blends in three different ratios, (70:20:10, 60:30:10 and 50:40:10) where maize-cowpea -karkashi (Mck) is the control (in the ratio of 70:20:10). The total of ten (10) different samples were produced including the control. Proximate composition, functional and microbial content of lamba samples were determined. The proximate composition of the lamba such as moisture, protein, fat, ash, crude fiber and carbohydrate ranged from .40 –9.92%, 7.92 – 15.39%, 3.82 – 9.25%, 2.78 – 3.48%, 2.03 – 3.55% and 64.24 – 73.55% respectively. Subsequently, there are significant differences ( $p \leq 0.05$ ) between the functional properties such as wettability, bulk density, water absorption capacity and swelling index of the flour blends which ranged from 50.13 – 68.18 sec, 0.60 – 0.76 g/ml, 58.93 – 105.58 %, 1.36 – 2.15% respectively. Also, wettability, bulk density, water absorption capacity and swelling index have been determined and the control sample (Mck) had the highest. Similarly, microbiological analysis shows the bacterial load ranged from  $4.9 \times 10^4$  –  $8.1 \times 10^4$  cfu/g and sample Wbk 3 had the highest Mck (control sample) had the lowest. However, there was no significant difference between all the remaining samples. additionally, fungal load ranged from  $1.6 \times 10^5$  –  $4.4 \times 10^5$  cfu/g and sample Wsk 2 had the highest fungal count while sample Wbk 3 had the lowest. Sensory attributes of lamba were evaluated ranging from 5.09 – 6.13 for texture, 5.01– 6.38 for aroma, 4.92 – 7.98 for taste, 4.61 – 6.08 for colour and 5.18 – 8.49 for overall acceptability. The study shows that lamba produced from different ratio of wheat, soybean, cowpea, bambara groundnut and karkashi contains higher nutritive value. It is also acceptable as compared to lamba produced from maize, cowpea and karkashi. Therefore, this study recommends that the blend of 60% wheat, 30% soybeans and 10% karkashi (Wsk 2) can be used for the production of lamba with the desired nutritional and sensory quality as alternative to soybean

## 1.0 Introduction

A wide range of traditional foods is produced in Nigeria from local raw materials such as cereals (rice, sorghum, millet) and legumes (soybeans, cowpea, and bambara groundnuts). Traditions of cultures and regions have been greatly influenced by traditional foods for decades including foods that have been consumed locally and regionally. Furthermore, several traditional foods developed for decade may still have their place in a healthy diet today. Some traditional foods may not meet nutritional needs and acceptability. Therefore; modification of these food products becomes necessary. Generally, the origin of traditional foods in Nigeria is lost in antiquity, however, it was believed to have started along with the time the crop cultivation started in the region (Mamudu et al., 2017). Cereals and legumes are considered as major staple foods. Cereal grains such as rice, wheat and maize are important members of the grass family Graminae and are of great value within the staple food crops. For decades, cereal grains have been the most important sources of nutrients such as carbohydrates, proteins, vitamins and most importantly dietary fibers, necessary for the growth and human body development (Nadeem et al., 2010). Wheat is one of the key edible food crops, about two-thirds of the wheat produced is consumed by the world's population (Grote et al., 2021). Wheat is the most diverse crop, which is grown throughout the world with approximately 750 million tons produced annually (FAOSTAT, 2016). According to Adeyeye and Akingbala, (2016), extensive attention has been given to wheat-based foodstuffs in the consumer market and also from food companies due to their health-beneficial components.

Another material is Legumes, which are edible crops that belong to the Leguminosae family with an enormous diversity of plants and second only to cereals in terms of the level of human consumption (Sánchez-Chino et al. 2015). They contain desirable amounts of micro and macronutrients that can enhance nutritional quality such as protein concentration, potassium, fiber, and low glycemic index. Globally, legumes are the most important source of protein in the diet which has high nutritional value (Semba et al., 2021). Consumption of legume seeds is believed to have a strong impact on blood pressure reduction while conferring antioxidant benefits (Polak et al. 2015; Vaz Patto et al., 2015). However, supplementing cereals and legumes is known to improve the nutritional quality of foods (Gebrelibanos et al., 2013). Thus, the combination of cereal and legumes will improve the protein and nutrient density of the food. Subsequently, legumes contain high amounts of the amino acid lysine which is low in cereals products hence, can solve the issue of malnutrition in developing countries (Abamecha, 2020).

*Lamba* is a traditional steamed food product produced from a mixture of maize, cowpea and *karkashi* (false sesame leaves) complemented with cowpea flour. It is commonly processed in the northern part of Nigeria (Potiskum, Yobe State) by the *kare-kare* people and is eaten with spiced oil or groundnut soup called *Daba*. It is a local delicacy which form part of the cultural heritage with low nutritional quality because it is produced from only maize (carbohydrate) with little cowpea. Therefore, the use of other cereal and legumes has a significant impact on the nutritional value of food especially in developing countries by delivering good nutrients in the diet. (Kumari, and Sangeetha., 2017). Therefore, the objective of this study is to produce *lamba* from other cereal (wheat and maize flour) and legumes (cowpea, soybeans and Bambara nut) blends and to determine the proximate composition, functional properties, sensory characteristics and microbial loads.

## **2. Materials and Methods**

### **2.1 Materials**

The raw materials used in the study were maize, cowpea, bambara groundnut, soybean and *karkashi* (false sesame leaves). The materials were obtained from Maiduguri Monday market except for wheat which was gotten from Lake Chad Research Institute Maiduguri. The chemicals/reagents used were analytical grade and were sourced from food analysis laboratory of the Department of Food Science and Technology University of Maiduguri and the University of Science and Technology Wudil, Kano State.

### **2.2 Methods**

#### **2.2.1 Preparation of Wheat Flour**

Wheat samples were processed as previously described by Quaye et al. (2009), where the sample was sorted and cleaned. The wheat samples were then winnowed to remove the hulls and then thoroughly washed, sun-dried, milled and sieved into flour. The fine flour was then packed and stored for further use.

#### **2.2.2. Preparation of Maize Flour**

The Maize sample was prepared according to the method described by Umar et al. (2022) with slight modifications by dehulling the maize sample, winnowed to remove hulls and chaff and sun-dried. It was then thoroughly washed, soaked for 24 hours (1 day) and then sun-dried again after the maize sample was sorted and cleaned to remove stones, dirt and foreign materials. The dried maize was milled and sieved.

#### **2.2.3. Preparation of Cowpea Flour**

Preparation of the cowpea (*Vigna unguiculata*) was carried out according to the method described by Quaye et al. (2009) where the cowpea was steeped in cool water (25°C) for about 15 minutes, dehulled and dried. The cowpea was then coarsely milled, sieved, packaged and stored for further use.

#### **2.2.4. Preparation of Soya Bean and Bambara groundnut Flour**

Soya bean (*Glycine max*) and Bambara groundnuts (*Vigna subterranean* L. Verdc) were prepared according to the method described by Agbara et al. (2022) where the preparations of both legumes were carried out separately using the same method. The legumes were sorted, winnowed, washed, sundried, then coarsely milled, sieved packaged and stored for further use.

### 2.2.5. Formulation of Flour Blend

The *lamba* flour blends were prepared from cereal (wheat and maize), legumes (soybean, cowpea and Bambara nut) and *karkashi* in the ratio of 70:20:10, 60:30:10, 50:40:10 of any cereal: legume: *Karkashi*. A total of 10 different blends were obtained including control as shown in Table 1.

**Table 1: Formulation of flour blends for *lamba* production**

Sample	Cereal (%)	Legume (%)	Karkashi (%)
Wck1	70	20	10
Wck2	60	30	10
Wck3	50	40	10
Wheat, soybean, <i>Karkashi</i>	Wheat	Soybeans	Karkashi
Wsk1	70	20	10
Wsk2	60	30	10
Wsk3	50	40	10
Wheat, Bambaranut, <i>Karkashi</i>	Wheat	Bambara groundnut	Karkashi
Wbk1	70	20	10
Wbk2	60	30	10
Wbk3	50	40	10
Maize, cowpea, <i>Karkashi</i> (control)	Maize	Cowpea	Karkashi
Mck	70	20	10

Mck=Maize, cowpea and *karkashi*(70:20:10), Wck1=Wheat, cowpea and *karkashi* (70:20:10), Wck2=Wheat, cowpea and *karkashi* (60:30:10) Wck3=Wheat, cowpea and *karkashi* (50:40:10), Wsk1=Wheat, soybeans and *karkashi*(70:20:10), Wsk2=Wheat, soybeans and *karkashi* (60:30:10) Wsk3=Wheat, soybeans and *karkashi* (50:40:10), Wbk1=Wheat, Bambara groundnut and *karkashi*(70:20:10), Wbk2=Wheat, Bambara groundnut and *karkashi* (60:30:10) Wbk3=Wheat, bambara groundnut and *karkashi* (50:40:10),

### 2.2.6. Production of Lamba

Five (5) g of potash was placed into 100 ml water and allowed to disperse. The potash solution was thoroughly mixed and added to the chopped fresh *Karkashi* leaves (10%). It was then mixed using a spatula to ensure a homogenous mixture. The flour blends of different ratios from cereal: legumes: *karkashi* were then added to the mixture to form a stiff dough. The dough was then wrapped into polythene bags and placed in boiling water to cook for 45 min; on high heat.

### 2.3. Proximate Analysis

The proximate composition of the flour blends and processed *lamba* sample was carried out according to the standard methods of AOAC, (2012) where the moisture, ash, protein, fat, crude fiber and energy level were determined while carbohydrate content was determined by the difference using the Equation 1.

$$\text{CHO} = 100\% - (\% \text{MC} + \% \text{Ash} + \% \text{Crude protein} + \% \text{Fat} + \% \text{Crude fiber}) \quad (1)$$

### 2.3.1. Determination of protein content.

The protein content of the samples was determined using micro Kjeldhal method. Ten grams (10g) of catalyst was added to 0.2 g of each sample placed into a digestion flask, concentrated sulfuric acid (25 ml) were added to each digestion flask and placed on the digestion block in a fume cupboard

After digestion, a clear and light blue–green colouration solution was obtained. The mixture was then cooled and diluted with 250 ml of distilled water. About 10 ml of the sample was distilled using a distillation apparatus and 10 ml of sodium hydroxide (40%) was added. The released ammonia was absorbed by boric acid which was then titrated with hydrochloric acid (0.02 ml) until the green colour changed to purple. The percentage of nitrogen in the sample was calculated using Equation 2.

$$\% \text{ Nitrogen} = \frac{(T-B) \times \text{normality of acid} \times 14.008}{(\text{weight of sample} \times 1000)} \times 100 \quad (2)$$

Where B= blank titer value,

T = Actual titer value,

% protein = %N × 6.25

### 2.3.2. Moisture content determination

The moisture content of the samples was determined by the oven–drying method. Two (2) g of the sample was weighed and placed in the oven at 105°C for an hour. Weight loss expressed as the percentage of the initial weight was regarded as % moisture content.

### 2.3.3. Ash content

Ash content was determined using a muffle furnace by incinerating 5 g of each sample at 550°C for 5 h. The grey ash was cooled in a desiccator to avoid moisture absorption from the surroundings and weighed to obtain the ash content.

### 2.3.4. Crude fiber

The crude fiber was determined by weighing 5g ( $W_o$ ) of the sample into a 500ml Erlenmeyer flask. TCA digestion reagent (100ml) was added and then boiled for 40 min. The sample was then cooled for 30 min. and filtered through a Whatman (No. 4). The residues were then washed with hot water, dried overnight at 105°C and cooled in desiccators. The initial weight of the sample was taken as  $W_1$ . The samples were burnt in a muffle furnace at 500 °C for 6 h, allowed to cool and re–weighed as  $W_2$ . The crude fiber was determined using Equation 3.

$$\% \text{ Crude fiber} = \frac{W_1 - W_2}{W_o} \times 100 \quad (3)$$

where:  $W_o$  =Dry weight of food sample,

$W_1$  = Weight of crucible + fiber + ash,

$W_2$  = Weight of crucible + ash

### 2.3.5. Fat content

The Soxhlet extraction method was used for the determination of the fat content of the samples. Five (5) g of each sample was weighed into a flat bottom flask of a known weight

with the extractors mounted on them. The thimbles were held halfway into the extractors with the weighed samples. Petroleum ether (boiling point 40–60°C) was used for the extractions. Where thimbles were plugged with cotton wool. After the extraction, the solvents were removed by evaporation in a water bath and the remaining part in each flask was dried at 80°C for 30 min in the oven to dry the fat. The flasks were cooled in a desiccator and reweighed to obtain the weight of fat (%).

#### 2.4. Physicochemical Analysis of the Flours Blends.

The wettability of the flours was determined according to the method described by Okezie and Bello, (1988) with slight modification where 1.0g of the sample was suspended in a plastic spatula from a retort stand (15cm) above a beaker containing 500ml distilled water. The sample in the spatula was gently dropped unto the surface of the water, the time taken for the sample to disappear or wetting of the sample is recorded as wettability (sec).

Water absorption capacity of the flour blends was carried out as previously described by Adeleke and Odedeji, (2010) with slight modification where 1g of the sample was measured into a centrifuge tube and 15 ml of water was added. The sample was then centrifuged at 3250 rpm for 25 min where the supernatant was decanted. The water absorption was then determined by measuring the free water while retained water by the sample was recorded as water absorbed which was expressed as ml of water absorbed per gram of sample.

The bulk density was determined according to the method described by Murphy et al. (2003). A measuring cylinder was filled with tap water to the mark of 10 ml and the volume was noted. The measuring cylinder was emptied and 10 ml of the composite flour was poured to the mark of 10 ml. Air space between the flour blends was removed by tapping the cylinder for 5 min and the weight was noted. Therefore, bulk density was then calculated as

$$\text{Bulk density} = \frac{\text{Weight of the sample}}{\text{Volume of the sample}} \quad (4)$$

Swelling index of the flour blends was recorded as the ratio of the swollen volume of the flour to the original volume of a unit weight of the flour. 1g of the flour blends was weighed and placed into a measuring cylinder, the original height was recorded then 5 ml of distilled water was added to the sample and left to stand for 60 mins and the swollen volume was recorded (Onwuka, 2018).

#### 2.5. Microbiological analyses

Microbiological analysis was carried out as previously described by Obueh et al. (2017) with slight modification where 10 g of *lamba* sample was blended aseptically using a blender and aseptically introduced into 90 ml of sterile distilled water. Serial dilutions of all the samples were carried out to 10<sup>-5</sup> and 0.1 ml of selected dilutions were plated out using the pour plate method into Nutrient Agar (NA) (Lab M Ltd UK) and incubated at 37°C for 24 h for the total bacterial count and Potato Dextrose Agar (PDA) (Lab M Ltd UK) with chloramphenicol was incubated at 25°C for 72 h for total fungal count. All media used were prepared according to manufacturers' instructions.

## 2.6. Sensory Evaluation of *lamba* produced

The sensory properties of *lamba* were evaluated using the 9–point hedonic where 9 represents like extremely, 1 dislike extremely and 5 neither liked nor disliked. Twenty (20) semi-trained panelists (students, all females) from the Department of Food Science and Technology, University of Maiduguri. The coded sample was assessed by the panelists based on the flavour, aroma, taste, colour and overall acceptability at a single session as previously described by Ibanoglu et al., (1995)

## 2.7. Statistical Analysis

Statistical analysis was determined in duplicates and data generated were subjected to analysis of variance (ANOVA) using SPSS software (version 16). Means were separated using Duncan multiple range test and a *p*-value ( $p \leq 0.05$ ) was set.

## 3. Results and Discussion

### 3.1. Proximate Composition of Flour Used for the Preparation of *Lamba*

Table I shows the proximate composition of the flour used for different blends of *lamba*. The moisture content of the flour ranged from  $8.12 \pm 0.01$  –  $10.04 \pm 0.03$  %. Wheat flour (Wt) was observed to have the highest moisture content followed by maize flour (Mz), Bambara groundnut (Bg), and soybeans (Sb) while cowpea flour (Co) had the least. According to Godswill, (2019), the most suitable and acceptable limit of moisture content for long-term storage should not be more than 10%. In this study, the moisture content of the flour is within the acceptable limit which will enhance the shelf life of the flour by preventing microbial growth and chemical changes.

The protein content of the flour ranged from  $9.23 \pm 0.06$  –  $39.12 \pm 0.04$  %. However, soybeans flour (Sb) had the highest protein content ( $38.12 \pm 0.04$  %) as compared to cowpea ( $21.42 \pm 0.03$  %), followed by bambara groundnut ( $19.41 \pm 0.02$  %), wheat flour ( $10.92 \pm 0.03$  %) while maize flour ( $9.23 \pm 0.06$  %) had the lowest. However, this was expected because the protein content of cereals and legumes varied significantly as maize is cereal and soybean is a legume with higher nutritional quality. This is similar to a previous study reported by Agbara et al. (2022) on the proximate composition of different flour although for the production of bread. Fat content of the flour varied significantly ( $p <$ , ranging from  $3.76 \pm 0.04$  –  $20.89 \pm 0.01$  %. The fat content of soybeans flour is significantly higher than all the samples while maize flour had the lowest fat content. Subsequently, soybeans are also regarded as oil seed crop that provides more than 50% of the world's oilseed production (Wilson, 2008). Ash is the inorganic residue remaining after the water and organic matter are removed by heating. The ash content in food products could be used as an index of mineral constituents of the food (Sanni et al., 2008). The ash content of the flour ranged from  $1.52 \pm 0.04$  –  $4.84 \pm 0.01$  %. The ash content in soybeans was significantly ( $P < 0.05$ ) higher as compared to all the samples. The ash content of legumes is expected to be higher than cereals as they are good sources of minerals. Crude fiber of the flour ranged from  $2.48 \pm 0.05$  –  $4.08 \pm 0.01$  %. However, the most important function of fiber is to provide roughage or bulk that aids in the digestion of food leading to lower plasma cholesterol and softens stool (Saini et al., 2022). Carbohydrate content ranged from  $24.81 \pm 0.01$  –  $73.76 \pm 0.01$  % with maize flour having the highest while soybeans had the least. The carbohydrate content of maize is higher as compared to all the samples.

**Table I:** Proximate composition of flour used for preparation of *lamba*

Flour	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fiber (%)	CHO (%)
Wt	10.04±0.03 <sup>a</sup>	10.92±0.03 <sup>d</sup>	3.61±0.04 <sup>c</sup>	4.06±0.05 <sup>c</sup>	3.83±0.01 <sup>b</sup>	67.55±0.02 <sup>ab</sup>
Cw	8.12±0.01 <sup>d</sup>	21.42±0.03 <sup>b</sup>	5.23±0.02 <sup>b</sup>	3.16±0.05 <sup>ab</sup>	4.07±0.02 <sup>ab</sup>	58.00±0.01 <sup>c</sup>
Sb	7.26±0.04 <sup>d</sup>	38.12±0.04 <sup>a</sup>	20.89±0.01 <sup>a</sup>	4.84±0.01 <sup>a</sup>	4.08±0.01 <sup>c</sup>	24.81±0.01 <sup>d</sup>
Bg	8.36±0.02 <sup>c</sup>	19.41±0.02 <sup>c</sup>	5.84±0.02 <sup>b</sup>	2.98±0.03 <sup>ab</sup>	3.08±0.04 <sup>ab</sup>	60.33±0.04 <sup>b</sup>
Mz	9.25±0.01 <sup>b</sup>	9.23±0.06 <sup>e</sup>	3.76±0.02 <sup>d</sup>	1.52±0.04 <sup>b</sup>	2.48±0.05 <sup>a</sup>	73.76±0.01 <sup>a</sup>

Data are Mean ± SD (n = 3). Mean values bearing similar superscripts are not significantly different ( $p < 0.05$ )

Results are Mean ± SD (n = 3). Mean values bearing different superscripts are significantly different ( $p < 0.05$ ) Wt = wheat flour, Cw= cowpea flour, Sb= soyabeans flour, Bg = Bambara groundnut flour, Mz = Maize flour



### 3.2. Functional Properties of Flour Blends for *Lamba* Production

Table 2. shows the functional properties of *lamba* produced from different flour blends. There was significant difference ( $p \leq 0.05$ ) between the wettability, bulk density, water absorption capacity and swelling index of the flour blends. Sample Mck had the highest wettability, bulk density, water absorption capacity and swelling index as compared to other samples. The wettability of the flour blends ranged from 50.13 – 68.18 sec. The wettability varied significantly ( $p < 0.05$ ) and sample Mck was higher as compared to all the samples while sample Wsk1 had the list value. In this study, there is no significant difference between samples containing soybeans (Wsk 1, Wsk 2 and Wsk 3). Subsequently, there is no significant difference between the samples containing cowpea and Bambara groundnuts. However, the wettability increased with an increase in legume content (cowpea, soybeans and Bambara groundnut).

WAC is the ability of a product to bind water under limited water conditions such as dough and paste (Hasmedi et al., 2020). This varies depending on the presence of hydrophilic carbohydrates and protein structures (Kaur et al., 2015). The WAC ranged from 58.93 – 105.58 % and the results indicated that sample Mck (control) exhibited the highest (105.58%) while the least was observed for sample Wsk 3 (58.93%). Generally, the results show that besides the control samples (Mck), samples containing soybeans (Wsk1, Wsk 2 and Wsk 3) had lower WAC as compared to samples containing cowpea (Wck 1, Wck 2 and Wck 3) and Bambara groundnut (Wbk 1, Wbk 2 and Wbk 3). Bulk density is the criteria for selecting the packaging which measures the amount of load a sample can carry when resting on each other (Otondi et al., 2020). The bulk density of the flour blends varies significantly ( $p < 0.05$ ) ranging from 0.50 – 0.76g/ml. Among all the samples, Mck had the highest value as compared to other samples. However, there is no significant difference between the samples containing cowpea (wck 1, Wck 2 and Wck 3) and samples containing bambara groundnut (wbk 1, wbk 2 and wbk 3) while samples containing soybeans had the least. This is similar to a previous study on the bulk density of whole and decorticated maize and millet (Umar et al., 2022). According to Oladunmoye et al. (2010), particle size distribution would significantly affect the bulk density of the flour. Therefore, bulk density is a function of particle size, particle size being inversely proportional to bulk density (Appiah et al., 2011). Also, bulk density has a significant effect on the strength and amount of packaging material, texture and mouthfeel of the product (Ahaotu et al., 2021). One of the factors to be considered as quality criteria in food bakeries is the swelling index (SI). In this study, the SI of the flour blends varied significantly ranging from 1.62 – 2.15%. Among all the samples, sample Mck (control) was observed to exhibit the highest SI as compared to all the samples. However, there is no significant difference between sample Mck and sample Wbk 3. Subsequently, the least SI was observed for sample Wsk 1. This is similar to a previous study where the SI of wheat and soybeans blend was between 1.13 – 1.38 % depending on the ratio of wheat to soybeans (Godswill, 2019). Swelling capacity of the flour depends on the type of starch, availability of water, protein, temperature, and carbohydrates (Sui et al., 2006). However, a decrease in the SI of the flour blends may be caused by the formation of the protein-amylose complex in the native starches.

**Table 2: Functional properties of the flour blends**

Flour blends	Wettability (sec)	Water absorption capacity (%)	Bulk density (g/ml)	Swelling index (%)
Mck	68.18±0.21 <sup>a</sup>	105.58±4.82 <sup>a</sup>	0.76±1.28 <sup>a</sup>	2.15±0.36 <sup>a</sup>
Wck 1	54.51±0.36 <sup>b</sup>	78.21±0.04 <sup>c</sup>	0.60±3.61 <sup>a<sup>b</sup></sup>	1.76±0.53 <sup>c</sup>
Wck 2	55.51±0.03 <sup>b</sup>	76.83±2.05 <sup>c</sup>	0.63±5.10 <sup>a<sup>b</sup></sup>	1.85±0.42 <sup>b</sup>
Wck 3	56.01±2.01 <sup>b</sup>	77.12±3.55 <sup>c</sup>	0.63±2.01 <sup>a<sup>b</sup></sup>	1.86±2.01 <sup>b</sup>
Wsk 1	50.13±2.43 <sup>c</sup>	62.36±1.03 <sup>d</sup>	0.51±4.82 <sup>c</sup>	1.62±8.23 <sup>d</sup>
Wsk 2	52.92±0.26 <sup>c</sup>	63.10±0.42 <sup>d</sup>	0.50±5.27 <sup>c</sup>	1.72±1.20 <sup>c</sup>
Wsk 3	53.21±0.21 <sup>c</sup>	58.93±0.61 <sup>e</sup>	0.52±0.04 <sup>c</sup>	1.72±0.04 <sup>c</sup>
Wbk 1	55.83±2.01 <sup>b</sup>	92.73±2.65 <sup>bc</sup>	0.65±0.28 <sup>b</sup>	1.87±3.01 <sup>b</sup>
Wbk 2	56.17±3.10 <sup>b</sup>	96.12±0.03 <sup>b</sup>	0.65±0.15 <sup>b</sup>	1.96±7.20 <sup>ab</sup>
Wbk 3	57.81±0.45 <sup>b</sup>	98.42±0.84 <sup>b</sup>	0.68±2.01 <sup>ab</sup>	2.05±0.03 <sup>a</sup>

Data are Mean ± SD (n=3). Mean values bearing different superscripts are significantly different (p<0.05)

### 3.3. Proximate Composition of *Lamba* Produced from Different Flour Blends

Table 3 shows the proximate composition of *lamba*. The moisture content of *lamba* varied from 5.40 – 9.92%, where sample Wck 2 (9.92%) had the higher moisture content while sample Wsk 2 (5.40%) had the least. However, the aim of moisture determination in food is to know about the characteristics of the food products in terms of their physical appearance, texture, taste and the keeping quality of the food products (Zambrano et al., 2019). Although it has been reported that high moisture content in food favours the growth and multiplication of spoilage microorganisms which leads to short shelf life of the food product (Ahaotu et al., 2021). The protein content ranged from 7.92%–15.39% and varied significantly from all the samples. Subsequently, sample Wsk 3 had the highest protein content as compared to the other samples. According to Arise et al. (2018), complimenting cereals with legumes such as groundnut, soybeans, cowpea and Bambara groundnut may improve the protein content of the cereal. Thus, the protein content of the *lamba* increases with complimenting cereal and legumes, however, this depends on the type of legume used. As the protein content of soybeans is higher than that of bambara groundnut and cowpea, samples containing are expected to have higher protein content. The fat content of *lamba* ranged from 3.28 – 9.25% and a significant difference was observed. Among all the samples, sample Wsk 3 had the highest fat content and sample Mck (control) had the least. The difference in fat content could be as a result of the legumes used where soybeans are a good source of fat as compared to cowpea and bambara groundnut. In this study, the ash content of *lamba* ranged between 2.78%–3.48%, with sample Wsk 1 showing the highest while Mck 1 was the lowest. However, there is no significant difference (p>0.05) in ash content of samples Wck 2, Wck 3, Wsk 1, Wbk 2 and Wbk 3 which were significantly higher than other samples. Subsequently, no significant difference (p>0.05) existed between the rest of the samples and were slightly lower. The ash content in food products is an indication of mineral availability. The dietary fibre contents of the *lamba* ranged between 2.03 – 3.55% where sample Mck had high fibre content which originated from the added maize flours while there was no significant difference (p>0.05) among all other samples. Furthermore, maize grain proved to be richer in fibre than wheat flour. Both soluble and insoluble fibre is now recognized to be beneficial to humans. According to Arinola et al. (2014), crude fibre enhances bowel movement, digestibility, and prevents bowel cancer by reducing the rate at which glucose is released in the bloodstream.

The carbohydrate content of *lamba* ranged from 61.91 – 73.59%, among all the samples, lower carbohydrate content was observed in samples containing soybeans (Wsk 1, Wsk 2 and Wsk 3) as compared to the samples containing cowpea and bambara groundnut although the control sample (Mck) had the highest carbohydrate content. Higher carbohydrate content indicates higher energy value Although, there was no significant difference in the energy value obtained. In this study, the variation of the proximate composition among *lamba* samples depends on the kind of legume used which could be attributed to their variations in varieties, genetic makeup and environmental conditions (Kaur et al., 2007).

**Table 3:** Proximate composition of *lamba* produced from different flour blends

Sample	Moisture	Protein	Fat	Ash	Fiber	CHO
Mck	8.58±0.02 <sup>b</sup>	8.02±0.04 <sup>f</sup>	3.82±0.05 <sup>f</sup>	2.81±0.01 <sup>b</sup>	3.55±0.07 <sup>a</sup>	72.22±0.01 <sup>a</sup>
Wck1	8.45±0.07 <sup>b</sup>	7.92±0.05 <sup>g</sup>	4.28±0.39 <sup>f</sup>	2.78±2.13 <sup>b</sup>	2.98±0.04 <sup>b</sup>	73.59±0.06 <sup>a</sup>
Wck2	9.92±0.11 <sup>a</sup>	8.95±0.07 <sup>f</sup>	5.49±0.01 <sup>e</sup>	3.28±0.04 <sup>a</sup>	2.78±0.28 <sup>b</sup>	69.58±0.28 <sup>b</sup>
Wck3	9.65±0.04 <sup>a</sup>	10.53±0.04 <sup>d</sup>	6.09±0.02 <sup>d</sup>	3.23±0.11 <sup>a</sup>	2.03±0.11 <sup>b</sup>	67.47±0.01 <sup>b</sup>
Wsk1	8.64±0.02 <sup>b</sup>	13.78±0.04 <sup>c</sup>	7.78±0.04 <sup>c</sup>	3.48±0.04 <sup>a</sup>	2.08±0.52 <sup>b</sup>	64.24±0.12 <sup>b</sup>
Wsk2	5.40±0.06 <sup>d</sup>	14.39±0.01 <sup>b</sup>	8.53±0.05 <sup>b</sup>	2.88±0.16 <sup>b</sup>	2.68±0.03 <sup>b</sup>	66.12±0.10 <sup>b</sup>
Wsk3	8.02±0.07 <sup>b</sup>	15.39±0.02 <sup>a</sup>	9.25±0.07 <sup>a</sup>	2.85±0.02 <sup>b</sup>	2.58±0.02 <sup>b</sup>	61.91±0.06 <sup>b</sup>
Wbk1	8.09±0.05 <sup>b</sup>	8.14±0.19 <sup>f</sup>	4.43±0.04 <sup>f</sup>	2.90±1.04 <sup>b</sup>	2.89±0.01 <sup>b</sup>	73.55±0.08 <sup>a</sup>
Wbk2	7.70±0.01 <sup>c</sup>	9.14±0.02 <sup>e</sup>	5.24±0.02 <sup>e</sup>	3.11±0.01 <sup>a</sup>	2.81±0.21 <sup>b</sup>	71.80±0.11 <sup>a</sup>
Wbk3	6.49±0.14 <sup>d</sup>	11.01±0.01 <sup>d</sup>	5.98±0.04 <sup>e</sup>	3.32±0.02 <sup>a</sup>	2.98±0.50 <sup>b</sup>	67.92±0.02 <sup>b</sup>

Data are Mean ± SD (n=3). Mean values bearing similar superscripts are not significantly different (p<0.05)

### 3.4. Microbial Properties of Lamba Produced from Different Flour Blends

Table 4. shows the microbial load of *lamba* samples. Bacterial growth ranged from  $4.9 \times 10^4$  –  $8.1 \times 10^4$  cfu/g. Sample Wbk 3 had the highest bacterial load while sample Mck (control) had the lowest. However, there was no significant difference ( $p>0.05$ ) between samples Wck1, Wck 2, Wck3, Wsk1, Wsk 2 and Wsk 3 while samples Wbk1, Wbk 2 and Wbk 3 are significantly different. Also, the value of the fungal load ranged from  $1.6 \times 10^4$  –  $4.4 \times 10^4$  cfu/g. It has been observed that sample Wsk 2 had the highest fungal count while sample Wbk 3 had the lowest. This is similar to a previous study reported by Victor-Aduloju et al., (2021) although on the proximate, microbial and sensory properties of moi–moi produced from crayfish and grasshoppers.

**Table 4. Microbial load of *lamba***

Samples	Bacterial count CFU/g	Fungal count cfu/g
Mck	$4.9 \times 10^4$	$1.8 \times 10^4$
Wck 1	$6.1 \times 10^4$	$3.8 \times 10^4$
Wck 2	$6.1 \times 10^4$	$2.4 \times 10^4$
Wck 3	$6.5 \times 10^4$	$2.8 \times 10^4$
Wsk 1	$6.2 \times 10^4$	$1.7 \times 10^4$
Wsk 2	$6.1 \times 10^4$	$4.4 \times 10^4$
Wsk 3	$6.0 \times 10^4$	$2.8 \times 10^4$
Wbk 1	$7.0 \times 10^4$	$4.2 \times 10^4$
Wbk 2	$7.8 \times 10^4$	$2.1 \times 10^4$
Wbk 3	$8.1 \times 10^4$	$1.6 \times 10^4$

Data are Mean  $\pm$  SD (n=3).

### 3.5. Sensory Properties of Lamba

The mean sensory scores of *lamba* produced from different flour blends are shown in Table 5. The sensory evaluation was analysed in terms of texture, aroma, taste, colour and overall acceptability and their values obtained varied significantly ( $p < 0.05$ ) ranging from 5.09 – 6.13, 5.01 – 6.38, 4.92 – 7.98, 4.61 – 6.08 and 5.18 – 8.49 respectively. On texture, there was no significant difference among all the samples except for sample Wsk 2 ( $6.13 \pm 0.02$ ) which was rated the highest. Considering the aroma of *lamba* samples, Wsk 2 ( $6.38 \pm 0.04$ ) had the highest aroma as compared to other samples, however, there was no significant difference ( $p>0.05$ ) in flavour among the other samples produced. In this study, the variation in the taste of the *lamba* depends on the types of legumes used. The result shows that there was no significant difference ( $p>0.05$ ) in the taste of samples produced from cowpea flour (Wck1, Wck2 and Wck3 which are  $6.92 \pm 0.03$ ,  $6.06 \pm 0.04$  and  $6.09 \pm 0.01$  respectively). Also, the samples produced from Bambara groundnut are not significantly different from each other. However, there was variation in the taste of the samples produced from soybeans. Furthermore, sample Wsk 2 had the highest value in taste as compared to all the samples. Considering the colour, there was no significant difference among all the samples. Subsequently, the acceptability of *lamba* varied significantly and sample Wsk 2 had the highest value and is considered the most acceptable among all the samples while sample Mck (control) had the least value.

**Table 5: Sensory properties of *lamba* produced from different flour blends**

Sample	Texture	Aroma	Taste	colour	Overall acceptability
Mck	5.09±0.02 <sup>b</sup>	5.01±0.02 <sup>b</sup>	4.99±0.02 <sup>d</sup>	5.15±0.01 <sup>a</sup>	5.18±0.12 <sup>d</sup>
Wck 1	5.09±0.93 <sup>b</sup>	5.11±0.01 <sup>b</sup>	6.92±0.32 <sup>b</sup>	5.06±0.94 <sup>a</sup>	7.11±0.01 <sup>b</sup>
Wck 2	5.10±0.28 <sup>b</sup>	5.25±0.01 <sup>b</sup>	6.06±0.04 <sup>b</sup>	5.21±0.05 <sup>a</sup>	7.24±0.02 <sup>b</sup>
Wck 3	5.17±0.03 <sup>b</sup>	5.24±0.02 <sup>b</sup>	6.09±0.01 <sup>b</sup>	5.21±0.63 <sup>a</sup>	7.22±0.02 <sup>b</sup>
Wsk 1	5.30±0.01 <sup>b</sup>	5.58±0.01 <sup>ab</sup>	6.43±0.12 <sup>b</sup>	5.21±0.02 <sup>a</sup>	7.72±0.02 <sup>ab</sup>
Wsk 2	6.13±0.02 <sup>a</sup>	6.38±0.04 <sup>a</sup>	7.98±0.01 <sup>a</sup>	5.08±0.01 <sup>a</sup>	8.49±0.23 <sup>a</sup>
Wsk 3	5.10±0.04 <sup>b</sup>	5.09±0.03 <sup>b</sup>	6.09±0.01 <sup>b</sup>	5.26±0.04 <sup>a</sup>	7.18±0.18 <sup>b</sup>
Wbk 1	5.25±0.02 <sup>b</sup>	5.29±0.02 <sup>b</sup>	5.28±0.04 <sup>c</sup>	5.19±0.01 <sup>a</sup>	6.28±0.58 <sup>c</sup>
Wbk 2	5.14±0.01 <sup>b</sup>	5.15±0.01 <sup>b</sup>	5.16±0.42 <sup>c</sup>	5.14±0.01 <sup>a</sup>	6.32±0.32 <sup>c</sup>
Wbk 3	5.11±0.11 <sup>b</sup>	5.15±0.02 <sup>b</sup>	5.12±0.24 <sup>c</sup>	5.31±0.03 <sup>a</sup>	6.29±0.21 <sup>c</sup>

Data are Mean±SD (n=3). Mean values bearing similar superscripts are not significantly different (p<0.05)

#### 4.0 Conclusion

The study showed that nutritious and acceptable complimentary food (*lamba*) can be produced from different cereal and legume flour blends of wheat and soybeans. It is clear that *lamba* produced from composite flour blends of Wheat, soybeans and *karkashi* (60:30:10) had better acceptance in terms of all the sensory attributes assessed. The utilization of composite flour of 60% wheat flour, 30% soybeans and 10% *karkashi* for the production of *lamba* is advocated as it resulted in acceptable *lamba* with improved nutritional values. The use of the composite flour blend for the development of other food products should also be explored greatly.

#### References

- Abamecha, N. 2020. Research review on formulation and sensory evaluation of complementary foods from cereals and legumes in Ethiopia. Food Science and Nutrition Technology, 5: 1-7.
- Adeleke, RO. and Odedeji, JO. 2010. Functional properties of wheat and sweet potato flour blend. Pakistan Journal of Nutrition, 9: 535-538.
- Agbara, Gl., Ige, AC., Agbara, NH., Ahmad, G., Masaya, FA., and Aliyu, B. 2022. Evaluation of the quality characteristics of composite flour bread produced from a wheat-root tuber and wheat-grain legume flour blends. Arid Zone Journal of Engineering, Technology and Environment, 18: 331-344.
- Adeyeye, SA. and Akingbala, JO. 2016. Quality, functional, and sensory properties of cookies from sweet potato–maize flour blends. Journal of Culinary Science and Technology, 14: 363-376.
- Ahaotu, I., Eni, CV. and Maduka, N. 2021. Quality assessment of powdered maize ogi fortified with African walnut (*Tetracarpidium conophorum*) flour. Microbiology Research Journal International, 31: 28-51.
- AOAC. 2012. Association of Official Analytical Chemists. Official method of analysis of AOAC international, 19th ed. AOAC., Washington DC.
- Appiah, F., Asibuo, JY. and Kumah P. 2011. Physical and functional properties of bean flours of three cowpea (*Vigna unguiculata* L. Walp) varieties in Ghana. African Journal of Food Science, 5: 100-104
- Arinola, SO., and Adesina, K. 2014. Effect of thermal processing on the nutritional, antinutritional, and antioxidant properties of *Tetracarpidium conophorum* (African walnut). Journal of Food Processing, 2014: 1-4

Arise, AK., Oyeyinka, SA., Dauda, AO., Malomo, SA. and Allen, BO. 2018. Quality evaluation of maize snacks fortified with bambara groundnut flour. *Annals of Food Science and Technology*, 19: 283-291

FAOSTAT, F. 2016. FAOSTAT statistical database. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.

FAO. IFAD, UNICEF, WFP and WHO. 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome: FAO. Retrieved from <http://www.fao.org/3/i9553en/i9553en.pdf>

Gebrelibanos, M., Tesfaye, D., Raghavendra, Y. and Sintayeyu, B. 2013. Nutritional and health implications of legumes. *International Journal of Pharmaceutical Sciences and Research*, 4: 1269.

Godswill, AC. 2019. Proximate composition and functional properties of different grain flour composites for industrial applications. *International Journal of Food Sciences*, 2: 43-64.

Grote, U., Fasse, A., Nguyen, TT. and Erenstein, O. 2021. Food security and the dynamics of wheat and maize value chains in Africa and Asia. *Frontiers in Sustainable Food Systems*, 4: 617009.

Hasmadi, M., Noorfarahzilah, M., Noraidah, H., Zainol, MK. and Jahurul, MHA. 2020. Functional properties of composite flour: a review. *Food Research*, 4: 1820-1831.

Ibanoglu, S., Ainsworth, P., Wilson, G. and Hayes, GD. 1995. The effect of fermentation conditions on the nutrients and acceptability of tarhana. *Food Chemistry*, 53: 143-147.

Kaur, M., Singh, SK., Arora, AP. and Sharma, A. 2015. Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: Physicochemical and sensory properties. *Lebensmittel-Wissenschaft und -Technologie- Food Science and Technology*, 62: 628-632.

Kumari, PV. and Sangeetha, N. 2017. Nutritional significance of cereals and legumes based food mix-A review. *International Journal of Agricultural and Life Sciences*, 3: 115-122.

Mamudu, HB., Iro, N., Afodia, LK. and Danbaba N. 2017. Rice in nigeria. Traditional recipes and research needs. In Danbaba, N., Iro, N, Alhassan, TM., Mark, NU. (eds). History and preparation of traditional rice foods of northern Nigeria, pp 21-33. Ronab Graphix Prints, Niger State. Nigeria.

Murphy, MG., Skonberg, DI., Camire, ME., Dougherty, MP., Bayer, RC., and Briggs, JL. 2003. Chemical composition and physical properties of extruded snacks containing crab-processing by-product. *Journal of the Science of Food and Agriculture*, 83: 1163-1167.

Nadeem, M., Anjum, FM., Amir, RM., Khan, MR., Hussain, S. and Javed, MS. 2010. An overview of anti-nutritional factors in cereal grains with special reference to wheat-A review. *Pakistan Journal of Food Sciences*, 20: 54-61.

Obueh, H., Kolawole, S. and Oyem, J. 2017. Proximate and microbiological compositions of some foods and vegetable from food vendors at Lagos street in benin city. *Integrative Food, Nutrition and Metabolism*, 4: 1-4.

Okezie, BO. and Bello, AB. 1988. Physicochemical and functional properties of winged bean flour and isolate compared with soy isolate. *Journal of Food Science*, 53: 450- 454.

Oladunmoye, OO., Akinoso, R., and Olapade, AA. 2010. Evaluation of some physical-chemical properties of wheat, cassava, maize and cowpea flours for bread making. *Journal of Food Quality*, 33: 693-708.

Onwuka GI. 2018. Food analysis and instrumentation: Theory and Practice (2nd edn) Naphtali prints, Shomolu Lagos, Nigeria.

Otondi, EA., Nduka, JM. and Omwamba, M. 2020. Physico-chemical properties of extruded cassava-chia seed instant flour. *Journal of Agriculture and Food Research*, 2: 100058,

Polak, R., Phillips, EM. and Campbell, A. 2015. Legumes: health benefits and culinary approaches to increase intake. *Clinical Diabetes*, 33: 198-205.

Quaye, W., Adofo, K., Madode, YEE. and Abizari, AR. 2009. Exploratory and multidisciplinary survey of the cowpea network in the Tolon-Kumbungu district of Ghana: A food sovereignty perspective. *African Journal of Agricultural Research*, 4: 311-320.

Sánchez-Chino, X., Jiménez-Martínez, C., Dávila-Ortiz, G., Álvarez-González, I. and Madrigal-Bujaidar, E. 2015. Nutrient and nonnutrient components of legumes, and its chemopreventive activity: a review. *Nutrition and Cancer*, 67: 401-410.

Saini, P., Islam, M., Das, R., Shekhar, S., Sinha, ASK. and Prasad, K. 2022. Wheat bran as potential source of dietary fiber: prospects and challenges. *Journal of Food Composition and Analysis*, 105030

Sanni, SA., Adebawale, AA., Olayiwola, IO. and Maziya-Dixon, B. 2008. Chemical composition and pasting properties of iron fortified maize flour. *Journal of Food, Agriculture and Environment*, 6: 172-175.

Semba, RD., Ramsing, R., Rahman, N., Kraemer, K. and Bloem, MW. 2021. Legumes as a sustainable source of protein in human diets. *Global Food Security*, 28: 100520.

Sui, Z., Lucas, WP. and Corke, H. 2006. Optimal cooking time of noodles related to their notch sensitivity. *Journal of Texture Studies*, 37: 428-441.

Umar, BH., Agbara, GI., Alkali, MY., Masaya, AF. and Akubuiro, SC. 2022. Proximate composition, functional, and sensory properties of kadal (fermented grain flour) produced from whole and decorticated maize and pearl millet grains. *Arid Zone Journal of Engineering, Technology and Environment*, 18: 345-356.

Vaz Patto, MC., Amarowicz, R., Aryee, AN., Boye, JI., Chung, HJ., Martin-Cabrejas, MA. and Domoney, C. 2015. Achievements and challenges in improving the nutritional quality of food legumes. *Critical reviews in plant sciences*, 34: 105-143.

Victor-Aduloju, AT., Okonkwo, HC., Osuji, JC., Ukachi, NJ., Okonkwo, IW., Okafor, PI., Uchegbu, TM., Ezegbe, CC. and Olopade, AJ. 2021. Proximate, microbial and sensory properties of moi-moi produced with crayfish and grasshopper. *Microbiology Research Journal International*, 31: 55-62.

Wilson, RF. 2008. Soybean: market driven research needs. In: Stacey, G. (eds) *Genetics and genomics of soybean. plant genetics and genomics: crops and models*, pp 3-15. Springer, New York,

Zambrano, MV., Dutta, B., Mercer, DG., MacLean, HL. and Touchie M. 2019. Assessment of moisture content measurement methods of dried food products in small-scale operations in developing countries: A review. *Trends in Food Science and Technology*, 88: 484-496.