

Research Article

Production, Quality Characteristics and Beta Carotene Content of *Kamu* (Dried Millet Powder) from *Chakti* and *Jirani* Millet as Affected by Addition of Groundnut Flour

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Abstract

Kamu (dried millet powder) is a non-carbonated and non-alcoholic beverage produced from cereal grain such as millet, maize and sorghum popularly consumed in Nigeria, which serves as meal for children and adults across all ages. This study investigates the effect of groundnut flour addition in *kamu* (dried millet powder) produced from *chakti* and *jirani* millet variety with groundnut flour. The proximate composition, mineral content, functional properties, microbial and sensory attributes were determined using standard methods. Results showed that the addition of groundnut flour significantly increased the protein and fat contents of *kamu* (dried millet powder), where sample C and F had the highest protein content of 11.05% and 10.95%, and higher fat content of 8.85% and 8.39%. Iron content of sample C and F was 3.15 and 3.20mg/100g while the zinc content of sample E and F was 3.60 and 3.52mg/100g was found to be higher. Bulk density increased and water absorption capacity tends to decreased with substitution with groundnut flour. Total bacterial count increased from 2.0×10^4 to 4.5×10^4 cfu/g, while the total fungal count decreased from 4.4×10^4 to 3.3×10^4 cfu/g, with increased in groundnut flour substitution. *Kamu* (dried millet powder) from *chakti* substituted with groundnut flour was more accepted than *kamu* (dried millet powder) produced from *jirani* substituted with groundnut flour in all the sensory attributes such; taste 7.35, colour 7.45, texture 7.55, appearance 7.60 and overall acceptability 7.75. It can be concluded that addition of groundnut flour in *kamu* samples produced from *chakti* millet variety and groundnut tends to improve the nutritional value.

Keywords

Kamu (Dried Millet Powder), Proximate, Mineral, Microbiology, Acceptability

1. Introduction

Kamu (dried millet powder) refers to a non-carbonated and non-alcoholic beverage produced from cereal grains in Nigeria [17]. *Kamu* is universally consumed in Nigeria as

a meal for children and adults across all ages [2]. It is produce from cereals grains such as Millet (*Pennisetum typhoideum*), Sorghum (*Sorghum bicolor*) and Maize (*Zea mays*), were sorted and cleaned, soaked in water for 8 hours,

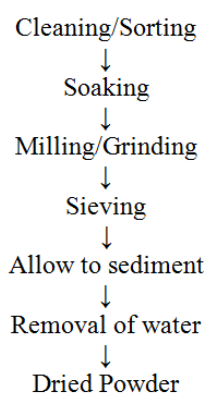
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and then grinded with optional ingredients such as; spices (ginger, red pepper, black pepper, clove and garlic), sweet potatoes and tiger nut (*Cyperus esculentus*) were added to enhance the flavor. Thus addition of groundnut flour improves the nutritional content of the product. *Kamu* (dried millet powder) millet based food serves as a good source of beta-carotene, with some varieties containing up to 2.5 times more beta-carotene than rice or wheat [2]. Moreover, it contains significant amounts of zinc and iron, making it a nutritious addition to the diet. Therefore, the beta-carotene improves the absorption of zinc and iron in the body, ensuring that these important minerals are utilized effectively. Developments in genetics, agronomics and processing have positioned staple cereals as important sources of iron, zinc and pro-vitamin A (carotenoid) for nutritionally vulnerable populations. Significant effort has been placed on understanding the bioavailability of these micro-nutrients from cereal foods, including the exploration of underlying mechanisms by which their bioavailability can be modified. Therefore, the use of millet 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.



Source: local processors.

Figure 1. Flow Chart for the Processing of Chakti and jirani Millet Dried Powder.

2. Materials and Methods

The chemicals and reagent used in this study are of analytical grade. The *Chakti* and *jirani* millet variety were obtained from Lake Chat Research Institute, Maiduguri, Borno State Nigeria. While, groundnut was purchased from Wudil Market, Kano State Nigeria. Samples were analyzed and processed in the Food Analysis Laboratory, Aliko Dangote University of Science and Technology, Wudil, Kano Nigeria.

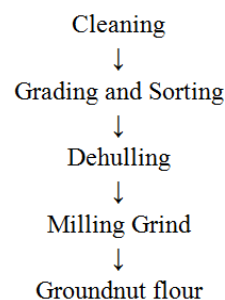
2.1. Sample Preparation

2.2. Preparation of Chakti and Jirani Millet

Cleaning and grading of the two millet (*Chakti* and *jirani*) types of grain that removed the impurities, and sorting was based on the size and weight of the grain, soaking to soften the kernel to facilitate the separation of the endosperm and the bran layer, and then milling or grinding, sieving and allowed to sediment for 12 hours, then dried into fine particle power known as *kamu* (millet dried powder).

2.3. Preparation of Groundnut

The groundnut was cleaned and removal of outer shell or hull to expose the nut kernel, then drying to reduce the moisture, grading and sorting of nuts based on size and de-hulling, and milling the nut into a fine powder.



Source: local processing

Figure 2. Flow chart preparation of groundnut fine powder.

2.4. Preparation of Chakti, Jirani Millet and Groundnut into Kamu (Millet Dried Powder)

Table 1. Formulation of chakti, Jirani and groundnut.

S/N	Sample	Chakti	Jirani	Groundnut
1	A:(100%C)	100	-	-
2	B:(80%C, 20%G)	80	-	20

S/N	Sample	Chakti	Jirani	Groundnut
3	C:(70%C, 30%G)	70	-	30
4	D:(100%J)	-	100	-
5	E:(80%J, 20%G)	-	80	20
6	F:(70%J, 30%G)	-	70	30

Mixing of dried *kamu* (millet dried powder) and groundnut flour with cold water



Pour the hot water into the mixture



Kamu (millet dried powder)

Source: local processing

Figure 3. Flow Chart for *Kamu* (dried millet powder) Production.

2.5. Proximate Composition of *Kamu* (Millet Dried Powder) from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour

Proximate composition of formulated blends of *kamu* (millet dried powder) in-terms of moisture, crude fat, crude protein, ash and carbohydrate were determined using the [3] method. That was conducted in triplicates.

2.6. Mineral Content of *Kamu* (Millet Dried Powder) Produced from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour

Mineral determination of formulated blends of *kamu* (millet dried powder) was adopted using [3]. 5g of was weighed in a crucible, and placed in a muffle furnace at a temperature of 550°C for two hours. 10cm³ of 6M Nitric acid (HNO₃) was added to the ashed sample and agitated to obtain a uniform solution. And filter a bottle. Distilled water was added to the filtrate, until it was filled up to the 50cm³ level. Blank sample was also prepared involving the addition of 10 cm³ 6M Nitric acid [3]. The solution was analyzed using Atomic Absorption Spectrophotometer (AAS). An alpha four model atomic absorption spectrophotometer equipped with adequate with a digital read out system was used for the work. Operating conditions was recommended by the instrument manufacturer. The device consist of an atomizer (usually a flame) a source of radiation (usually a hallow cathode lamp) a device for dispersing radiation (example, a mono-chromator) and an electronic processing unit (photo multiplier, amplifier, etc.). The intensity of the diminished wave length band was measured and recorded by the electronic processing unit. The Concen-

tration of the element in the sample was proportional to its absorbance. A blank and the standard were first aspirated and the absorbance reading also recorded. Average absorbance reading of both standard and samples was corrected using blank reading, and a similar procedure was repeated for different lamps and samples. A calibration curve was plotted for standard of each metal with the absorbance versus concentration. By interpolation, the concentration of metals in part per million (ppm) was determined in the calibration graphs [3].

2.7. Functional Properties of *Kamu* (Dried Millet Powder) from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour

2.7.1. Determination Bulk Density

The method described by [12] was adopted. Ten (10 ml) capacity graduated measuring cylinder was pre-weighted. The cylinder was filled gently with the sample. The cylinder was tapped gently several times on the laboratory bench until no further reduction of the sample level after filling to the 10ml mark. It was weighed, calculated as follows;

$$\text{Bulk Density (g/ml)} = \frac{\text{weight of sample (g)}}{\text{volume of samples}}$$

2.7.2. Determination of Water Absorption Capacity

Water absorption capacity was determined using the method described by [12]. One gram (1 g) of the sample was weighed in a graduated centrifuge tube. It was mixed thoroughly with 10 ml distilled water using a continuous whirl mixer for 30 seconds. The sample was allowed to stand for 30 minutes at room temperature and then centrifuge at 5000 ×g for 30 minutes. The volume of free water (supernatant) was read directly from the graduated centrifuged tube.

$$\% \text{ WAC} = \frac{\text{weight of sample after centrifuge}}{\text{weight of the original sample}}$$

2.7.3. Determination of Swelling Capacity

The method described by [8] was used for swelling capacity determination. One gram of the formulated blends of *kamu* (millet dried powder) 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 petri-dish was weighed and dried at 105°C for 1 h. The sediment in the tube was weighed and the reading recorded. The starch swelling capacity was determined according to the equations below;

$$\text{Swelling power} = \frac{\text{weight of swollen sediment}}{\text{weight of starch sample}}$$

2.8. Microbiological Count of *Kamu* (Dried Millet Powder) from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour

2.8.1. Determination of Total Plate Count

Enumeration of aerobic micro-organism was carried out using nutrient agar. Using serial dilution method as described by [11] was employed. One gram of formulated blends of *kamu* (dried millet powder) sample was mixed with 0.2% peptone water. Shaken and thoroughly comminuted to make a homogenate solution; this gave the dilution of 10¹. One milliliter of the prepared solution was transferred in to one milliliter of the diluents (0.1% peptone water), this gave the dilution of 10¹. This was repeated to the dilution of 10³, and, then agitated. One milliliter of each dilution was pipetted into a separate corresponding petri-dish in duplicates. About 15 ml of the nutrient agar (NA) cooled to 45°C 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 35°C 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 gram of the sample (cfu/g).

2.8.2. Determination of Fungal Count

Enumeration of fungi and mould was carried out using Potato dextrose agar. Using serial dilution method as described by [11] was employed. One gram of the flours or the formulated blends of *kamu* (millet dried powder) 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 10¹. One milliliter of this prepared solution was transferred in to 9 milliliter of the diluents (0.1% peptone water); this gave the dilution factor of 10². This procedure was repeated up to the third dilution which gave the dilution of 10⁴. 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 45°C) 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°C for 3-5 days American Public Health Association [4]. 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 gram 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.

$$N=nVd$$

Where

N= the number of bacterial colony per gram of sample

$N=n/vd$

n= Number of colonies counted

v= volume of sample used

d= dilution factor

2.9. Sensory Evaluation of *Kamu* (Dried Millet Powder) Produced from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour

Sensory evaluation samples and the controls were assessed using students and staff (15) drawn from the department of Food Science and Technology, Aliko Dangote University of Science and Technology, Wudil Kano State Nigeria. Sensory evaluation was carried out as described by [10]. A 9-point hedonic scale (where 1 represents extremely disliked, 9 extremely liked), was evaluate using the following attributes: colour, taste, colour, texture (hand feel) appearance, and overall acceptability. Coded samples were randomly presented to the panelists, water was provided for mouth gargling before proceeding to the next sample.

2.10. Statistical Analysis

Statistical analysis shows that data obtained were subjected to appropriate statistical analysis (ANOVA) using a statistical package for the Social Sciences [18]. Mean separation was done using Duncan multiple range test and significance difference was accepted at 5% confidence level. Table 1 shows the formulated blends of *kamu* (millet dried powder) processing method.

Table 1 Proximate composition of *kamu* (millet dried powder) produced from the blends of *chakti*, *jirani* millet and groundnut flour. This shows that the ranged of moisture content was 13.73 to 12.03%, protein ranged from 10.95 to 10.00%, fat from 8.85 to 6.73%, fibre from 1.80 to 1.34%, ash ranged from 0.69 to 0.45%, carbohydrate from 68.68 to 64.47% and the energy was between the ranged of 384.19 to 371.33kcal. There are significant difference $p \geq 0.05$. Sample C: (70%C, 30%G) and F: (70%J, 30%G) had the highest protein content of 11.05% and 10.95%, and higher fat content of 8.85% and 8.39% which was produced from the blend of *chakti* and *jirani* millet with groundnut. Then, followed by sample B: (80%C, 20%G) with a protein of 10.67% and also 0.69% ash, which was produced from the blend of *chakti* and groundnut. It has also been reported that millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients [12, 16]. Fat contents were significant ($p \geq 0.05$). It was observed that samples C: (70%C, 30%G) and F: (70%J, 30%G) had the highest fat content of 8.85% and 8.39%, this shows that the two samples were substituted with 30% groundnut flour. Sample B: (80%C, 20%G) and F: (70%J, 30%G) had the highest fibre content of 1.80 to 1.70% this was attributed to the rate of substitution with groundnut flour. According [15], crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. Samples A: (100%C) and D: (100%J) that implies the control samples had the highest carbohydrate content of about 68.89% and 67.69%. Samples F: (70%J, 30%G) and C: (70%C, 30%G) were observed to have the highest energy value of 384.19 and 381.73kcal respectively, this corresponds to the report by [14] that Pearl millet was found significantly rich in resistant starch, soluble and insoluble dietary fibre, minerals, and antioxidants.

Table 2 Mineral and β -carotene of *kamu* (millet dried powder) produced from the blends of *chakti*, *jirani* millet and groundnut flour.

This shows the mineral and the β -carotene present in the *kamu* (millet dried powder) produced from the blends of *chakti* and *jirani* millet with groundnut flour. Iron ranged from 3.20 to 1.29mg/100g, zinc from 3.60 to 1.44mg/100g and β -carotene ranged from 98.3 to 78.0 $\mu\text{g}/100\text{g}$ which were significant difference ($p \geq 0.05$). It was observed that sample C: (70%C, 30%G) and F: (70%J, 30%G) had the highest iron value of 3.15 and 3.20mg/100g. Sample E: (80%J, 20%G) and F: (70%J, 30%G) had the highest zinc content of 3.52 and 3.60mg/100g. There was a significant difference ($P \geq 0.05$) in both iron and zinc. This shows that iron and zinc increased with groundnut flour substitution. This in line with the literature reported by [5], that the mineral content of groundnut of raw, boiled and fried groundnut seeds generally processed increasing the mineral content of the seeds, which stated that fried groundnut was more advantageous in mineral content than the raw. Heating at higher temperature therefore released

the minerals. The β -carotene was attributed higher to sample F: (70%J, 30%G) 98.3mg/100g and E: (80%J, 20%G) 95.5mg/100g this also implies that *jirani* millet had the highest β -carotene content when compared with *chakti* millet from the samples produced, sample D: (100%J), E: (80%J, 20%G) and F: (70%J, 30%G) of *jirani* millet treated with groundnut flour had the highest mineral content when compared with *chakti* with groundnut flour. There was a significant difference ($P \geq 0.05$) in both *chakti* and *jirani* millet as β -carotene increased with substitution. Millet had higher amount of β -carotene when compared with groundnut. β -carotene level in groundnut oil ranged from 0.21 to 1.67mg/100g. β -carotene content in groundnut oil varied significantly ($p < 0.05$). Variations could be attributed to genotype and maturity of groundnuts [13].

Table 3 Functional properties of *kamu* (millet dried powder) produced from the blends of *chakti*, *jirani* millet and groundnut flour.

This shows that bulk density of the *kamu* (millet dried powder) ranged from 1.92 to 1.72g/cm³, water absorption capacity from 0.90 to 0.44% and swelling capacity ranged from 1.15 to 0.60%. Bulk density of increased with groundnut substitution and water absorption capacity decreased with groundnut substitution these was due to the oil content present in the groundnut. Bulk density shows a significant different ($P \geq 0.05$). Variation were observed in the bulk density of "*kamu*" was higher in samples C: (70%C, 30%G) and F: (70%J, 30%G) which was significant ($P \geq 0.05$). Bulk density depends on the particle size and initial moisture content of the flour; this shows that fine particles size and high moisture content leads to a higher bulk density. Bulk density of flour was reported to increase with increased in starch content [6]. The increase in temperature caused an increase in the movement of the flour molecules, thereby allowing more samples to be dispersed in the solvent [7]. The higher WAC of flour 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 [1]. Swelling capacity of the *kamu* (millet dried powder) increased with increase in substitution with groundnut flour. The swelling capacities of flours depend on the variety and particle size of the flour [19].

Table 4 Microbial count of *kamu* (millet dried powder) produced from the blends of *chakti*, *jirani* millet and groundnut flour. From the table it shows that the total bacterial count ranged from 4.5×10^4 to 2.0×10^4 cfu/g and the total fungal count ranged from 4.4×10^4 to 3.3×10^4 cfu/g. Sample A: (100%C) and sample D: (100%J) had the least total bacteria count of 2.0×10^4 cfu/g and 2.4×10^4 cfu/g with no growth (NG) attributed to the total fungal count. Samples treated with the groundnut flour seem to have less count in both the total bacterial and total fungal count when compared with the control samples. Total bacterial count increased, while the total fungal count decreased with increased in groundnut flour substitution. The load varied from one sample to the other which could either due to either

poor handling or processing methods. Fungal growth had also been seen on some of the samples of *kamu* (millet dried powder) treated with groundnut flour. This could either be as a result of the high Moisture content present in the *kamu* (millet dried powder) or as a result of the water used during the process of production or could arise during harvest of the raw material. Contamination of street vended *kamu* (millet dried powder) foods has been attributed to exposure to poor sanitation, poor hygienic practices, polluted environment, and recontamination after production. High level of contamination may be linked to human source during production. The safe limit of 10^4 was accepted by ICMSF International Commission on Microbiological Specification for Foods [9], this implies that, the population of the microorganisms does not produce an effective dose that would render the food unfit for consumption.

Table 5 Sensory analysis of *kamu* (millet dried powder) produced from the blends of *chakti*, *jirani* millet and groundnut flour. The shows that taste ranged from 7.35 to 6.45, colour from 7.45 to 6.25, texture from 7.55 to 6.37, appearance from 7.60 to 6.05 and overall acceptability ranged from 7.75 to 6.05. Sample B:(80%C, 20%G) *chakti* and groundnut substitution had the better taste followed by the control sample A:(100%C) which was the *chakti*. This shows that *chakti* millet is tastier than the *jirani* millet. Sample B:(80%C, 20%G) *chakti* also had the best colour 7.45 when compared with the *jirani* millet, texture had 7.55 with sample B:(80%C, 20%G) having the best result in terms of texture, then sample C:(70%C, 30%G) with the said substitution. Appearance shows that sample B:(80%C, 20%G) and C:(70%C, 30%G) which showed that *chakti* millet substituted with groundnut flour had the best appearance when compared *jirani* millet substituted with the groundnut flour. As

relate to the overall acceptability, it was observed that sample B:(80%C, 20%G) had the best results in terms of taste, colour, texture, appearance and it was overall accepted by the panelist followed by sample C:(70%C, 30%G). These are the samples made from *chakti* substituted with groundnut flour and also *kamu* (millet dried powder) from this substitution is more accepted than *kamu* (millet dried powder) produced from *jirani* substituted with groundnut flour. Significant difference ($P \geq 0.05$) was observed in all the sensory attributes such taste, colour, texture, appearance and overall acceptability.

3. Conclusion

Kamu (millet dried powder) produced from the blends of *chakti* and *jirani* millet with groundnut flour was showed that sample C: (70%C, 30%G) and F: (70%J, 30%G) had the highest protein content of 11.05% and 10.95%, higher fat content of 8.85% and 8.39%, higher iron value of 3.20 and 3.15mg/100g and higher in beta-carotene value was attributed higher to sample F:(70%J, 30%G) and E:(80%J, 20%G) 98.3 and 95.5mg/100g which was produced from the blend of *chakti* and *jirani* millet with groundnut. The population of the microorganisms does not produce an effective dose that would render the food unfit for consumption. This shows that *kamu* (millet dried powder) from *chakti* substituted with groundnut flour was more accepted than *kamu* (millet dried powder) produced from *jirani* substituted with groundnut flour in all the sensory attributes such taste, colour, texture, appearance and overall acceptability.

Table 2. Proximate Composition of *Kamu* Produced from the Blends of *Chakti*, *Jirani* Millet and Groundnut Flour (%).

Sample code	Moisture	Protein	Fat	Fiber	Ash	Carbohydrate	Energy (kcal)
A: (100%C)	12.03±0.03 ^f	10.45±3.00 ^d	6.79±0.01 ^e	1.55±0.03 ^c	0.49±1.00 ^b	68.69±0.01 ^a	377.67±3.01 ^d
B: (80%C, 20%G)	13.05±1.00 ^c	10.67±0.01 ^b	7.45±3.00 ^d	1.80±0.20 ^a	0.69±0.01 ^a	66.34±0.12 ^d	375.09±0.01 ^e
C: (70%C, 30%G)	13.65±0.20 ^b	11.05±0.30 ^e	8.85±0.02 ^a	1.49±1.01 ^d	0.49±0.20 ^b	64.47±1.05 ^f	381.73±1.01 ^b
D: (100%J)	13.73±0.01 ^a	10.00±0.02 ^f	6.73±0.20 ^f	1.40±0.01 ^e	0.45±0.30 ^c	67.69±0.22 ^b	371.33±2.01 ^f
E: (80%J, 20%G)	12.40±0.30 ^d	10.55±0.30 ^c	7.79±1.00 ^c	1.34±2.00 ^f	0.45±2.00 ^c	67.47±3.00 ^c	380.19±0.03 ^c
F: (70%J, 30%G)	12.05±2.01 ^e	10.95±1.00 ^a	8.39±0.22 ^b	1.70±0.30 ^b	0.69±0.01 ^a	66.22±0.02 ^e	384.19±0.20 ^a

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at ($P \leq 0.05$). *Sample designated with C (*Chakti*), J (*Jirani*), G (Groundnut)

Table 3. Mineral and β -carotene of *Kamu* (millet dried powder) Produced from the Blends of *Chakti*, *Jirani* millet and groundnut flour.

Sample code	Fe (mg/100g)	Zn (mg/100g)	B-carotene (µg/100g)
A: (100%C)	1.30±2.01 ^e	1.44±1.00 ^f	78.00±2.00 ^f

Sample code	Fe (mg/100g)	Zn (mg/100g)	B-carotene (µg/100g)
B: (80%C, 20%G)	2.10±0.03 ^d	1.60±0.02 ^e	79.25±1.01 ^e
C: (70%C, 30%G)	3.15±0.00 ^b	2.55±0.10 ^d	85.05±0.00 ^d
D: (100%J)	1.29±1.00 ^f	3.50±0.03 ^c	90.20±0.30 ^c
E: (80%J, 20%G)	3.10±0.02 ^c	3.52±2.00 ^b	95.60±0.01 ^b
F: (70%J, 30%G)	3.20±0.30 ^a	3.60±0.01 ^a	98.30±02.00 ^a

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at ($P \leq 0.05$). *Sample designated with C (*Chakti*), J (*Jirani*), G (Groundnut)

Table 4. Functional Properties of Kamu (millet dried powder) Produced from the Blends of Chakti, Jirani Millet and Groundnut Flour.

Sample code	Bulk density (g/cm ³)	Water absorption capacity (%)	Oil absorption capacity (%)
A:(100%C)	1.78±0.02 ^e	0.90±0.02 ^a	0.60±0.10 ^f
B:(80%C, 20%G)	1.85±0.10 ^c	0.62±3.00 ^c	0.95±3.00 ^d
C:(70%C, 30%G)	1.92±2.00 ^a	0.45±0.01 ^d	1.15±0.02 ^a
D:(100%J)	1.72±0.03 ^f	0.85±0.20 ^b	0.65±0.20 ^e
E:(80%J, 20%G)	1.83±0.10 ^d	0.62±2.00 ^c	1.00±0.01 ^b
F:(70%J, 30%G)	1.90±3.00 ^b	0.44±0.10 ^c	1.05±2.00 ^c

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at ($P \leq 0.05$). *Sample designated with C (*Chakti*), J (*Jirani*), G (Groundnut)

Table 5. Microbial Count of Kamu (millet dried powder) Produced from the Blends of Chakti, Jirani Millet and Groundnut Flour.

Sample code	Total Bacterial Count (cfu/g)	Total Fungal Count (cfu/g)
A:(100%C)	2.0×10 ⁴	NG
B:(80%C, 20%G)	3.1×10 ⁴	3.8×10 ⁴
C:(70%C, 30%G)	4.0×10 ⁴	3.3×10 ⁴
D:(100%J)	2.4×10 ⁴	NG
E:(80%J, 20%G)	3.2×10 ⁴	4.4×10 ⁴
F:(70%J, 30%G)	4.5×10 ⁴	4.2×10 ⁴

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at ($P \leq 0.05$). *Sample designated with NG (No growth)

Table 6. Sensory analysis of kamu (millet dried powder) produced from the blends of chakti, jirani millet and groundnut flour.

Sample code	Taste	Color	Texture	Appearance	Overall acceptability
A:(100%C)	7.20±0.10 ^b	7.25±1.00 ^b	7.35±2.00 ^c	7.20±0.03 ^c	7.00±0.04 ^c
B:(80%C, 20%G)	7.35±0.13 ^a	7.45±0.04 ^a	7.55±0.30 ^a	7.60±1.00 ^a	7.75±3.00 ^a
C:(70%C, 30%G)	7.00±1.00 ^c	7.10±0.10 ^c	7.45±0.02 ^b	7.25±0.30 ^b	7.40±0.20 ^b

Sample code	Taste	Color	Texture	Appearance	Overall acceptability
D:(100%J)	6.00±0.30 ^f	7.25±0.03 ^b	6.65±3.00 ^d	6.55±0.02 ^d	6.75±1.00 ^d
E:(80%J, 20%G)	6.35±0.01 ^d	6.80±2.00 ^d	6.45±0.10 ^e	6.25±0.10 ^e	6.35±0.02 ^e
F:(70%J, 30%G)	6.45±0.03 ^e	6.25±0.14 ^e	6.37±0.03 ^f	6.05±0.02 ^f	6.05±0.10 ^f

Values are means ± standard deviation of three replicates, followed by the same superscripts within the column are not significantly different at ($P \leq 0.05$). *Sample designated with C (*Chakti*), J (*Jirani*), G (Groundnut)

Abbreviations

AOAC	Association of Official Analytical Chemists
APHA	America Public Health Association
ICMSF	International Commission on Microbiological Specification for Foods

Author Contributions

Aminu Barde: Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing

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Conflicts of Interest

The authors declare no conflicts of interest.

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