Quality Characteristics of Biscuits Produced from Composite Flour of Sweet Potato and Cashew Nut Flour Blends

O. O. Tanko[1], T. O. Hussaina[2] and N. S. Donaldben[1*]

[1]*Department of Food Technology, Federal Polytechnic, Kaura Namoda, Zamfara State, Nigeria.*
[2]*Department of Science Laboratory Technology, Federal Polytechnic, Kaura Namoda, Zamfara State, Nigeria.*

Authors' contributions

This research work was carried out in collaboration among all authors. Author OOT designed the study, supervised the production, analyzed of samples, wrote the protocol and approved the final manuscript. Authors TOH and NSD performed the statistical analysis, wrote the first draft of the manuscript, managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The research is aimed at adding value to sweet potato based biscuits using underutilized crops such as cashew nuts. The objective of the study was to add value to sweet potato based biscuits, the sweet potato was processed into flour; while the cashew nuts was unroasted cashew nuts were sorted to remove the stones, dirt's and unwholesome cashew nuts, roasted, shelled, dried, peeled and processed into flour and sieved. The cashew nuts flour was substituted at 20, 30, 40 and 50% into sweet potato flour to produce sweet potato and cashew nuts composite flour were used for the production of biscuits. Functional, proximate composition of the biscuits, physical and sensory properties of composite biscuits were determined. Significance difference (P<0.05) was observed Bulk density, water absorption capacity, oil absorption capacity, swelling capacity, emulsion activity, foaming stability and gelatinization temperature increased from 0.62 to 0.73 g/cm^3, 1.31 to

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Corresponding author: Email: STEPDONALD82@hotmail.co.uk;

1.81 g/g, 2.10 to 2.22 g/g, 6.42 to 7.18 ml, 59.71 to 60.51%, 6.19 to 6.43% and 68.20 to 72.10ºC, respectively with an increase in the addition of cashew nuts flour. The crude protein, crude fat, crude fibre and ash increase from 14.65 to 18.31%, 7.88 to 10.21%, 3.21 to 3.51% and 4.10 to 4.76% respectively; while the moisture and carbohydrate content of the biscuits decreased from 13.77 to 13.31% and 56.39 to 49.89%, respectively with increase in the addition of the cashew nuts flour. The physical properties of the composite biscuits such as the weight, thickness, diameter and spread ratio ranged from 16.09 to 17.45 g, 10.87 to 10.96 mm, 38.94 to 40.02 mm and 3.56 to 3.60 respectively. The average means scores for the appearance, crispness, taste, aroma and overall acceptability increase were observed. There was a significant difference (p<0.05) in the appearance, taste and aroma while there was no significant difference (p>0.05) in the crispness and overall acceptability.

Keywords: Sweet potato; cashew nuts; biscuits; composite flour.

1. INTRODUCTION

Urbanization in African Countries is changing the food habit and preference of the population towards convenient foods. Biscuit and other baked products are some of the food realized to be a fast and convenient foods by the populate [1]. The present high cost and demand of biscuits in Nigeria however, necessitated the need for further research for the production of biscuit from cashew nut and sweet potatoes flour [1].

Biscuit may be regarded as a form of confectionary, dried to very low moisture content. Biscuit is defined as a small thin crisp cake made from unleavened dough; Okaka [2] further described the production of biscuit as a mixture of flour and water but may contain fat, sugar and other ingredient mixed together into dough which is rested for a period and then passed between rollers to make a sheet [3].

Sweet potatoes *(Ipomoea batata)* belong to the convolvuliaceae or morning glory family. Sweet potato roots are bulky and highly perishable therefore the root can be sliced, dried and grounded in order to produce flour that remains in good condition for a long time. Sweet potato either fresh, grated, cooked and mashed or made into flour with high potential for success, replace the expensive wheat flour in making buns, chapattis flat unleavened bread, doughnut and biscuits [4].

Cashew *(Anarcadium Occidentale)* are nutritionally dense nuts belonging to the family of Anacardiaceae the manufacture of good quality biscuit would depend on selecting the correct flour for each type and applying processes, which are compatible, such process would involve steps such as mixing, aeration and fermentation where practiced machining including laminating, baking locally available sources in biscuit production will no doubt help break our industries over dependence on wheat flour and also diversity the utilization of these food sources which are normally consumed domestically in various form [5].

Cashews are very nutritious and power houses of essential minerals, including copper, calcium, magnesium, iron phosphorus, potassium and zinc. Sodium is also present in very small quantity. Cashew nuts are vital for the health development of bones, muscles, tissue and body organs. It contains low amount of sugar and making them safe for diabetic patients [6]. This research was carried out to determine the potential of sweet potato and cashew nut flour blends in the production of biscuits.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

Unroasted cashew nuts were purchased from Kaduna Central Market. Other ingredients such as sweet potatoes *(Ipomoea batatas)*, baking fat, baking powder, powder milk (peak), eggs, and salt (Dangote table salt) were purchased from Kaura-Namoda Main market, Zamfara state. The raw materials were properly cleaned by removing extraneous matter prior to their subjection to different processing treatments.

2.2 Processing Methods

2.2.1 Preparation of sweet potato flour

Sweet potato flour was produced using the method describing by Adeleke and Odedeji [7]. Sweet potato tubers were sorted and washed to remove sand, dirt and other adhering materials.

The deemed tubers were peeled using a stainless knife and sliced using a kitchen slicer to obtain a sliced thickness of 7 min. The slice where then washed in water and placed in a sieve to remove excess water. The slices were blanched at 70ºC for 5minutes to inactivate the enzyme that causes browning before drying in the cabinet dryer. The dried slices sweet potatoes were milled with ATLAS milling machine (model no. YL 112M-4, Japan) and sieved (0.3 mm aperture size sieve). The cashew flour was packaged in a polyethylene bag and stored at low temperature (5ºC).

2.2.2 Processing of cashew nuts flour

The unroasted cashew nuts were sorted to remove the stones, dirts and unwholesome cashew nuts. The nuts were soaked in water for two minutes and sun dried ready for roasting. The nuts were roasted for fifteen minutes using the open pan roasting method. The wood hammer was used for manual shelling of the nuts. The roasted cashew nuts were oven dried and the peels or covering tasta were removed by squeezing and then winnowed to obtain the cream coloured cashew nuts. After grading, the
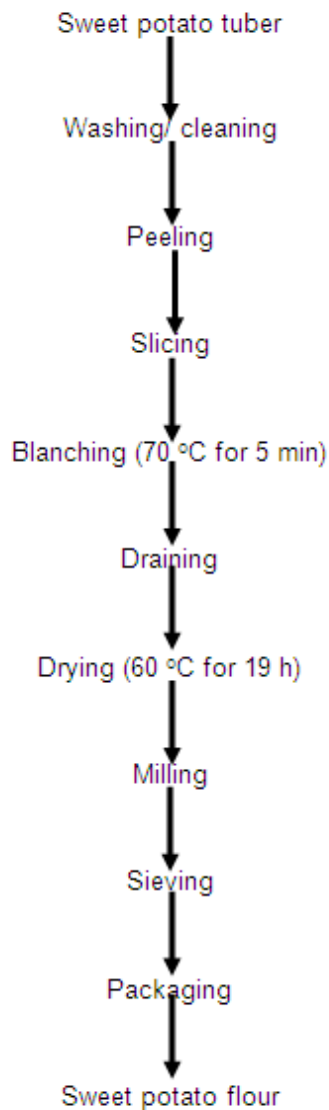

Fig. 1. Flour chart for the processing of sweet potato flour
Source: Adeleke and Odedeji, [7]

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Raw cashew nut seed
        │
        ▼
Sun drying of raw seed
        │
        ▼
    Roasting
        │
        ▼
Cutting/separation
        │
        ▼
Drying of cashew kernel
        │
        ▼
Peeling of kernels
        │
        ▼
    Grading
        │
        ▼
Milling/Grinding
        │
        ▼
Packaging/Labelling
        │
        ▼
Cashew nut flour
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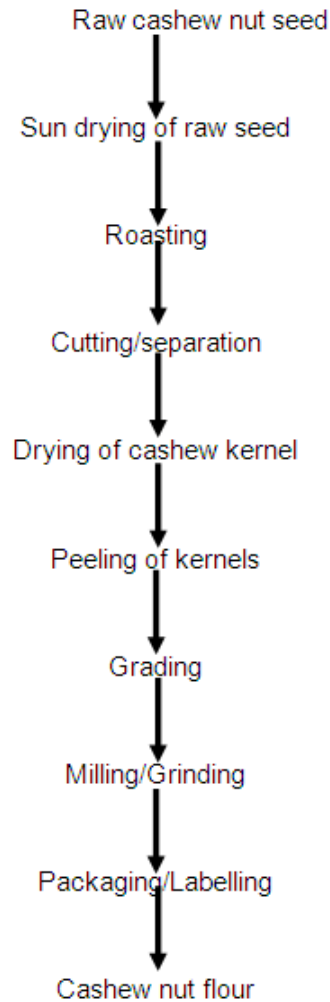
Fig. 2. Flow Chart for the Production of Cashew nut Flour
Source; Russel [8]

roasted cashew nuts were milled using ATLAS milling machine (model no. YL 112M-4, Japan) and sieved (0.3 mm aperture size sieve). The cashew nuts flour was packaged in a polyethylene bag and stored at low temperature (5ºC). As described by Russel [8] with modifications.

2.2.3 Production of biscuits from sweet potato and cashew nut flour blends

Biscuits were produced from the two blend formulations using the method of Olaoye et al. [9]. All ingredients except flour and sodium bicarbonate were added with continued mixing. The dough was then placed on a cutting board, rolled out until uniform thickness and textures were obtained. Biscuit cutter was used to cut the sheet of rolled dough into desired shapes and sizes. The shaped dough pieces were then baked at about 150ºC for 20 min, allowed to cool, packaged and stored.

2.3 Determination of Functional Properties of the Composite Flours from Sweet Potato and Cashew Nut

2.3.1 Bulk density

A 50 g the flour sample was weight into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm-3) was calculated as weight of flour (g) divided by flour volume (cm^3) method described by Onwuka [10].
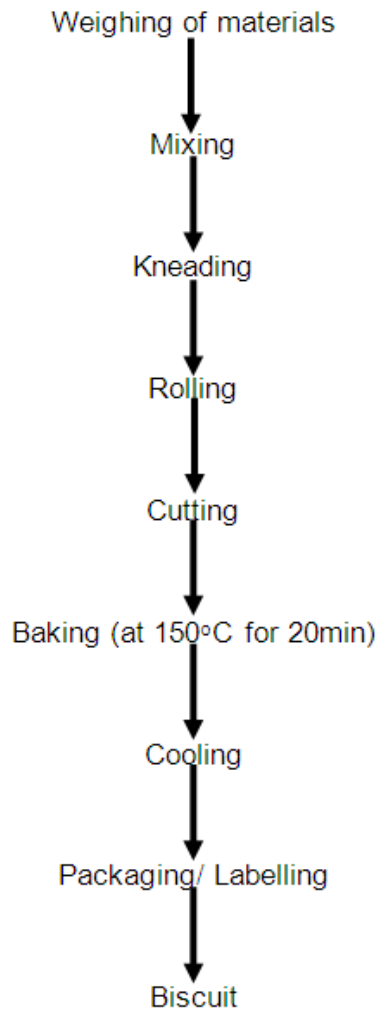
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Weighing of materials

↓

Mixing

↓

Kneading

↓

Rolling

↓

Cutting

↓

Baking (at 150°C for 20min)

↓

Cooling

↓

Packaging/ Labelling

↓

Biscuit

Fig. 3. Flow chart for the production of biscuit
Source; (Olaoye et al. [9])

2.3.2 Water and oil absorption capacity

Water and oil absorption capacities of the flour samples were determined by Onwuka [10] methods. One gram of the flour was mixed with 10 ml of water/oil in a centrifuge tube and allowed to stand at room temperature (30 ± 2°C) for 1 h. It was then centrifuged at 200 x g for 30 min. The volume of water or oil on the sediment water measured. Water and oil absorption capacities were calculated as ml of water or oil absorbed per gram of flour.

2.3.3 Swelling capacity

This was determined by the method described by Onwuka [10] with modification for small samples.

One gram of the flour sample was mixed with 10 ml distilled water in a centrifuge tube and heated at 80°C for 30 min. This was continually shaken during the heating period. After heating, the suspension was centrifuged at 10,000 rpm, decanted and the paste weighed. The swelling power was calculated as indicated below.

Swelling power = weight of the paste/weight of dry flour.

2.3.4 Emulsion activity

The emulsion activity was determined by the method described by Onwuka [10] (1 g sample, 10 mL distilled water and 10 mL soybean oil) was prepared in calibrated centrifuge tube. The

emulsion was centrifuged at 2000 × g for 5 min. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage.

2.3.5 Foaming stability

The method described by Onwuka [10] was used for the determination of foaming stability. Two grams of flour sample was added to 50 ml distilled water at 30 ± 2ºC in a 100 ml measuring cylinder. The suspension was mixed using glass rod and properly shaken to foam and the volume of the foam after 30 s was recorded. The Foaming stability was expressed as a percentage increase in volume.

2.3.6 Gelatinization

Gelatinization temperature was determined by Onwuka [10]. 1 g flour sample was weighed accurately in triplicate and transferred to 20 ml screw capped tubes. 10 ml of water was added to each sample. The samples were heated slowly in a water bath until they formed a solid gel. At complete gel formation, the respective temperature was measured and taken as gelatinization temperature.

2.4 Proximate Composition of the Biscuits Samples

2.4.1 Moisture determination

Moisture content was determined using the air oven dry method of AOAC [11]. A clean dish with a lid was dried in an oven at 100ºC for 30 min. It was cooled in desiccators and weighed. Two (2) grams of sample was then weighed into the dish. The dish with its content was then put in the oven at 105ºC and dried to a fairly constant weight. The loss in weight from the original sample (before heating) was reported as percentage moisture.

$$\% \, Moisture = \frac{weight \, loss \, (W2-W3)}{Weight \, of \, Sample \, (W2-W1)} \, x \, 100 \quad (1)$$

Where: W_1 = weight of dish, W_2 = weight of dish + sample before drying, W_3 = weight of dish + sample after drying.

2.4.2 Crude protein determination

The Kjeldahl method as described by AOAC [11] was used to determine the percentage crude protein. Two (2) grams of sample was weighed

into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01 g 6.6LB). A catalyst mixture weighing 0.88 g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) was added. Concentrated sulphuric acid (7 ml) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25 ml with distilled water in a volumetric flask. Ten (10) ml of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8 ml of 40% NaOH. To the receiving flask, 5 ml of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100 ml conical flask and titrated with 0.01 HCl. A blank titration was done. The percentage nitrogen was calculated from the formula:

$$\% \, Nitrogen = \frac{(S-B) \times 0.0014 \times 100 \times D}{sample \, weight} \quad (2)$$

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor

% Crude Protein = % Nitrogen x 6.25 (correction factor).

2.4.3 Crude fat determination

Fat was determined using Soxhlet method as described by AOAC [11]. Samples were weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the bottom extractor of the Soxhlet apparatus. Flat bottom flask (250 ml) of known weight containing 150 – 200 ml of 40 – 60ºC hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferred into a hot air oven at 105ºC for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 min before weighing. Percentage fat content was calculated as

$$\% \, Crude \, Fat = \frac{weight \, of \, extracted \, fat}{Weight \, of \, Sample} \, x \, 100 \quad (3)$$

2.4.4 Crude fibre determination

The method described by AOAC [11] was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2ºC for 2 h, cooled in a dessicator and weighed. The residue was then transferred in to a muffle furnace and ignited at 550ºC for 30 min, cooled and weighed. The percentage crude fibre content was calculated as:

$$\% \, Crude \, fibre \; = \frac{Loss \, in \, weight \, after \, incineration}{Weight \, of \, original \, food} \times 100 \qquad (4)$$

2.4.5 Ash determination

The AOAC [11] method for determining ash content was used. Two (2) gram of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace at 550ºC for 6-7 h. The dish was cooled in desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \, Ash = \frac{(W3 - W1)}{(W2 - W1)} \, x \, 100 \qquad (5)$$

Where:

W1 = Weight of empty crucible,
W_2 = Weight of crucible + sample before ashing,
W_3 = Weight of crucible + content after ashing.

2.4.6 Carbohydrate determination

Carbohydrate content was determined by difference as follows:

$$\% \, Carbohydrate \\ = 100 - \begin{pmatrix} \%moisture + \%Protein + \\ \%Fat + \%Ash \; + \; \%Fibre \end{pmatrix} \qquad (6)$$

2.5 Determination of Physical Properties of the Biscuits

The weight of the cookies was determined using Electronic compact weighing balance (model KDBN2010) as described by AOAC [11]. The thickness (mm) and diameter (mm) of the cookies were measured with digital vernier calipers with 0.01 mm precision according to the method of Ayo et al. [12]. And spread ratio was also determined according to the method of spread ratio was determined according to method described by Okaka [13].

2.6 Sensory Evaluation of the Biscuits

Sensory evaluation of the cookies was carried out according to the method described by Ihekoronye and Ngoddy [14].

2.7 Statistical Analysis

The Data obtained was subjected to analysis of variance (ANOVA) and means separated by Fisher's least significant difference test using Genstat statistical package, version 17.0.

3. RESULTS AND DISCUSSION

3.1 Functional Properties of the Flour Blends

Functional properties are those parameters that determine the application and use of food material for various uses [15]. The functional properties of sweet potato and cashew nuts flour blends are shown in Table 1. It shows that the bulk density of the flour samples ranged within 0.62 to 0.73 g/cm^3 respectively. Bulk density is a function of particle size as particle size is inversely proportional to bulk density [16]. It has been reported that bulk density is influenced by the structure of the starch polymers and loose structure of the starch polymers could result in low bulk density [17]. Bulk density is also an important parameter for determining the easy ability of packaging and transportation of particulate or powdery foods, with sample (T^1) was having the lowest value and sample (T^4) having the highest value. This result fell within the range reported for by Housson and Ayenor [18], who stated that the bulk density of appropriate processing and food functional properties of maize flour ranged from 0.595 to 0.725 g/cm^3. The water absorption capacity of the blends ranged within 1.31 to 1.81% with sample (T^4) having the highest value and sample (T^1) having the lowest value. Water absorption characteristic represents the ability of the product to associate with water under conditions when water is limiting such as dough and pastes. Water absorption capacity is important in the development of ready to eat foods. It has been observed that a high water absorption capacity assure product cohesiveness [18]. Niba et al. [19] also reported that water absorption capacity is important in bulking and consistency of

Table 1. Functional properties of the flour blends

Parameters	T[1]	T[2]	T[3]	T[4]	LSD
Bulk density (g/cm^{3})	0.62±0.01[b]	0.66±0.01[b]	0.70±0.00[a]	0.73±0.01[a]	0.097
Water absorption capacity (g/g)	1.31±0.02[c]	1.40±0.02[c]	1.55±0.01[b]	1.81±0.01[a]	0.128
Oil absorption capacity (g/g)	2.10±0.03[d]	2.16±0.02[c]	2.19±0.02[b]	2.22±0.01[a]	0.022
Swelling capacity (ml)	6.42±0.01[d]	6.68±0.04[c]	7.01±0.01[b]	7.18±0.02[a]	0.101
Emulsion activity (%)	59.71±0.01[c]	59.71±0.03[c]	60.23±0.02[b]	60.51±0.02[a]	0.176
Foaming stability (%)	6.19±0.02[d]	6.23±0.01c	6.39±0.02[b]	6.43±0.01[a]	0.041
Gelatinization temperature (°C)	68.20±0.04[d]	69.10±0.06[c]	70.20±0.01[b]	72.10±0.01[a]	0.076

Values are means ± standard deviations of triplicate determinations. Means in the same row with different superscripts differ significantly (p<0.05).
Key: T[1] = 80% sweet potato flour and 20 % cashew nuts flour, T[2] = 70% sweet potato flour and 30 % cashew nuts flour, T[3] = 60% sweet potato flour and 40 % cashew nuts flour, T[4] = 50% sweet potato flour and 50 % cashew nuts flour, LSD = Least significant difference

products as well as baking applications. Water absorption capacity represents the ability of the products to associate with water under conditions when water is limiting such as dough's and pastes.

The Oil Adsorption Capacity (OAC) increases as the cashew nut flour content increase which ranged from 2.10 to 2.22%. Oil absorption capacity is attributed mainly to the physical entrapment of oils. It is an indication of the rate at which protein binds to fat in food formulations [16]. Oil absorption capacity is useful in formulation of foods such as sausages and bakery products. Fat acts a flavour retainer and increases the mouth feel of foods. Fat increases the leavening power of the baking powder in the batter and improves the texture of the baked product.

The swelling capacity of the flour sample blends ranged between 6.47 to 7.18 ml. From Table 1, it is clear that lowest value of swelling capacity was observed in sample (T[1]) 6.47 ml whereas the maximum in sample (T[4]) 7.18 ml. There was a significant difference (p<0.05) between the swelling capacity of the flour blends. The swelling capacity of flours depends on size of particles, types of variety and types of processing methods or unit operations. Swelling capacity of composite flours increased with increase in the level of incorporation ratio of cashew nuts flour.

Emulsion activity (%) Protein being the surface active agents can form and stabilize the emulsion by creating electrostatic repulsion on oil droplet surface [20]. The EA of flour blends are shown in Table 1. Emulsion activity of different flour blends ranged between 59.71 and 60.51%. The highest EA was observed in sample (T[4]) flour blends 60.51% and lowest was observed in sample (T[1]) 59.71%. The emulsion activity of the composite

flour were found to be significantly significant difference (p<0.05) between the sample blends. Increasing emulsion activity and fat binding during processing are primary functional properties of protein in such foods as comminuted meat products, salad dressing, frozen desserts and mayonnaise. All composite flours showed relatively good capacity of emulsion activity.

The foaming stability varied from 6.19 to 6.43.40% among the flour blends. The highest FS was observed from sample (T[4]) flour blends 6.43% and lowest for sample (T[1]) 6.19%. There was a significant difference (p<0.05) in the foaming stability of the flour blends. Flours with high foaming ability could form large air bubbles surrounded by thinner a less flexible protein film. This air bubbles might be easier to collapse and consequently lowered the foam stability [21].

Gelatinization temperature (GT, °C) is the temperature at which gelatinization of starch take place is known as the gelatinization temperature [22]. GT of flours blends ranged from 68.20°C to 72.10°C. Highest GT was observed in sample (T[4]) flour blends 72.10C and the lowest in sample (T[1]) 68.02°C. GT was increased with increase in the incorporation of cashew nut flour. The study revealed that the flour which was higher in starch content took lowest temperature for gelatinization. Therefore, GT of composite flours increased with decrease in the incorporation ratio of the sweet potato flour. There was a significant difference (p<0.05) between the flour samples blends.

3.2 Proximate Composite of the Biscuits Samples

The protein content of the biscuits ranged from 14.65 to 18.31% samples were significantly

different ($p < 0.05$). Sample (T^4) had the highest percentage protein content of 18.31% while the least value was recorded for sample (T^1) with percentage value of 14.65%. The result implies that the biscuits samples were high in protein content and could be used as alternative protein source in protein deficiency. The protein content of cashew nuts has been reported to be 13.13 to 25.03% in various regions of India [23]. It has been suggested that protein content be considered as one of the most important factors in future breeding and selection programs of cashew nuts.

The fat content of the biscuits ranged from 7.88 to 10.21%. There was significant difference ($p < 0.05$) between the biscuits samples. Wade and Staffor [24] have reported 20.5% fat content in digestive biscuits. Fat plays a significant role in determining the shelf life of food products and as such relatively high fat content could be undesirable in baked food products. This is because fat can promote rancidity in food, leading to development of unpleasant and odorous compounds [14].

There was no significant difference ($p < 0.05$) in the fibre content of the biscuits samples. Sample T^4 had the highest fibre content of 3.51% while the least was recorded in sample (T^1) with value of 3.21%. The fibre content consists of hemicelluloses, cellulose and lignin. It contributes to the health of the gastro-intestinal system and metabolic system in man [14].

There was a significant difference ($p < 0.05$) in the ash content of the biscuits samples. Sample (T^4) had the highest value of 4.76% while the least value was recorded in sample (T^1) with 4.10%. Increase in the ash content indicates that the samples with high percentage of ash will be good sources of minerals; Ash is a non- organic compound containing mineral content of food and nutritionally it aids in the metabolism of other organic compounds such as fat and carbohydrate [25].

There was a significant different ($p < 0.05$) in terms of moisture content. The moisture content ranged between 13.32 to 13.77%. There was significant different ($p < 0.05$) in terms of the carbohydrate. According to Messiaen [26], the higher the protein fat, ash content, the less the carbohydrate. Similar results have been reported by [27,28]. Biscuit is an energy food which is taken mostly in between meals by both young and old [29].

Table 2. Proximate composite of the biscuits samples

Parameters	T^1	T^2	T^3	T^4	LSD
Crude protein	14.65±0.04[c]	17.55±0.00[b]	17.72±0.02[b]	18.31±0.01[a]	01.242
Crude fat	7.88±0.02[c]	9.85±0.01[b]	9.98±0.01[b]	10.21±0.02[a]	0.220
Crude fibre	3.21±0.02[a]	3.33±0.01[a]	3.40±0.01[a]	3.51±0.02[a]	0.007
Ash	4.10±0.01[c]	4.29±0.02[c]	4.32±0.01[b]	4.76±0.02[a]	0.402
Moisture	13.77±0.02[a]	13.83±0.01[a]	13.94±0.02[a]	13.32±0.01[a]	1.056
Carbohydrate	56.39±0.02[a]	51.15±0.02[b]	50.64±0.02[b]	49.89±0.01[b]	2.023

Values are means ± standard deviations of triplicate determinations. Means in the same row with different superscripts differ significantly ($p < 0.05$).
Key: T^1 = 80% sweet potato flour and 20% cashew nuts flour., T^2 = 70% sweet potato flour and 30% cashew nuts flour, T^3 = 60% sweet potato flour and 40% cashew nuts flour, T^4 = 50% sweet potato flour and 50% cashew nuts flour, LSD = Least significant difference

Table 3. Physical properties of the biscuits samples

Parameters	T^1	T^2	T^3	T^4	LSD
Weight (g)	17.45±0.02[a]	16.78±0.03[b]	16.22±0.01[c]	16.09±0.01[c]	0.342
Thickness (mm)	10.96±0.01[a]	10.93±0.01[a]	10.91±0.02[a]	10.87±0.02[a]	1.034
Diameter (mm)	40.02±0.01[a]	39.38±0.03[b]	39.10±0.02[c]	38.94±0.02[d]	0.211
Spread ratio	3.56±0.02[a]	3.60±0.00[a]	3.58±0.01[a]	3.58±0.02[a]	0.099

Values are means ± standard deviations of triplicate determinations. Means in the same row with different superscripts differ significantly ($p < 0.05$).
Key: T^1 = 80% sweet potato flour and 20% cashew nuts flour, T^2 = 70% sweet potato flour and 30% cashew nuts flour, T^3 = 60% sweet potato flour and 40% cashew nuts flour, T^4 = 50% sweet potato flour and 50% cashew nuts flour, LSD = Least significant difference

Table 4. Sensory characteristics of the biscuits

Parameters	T[1]	T[2]	T[3]	T[4]	LSD
Appearance/colour	7.20±0.02[c]	7.29±0.02[c]	7.41±0.01[b]	7.60±0.01[a]	0.145
Crispiness	7.20±0.02[a]	7.37±0.01[a]	7.40±0.00[a]	7.50±0.03[a]	0.672
Taste	7.08±0.01[c]	7.26±0.01[b]	7.41±0.02[b]	7.75±0.02[a]	0.211
Aroma	7.40±0.00[c]	7.58±0.02[c]	7.67±0.02[b]	7.75±0.01[a]	0.081
Overall acceptability	8.69±0.06[a]	8.70±0.00[a]	8.75±0.01[a]	8.90±0.04[a]	0.310

Values are means ± standard deviations of triplicate determinations. Means in the same row with different superscripts differ significantly (p<0.05).
Key: T[1] = 80% sweet potato flour and 20% cashew nuts flour, T[2] = 70% sweet potato flour and 30% cashew nuts flour, T[3] = 60% sweet potato flour and 40% cashew nuts flour, T[4] = 50% sweet potato flour and 50% cashew nuts flour, LSD = Least significant difference

3.3 Physical Properties of the Biscuits Samples

The result of the physical properties of the biscuits from sweet potato and cashew flour blends is as presented in Table 3: The results shows significant different in weight and diameter, while there was no significant difference in thickness and spread ratio at (p<0.05) between the biscuits samples. The weight of the biscuits ranged from 16.09 to 17.45 g, diameter ranged from 38.94 to 40.02 mm, thickness ranged from 10.87 to 10.96 mm and spread ratio ranged from 3.56 to 3.58, respectively. The weight of the cookies samples decreased as a result of the increase level of cashew nuts flour substitution, there was significant difference (p>0.05) between the various biscuits samples. The findings were in line with [30] who reported significant reduction in the weight of cookies produced from soya bean supplemented with wheat flour.

There was a significant difference (p<0.05) between the value obtained for the biscuits diameter and thickness. As the proportion of cashew nuts flour increased in the formulation, a decreased in the average diameter and thickness was observed. A similar decreased in the average biscuits diameter and thickness was also reported by [31] for biscuits from millet and sesame seed flour blends. The average spread ratio of the biscuits showed significantly increased as the proportion of cashew nuts flour increases in the formulation.

3.4 Sensory Characteristics of the Biscuits

There was no significant difference (p> 0.05) in terms of crispiness of the biscuits. Sample (T[4]) had the highest mean score of 7.50 while the least value was recorded in sample (T[1]) with

value of 7.20. The result indicates that sample all the biscuits samples were preferred in terms of crispness. The value ranged from 7.20 to 7.50. There was no significant difference (p < 0.05) in the taste of the biscuits samples. Sample T[4] had the highest mean score of 7.75 while the least was recorded in sample (T[1]) with 7.08. The sense of taste provide to its ingestion and uptake into the body [32].

There was a significant difference (p < 0.05) in the aroma of the biscuits. Sample (T[4]) had the highest mean score of 7.75 while the least mean score was recorded in sample T[1] with 7.40. The result indicates that sample (T[4]) biscuits was the most preferred in terms of aroma. There was no significant difference (p > 0.05) in the overall acceptability of the between the biscuits samples Sample (T[4]) had the highest score of 8.90 while the least value was recorded in sample (T[1]) with 8.69. The results are similar to the finding of Ayo. [3] Physicochemical, phytochemical and sensory evaluation of acha-carrot flours blend biscuit.

4. CONCLUSION

The functional properties of sweet potato and cashew composite flours such as the bulk density, water absorption capacity, oil absorption capacity, swelling capacity, emulsion activity, foam stability and gelatinization temperature were increased with increase in the incorporation of cashew nuts flour. The result showed that the addition of cashew nuts flour to sweet potato based biscuits in the proportion of 20 to 50% for each produced acceptable biscuits and also functionality of the flour was not affected. The Sensory properties revealed that the appearance, crispness, taste, aroma and Overall acceptability of the biscuits increased with increasing in the incorporation of cashew nuts flour. The biscuits prepared with the flour ratio of 50:50 liked most of the panelists. Incorporation of

above cashew nuts flours to sweet potato flour would therefore help in combating protein-energy malnutrition in northern part of Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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