



ORIGINAL RESEARCH ARTICLE

PRODUCTION AND EVALUATION OF THE PHYSIOCHEMICAL AND SENSORY
PROPERTY OF BISCUITS FROM WHEAT-MAIZE-CASHEW NUT FLOUR BLENDS

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ABSTRACT

This study aimed to prepare and evaluate the quality characteristics of biscuits produced from wheat, maize and cashew nut flour blends. The flours were processed and blended using different proportions of eight (8) formulations with whole wheat flour as a control. The proximate composition of the flour blends, physical properties and sensory evaluation of the biscuits produced were determined using the standard analytical techniques. The data obtained were statistically analyzed using Analysis of Variance (ANOVA). The results show that moisture, ash, fat, protein and carbohydrate of the flours used for the blends ranged from 5.43-10.12 %, 1.74- 29.51, 9.34-26.56 and 34.48-77.25% respectively. Also, the moisture, ash, protein, fat, fibre carbohydrate and energy values of the biscuit ranged from 2.90 -3.92%, 0.99 - 1.57%, 11.19 - 14.59%, 16.24 - 20.30%, 0.97 - 4.85%, 56.04 - 66.96% and 457.68 - 470.80 Kcal/100g respectively. However, with an increase in maize flour (Mf), a significant increase in fibre contents was observed while moisture content decreased drastically. Additionally, the protein, fat and energy contents of supplemented samples were found to be higher than the control but decreased with an increase in maize flour levels. The weight, length, width, thickness and spread ratio of the biscuit samples differed significantly ($p < 0.05$) ranging from 15.25 - 17.36g, 51.70 - 53.03mm, 50.54 - 52.36mm, 9.57 - 11.27mm and 4.48 - 5.47mm respectively. The spread ratio and overall acceptability of biscuit samples decreased with the increased level of maize flour although the sensory evaluation showed that most values obtained are closer to the control. This shows that the acceptance level of the biscuits samples was higher except for sample Wmc 8 (sample produced from wheat, maize and cashew nut flour at the ratio of 20:70:10). In conclusion, the production of biscuits supplemented with cashew nuts and maize flour increased protein, energy contents and taste, which could be used to address protein-energy malnutrition prevalence.

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1.0 Introduction

Biscuits are the largest category of popular processed food items among bakery products (Caleja et al., 2017). They are widely consumed due to their acceptable taste and lower moisture content allowing a long shelf life (Chauhan et al., 2015). Although they vary in shape, size and composition, they are usually produced from 3 major ingredients (flour, sugar and fat) (Caponio et al., 2006). Generally, biscuits are high-energy foods made from whole wheat flour (100%). However, studies have shown the prospect of using locally available plant products as an alternative to substitutes or supplements wheat flour as composite flour in bakery products such as bread, cookies, biscuits and crackers (Ikuomola et al., 2017; Adeyeye, 2016; Ojinnaka et al., 2016; Dankwa and Liu, 2017; Raihan and Saini, 2017; Badje et al., 2018; Bello et al., 2020;

Babiker et al., 2021). Hence, supplementing wheat flour with suitable health-promoting plant materials can improve the overall acceptability and nutritional quality of biscuits (Swieca et al., 2017; Klunklin and Savage 2018).

Wheat (*Triticum spp.*) is the principal cereal for baked products, popular and unique among cereals due to its gluten protein (Dhanavath and Prasada, 2017). It is a common cereal grain that is widely grown and consumed in different parts of the world in different forms such as bread, biscuits, pasta and other products (Nadeem et al., 2010). Wheat flour contains 60.01 - 73.67% carbohydrate, 11.37 - 16.77% protein, 0.77 - 1.41% fat, 0.64 - 0.77% ash, 1.07 - 3.50% fibre (Ibidapo et al., 2019) with considerable proportions of vitamins (thiamine and other B-Vitamins) and minerals (Topping, 2007). With the rise in the market price of wheat, especially in regions where wheat does not thrive because of importation cost, efforts are being focused on the innovation of suitable flours from local plant sources such as cereals, legumes, roots, tubers, nuts and others that are readily available (Dotsey, 2009). Maize (*Zea mays*) is one of the cereal grains and a member of the *Gramineae* family. Maize has a multitude of uses and ranks second to wheat among the world's cereal crops in terms of production (Abdulrahman and Kolawole, 2006). The estimated annual production of maize is about 5.6 million tonnes (Carr et al., 2021). In Nigeria, maize has been rated the second-grown food crop with a total production of 9,180,270 tonnes (FAO, 2014). However, maize is used for food, feed and fuel. Maize grain has great nutritional value and can be used as raw material for manufacturing many industrial products (Afzal et al., 2009). Based on the nutritional value, maize flour contains 53.99 - 62.99% carbohydrate, 12.32 - 13.50% protein, 12.90 - 14.20% fat, 0.90 - 1.04% ash, 1.05 - 6.74% fibre and considerable proportions of minerals (Oladapo et al., 2017; Sule et al., 2014). Cashew (*Anacardium occidentale* Linn.) belonging to the family *Anacardiaceae* and is an extremely hardy tree that grows on poor soil under various climatic conditions. The nut is the most important product (Lima and Daurte, 2006). However, cashew nut is a good source of protein and oil, containing nutritionally unsaturated fatty acids and earning a huge amount of foreign exchange through its kernel and cashew nut shell liquid (CNSL) (Adepoju et al., 2019). According to Adepoju et al. (2019), cashew nut flour contains 5.73 - 5.90% moisture, 22.05 - 23.97% protein, 40.16 - 42.13% fat, 3.12 - 3.49% ash, 2.01 - 2.30% fibre and 22.39 - 26.72% carbohydrate. Despite the importance of these local agricultural products, information regarding their incorporation in many food formulations is limited.

Therefore, this study was aimed at evaluating the proximate composition, physical and sensory properties of biscuits produced from cashew nut, maize and wheat flour blends.

2.0 Materials and Methods

Wheat flour (*Triticum spp.*), Maize flour (*Zea mays*), roasted cashew nut (*Anacardium occidentale* Linn.), Simas margarine (PT Satimlvomas Pratama, Indonesia), salt and sugar (Dangote Nigeria Plc., Lagos), baking powder, eggs and powdered milk (Peak brand) were purchased from Maiduguri Monday market. The baking of the biscuit was carried out at food processing laboratory of the Department of Food Science and Technology University of Maiduguri.

2.1 Preparation of Wheat, Maize and Roasted Cashew Nut Flour

2.1.1 Processing of wheat into flour

The whole wheat flour (WF) was processed into flour following the method described by Ndife et al. (2014) with slight modification by sun drying instead of oven drying. The grains was cleaned by sorting out contaminants such as stones, sticks, leaves and any foreign object, washed, sun-dried and was then milled using an attrition mill, sieved and packaged until further use

2.1.2 Processing of maize into flour

The maize flour (MF) was processed following the method described by Obinna-Echem and Robinson (2019). The grains were sorted to remove foreign matters, winnowed and milled into flour using an attrition mill (Globe P44 Shanghai China), sieved, packaged and stored.

2.1.3 Processing of cashew nuts

The preparation of cashew nut (CF) was carried out according to the method described by Ojinnaka and Ogubulom, (2013) with slight modifications where no soaking in water was involved and was roasted for 20 min (not 15 min). The nut was cleaned (dry cleaning) and sorted to remove foreign materials and unwholesome nuts. It was then roasted for 20 min using an open pan method. Shelling of the nut was done by using a wooden hammer. The nuts were dried (oven drying method). Next, the nuts were ground into flour using a blender.

2.2 Experimental Design and Flour Formulation for the Production of Biscuit Samples

To produce biscuits from wheat-maize-cashew nut flour blends, a 3³ factorial design was used to evaluate the physiochemical and sensory properties of the biscuits. Table I. depicts the formulation of the flour blends for the production of biscuits using wheat, maize flour and cashew nuts where the wheat flour with maize flour and cashew nuts.

Table I. Formulation of Flour Blends for Biscuit Production

| Sample | Wheat flour (%) | Maize flour (%) | Cashew nut flour (%) |
|--------|-----------------|-----------------|----------------------|
| Wmc 1 | 100 | 0 | 0 |
| Wmc 2 | 80 | 10 | 10 |
| Wmc 3 | 70 | 20 | 10 |
| Wmc 4 | 60 | 30 | 10 |
| Wmc 5 | 50 | 40 | 10 |
| Wmc 6 | 40 | 50 | 10 |
| Wmc 7 | 30 | 60 | 10 |
| Wmc 8 | 20 | 70 | 10 |

2.3 Production of Biscuits

Preparation of biscuits was carried out as previously described by Srivatava et al. (2012) where 70g of Butter was creamed with sugar (30g) in a bowl until a uniform mixture was achieved. A large beaten egg (1 piece), formulated flour (300g), powdered milk (10g), baking powder (5

g), salt (a pinch) and vanilla flavour (5 g) were all added gradually to the initial mixture until a uniform dough was achieved as shown in figure 1. The resulting dough was put on a lightly floured board and flattened with a wooden rolling pin to about ¼ inch thickness. The flattened dough was cut into circular shapes using a biscuit cutter and arranged on a greased tray and baked in an oven at a temperature of about 120°C for 15 min. The biscuits were then removed from the oven allowed to cool on a rack and then packaged in a cellophane bag for further analysis. The same method was applied to the biscuit made from all the formulated flour samples

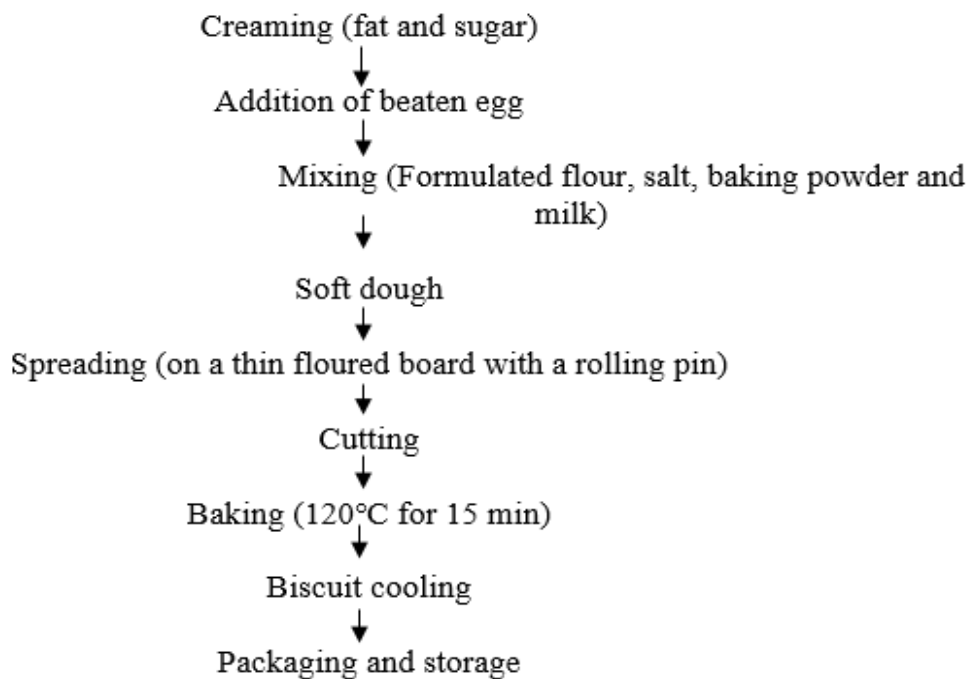


Figure 1. Preparation of biscuits.

2.4 Determination of Proximate Composition

The proximate composition of the flour blends and the biscuit samples were determined following the methods described by AOAC (2005). All the samples were analyzed for moisture, crude protein, crude fats, ash and fibre contents. However, the carbohydrate content was determined by difference as calculated using equation I.

$$\% \text{ CHO} = 100 - (\% \text{ moisture} + \% \text{ fat} + \% \text{ protein} + \% \text{ ash} + \% \text{ fibre}) \quad (1)$$

Where; CHO = Carbohydrate

2.5 Determination of Caloric Value

The caloric value (kcal) of the biscuits sample was determined according to the method described by Marero et al. (1998) applying factors 4, 9, and 4 to the percentage of protein, lipid, and carbohydrate, respectively as shown in equation II.

$$\text{Caloric value (kcal)} = (4 \times \% \text{ CHO}) + (4 \times \% \text{ Protein}) + (9 \times \% \text{ Fat}) \quad (2)$$

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2.6 Determination of the Physical Properties of Biscuits

2.6.1 The weight

The weight of the biscuits was determined according to the method described by Ayo et al. (2007) where the biscuits were weighed using an electronic balance (precision of 0.01g) immediately after cooling.

2.6.2 The size (width and thickness)

The width (W) (mm) and thickness (T) (mm) of the biscuits samples were measured using the digital vernier 150mm with an accuracy of 0.01 mm (Adeyeye, 2016).

2.6.3 The spread ratio

The spread ratio was determined according to the method described by Kaur et al. (2017). The spread ratio was calculated using Equation III below.

$$\text{Spread ratio} = \frac{\text{width}}{\text{thickness}} \quad (3)$$

2.7 Sensory Evaluation

The baked biscuit was given out to ten untrained panellists for sensory evaluation. The biscuit samples produced from wheat, maize and cashew nut flour at different ratios were labelled as Wf 1, Wmc 2, Wmc 3, Wmc 4, Wmc 5, Wmc 6, Wmc 7 and Wmc 8 as shown in Table I Ten (10) questionnaires were distributed to the panellists. They were asked to evaluate the eight products on colour, taste, texture, aroma and overall acceptability using a 9-point Hedonic scale as follows: 9- like extremely, 8- like very much, 7- like moderately, 6- like slightly, 5- moderately, 4- dislike slightly, 3- dislike moderately, 2- dislike much, 1- dislike extremely.

2.8 Statistical Analysis

All experiments were performed in triplicate, and the data generated were analysed using Analysis of Variance (ANOVA) where the separation of means using Duncan Multiple Range Test using Statistical Package for Social Science 23 version (SPSS).

3. Results and Discussion

3.1 Proximate composition of the flour blends

Table 2 shows the proximate composition of various flours used for the production of biscuits. There was a significant difference between the moisture, ash, protein, fat and carbohydrate content of the flours. The moisture content of the flour samples ranged from 5.43 - 10.12%. Sample Wf had a higher moisture content as compared to other samples while sample CF had the least. Ash content ranged from 0.79 - 3.02%, CF had the highest ash content however, the total amount of minerals in food is represented by the ash content (Bilge et al., 2016). The fat content of the flour significantly varied ranging from 1.74 - 29.51% where CF had the highest fat content. The ratio of saturated, monosaturated and polysaturated is 1:2:1 in cashew nut fat and is good which promotes the absorption of fat-soluble vitamins hence, it is very important in diets and therefore a good source of edible oil (Akinhanmi et al., 2008). Subsequently, protein is very important in a diet however, the protein content of cashew nuts was

significantly higher which could be compared to that of soybeans, cowpeas and melon seeds as previously reported by Hussain et al. (2008). Subsequently, the energy value of the flour ranged from 365.06-509.75. Among all the flour samples used for biscuit production, the protein, fat and ash content of CF was significantly higher than all the samples. This is in agreement with a previous study reported by Aremu et al. (2006) on the proximate composition of cashew nut flour. According to Emelike et al. (2015), the high protein content of cashew nut flour makes it suitable to be incorporated in the formulation of composite flour for snack production. This shows that the daily dietary needs of the individual could be reached by consuming a moderate amount of cashew nuts.

Table 2. Proximate Composition of the Flour Used for the Blends

| Flour | Moisture (%) | Ash (%) | Protein (%) | Fat (%) | Carbohydrate (%) | Energy (Kcal/100 g) |
|-------|--------------------------|-------------------------|--------------------------|--------------------------|--------------------------|---------------------|
| WF | 10.12± 0.03 ^a | 0.79± 0.01 ^c | 11.72± 0.04 ^b | 1.74± 0.04 ^c | 75.63± 0.12 ^a | 365.06 |
| MF | 9.35 ± 0.23 ^b | 0.85± 0.12 ^b | 9.34± 0.07 ^c | 3.21± 0.34 ^b | 77.25± 0.05 ^a | 375.28 |
| CF | 5.43 ± 0.06 ^c | 4.02± 0.03 ^a | 26.56± 0.05 ^a | 29.51± 0.03 ^a | 34.48± 0.03 ^b | 509.75 |

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

3.2 Proximate composition of biscuits.

The proximate compositions of the biscuits produced from cashew nut, wheat and maize flour are shown in Table 3. Supplementing wheat flour with 10% cashew nut and varying levels of maize flour significantly ($p < 0.05$) affected the moisture, protein, fat, ash, fibre, carbohydrate contents and energy value of the biscuits. Moisture content played a vital role on the shelf life of biscuits. In this study, the moisture content of the biscuit samples ranged from 2.90 - 3.92% and varied significantly ($p < 0.05$) from each other. Sample Wf I (3.92%) which is the control sample had the highest value while sample Wmc 8 (2.90%) had the least moisture content. However, the increased supplementation of wheat flour with maize flour caused a significant ($p < 0.05$) decrease in the moisture content of the biscuits. This is similar to a previous study reported by Raihan and Sanni (2017) which shows that the supplementation of wheat flour with other flour (maize and cashew nut flour) decreased the moisture content of the biscuits. Furthermore, elevated moisture content of about 14% may lead to microbial deterioration, loss of nutritional quality and a decrease in the shelf life of food products (Dabel et al., 2016). In this study, the moisture content of the biscuits obtained is within the acceptable range ($< 10\%$) which will improve the shelf life of the biscuits (Ayo et al., 2007). The ash content of the biscuit samples varies significantly ($p < 0.05$) and ranged from 0.99 – 1.57%. The ash content of sample Wmc 8 was significantly higher (1.57%) as compared to all the samples produced. However, the control sample (Wf I) had the lowest ash content. Hence, it has been observed that an increase in maize flour has led to a significant increase in the ash content of the biscuit samples. This could be due to the higher ash content in maize as compared to wheat.

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According to Ikuomola et al. (2017), the content of non-organic compounds containing mineral constituents indicates the amount of ash content in food. Nevertheless, the crude protein of the biscuits ranged from 11.19 – 14.59% whereas the crude protein content of sample Wmc 2 (14.59%) was significantly higher than all the samples. However, sample Wf 1 which is the control sample had the lowest crude protein content (11.19%). It has been observed that the addition of various flour blends (varying level of maize and cashew nut flour) lead to an increase in the crude protein content of the biscuits. This is expected because cashew nut paste has appreciable crude protein compared to wheat and maize flour. Therefore, the addition of cashew nut paste to any cereal-based snacks could balance the overall amino acid and help to overcome protein malnutrition in developing countries. Nevertheless, the fat content of the biscuit samples ranged from 16.24 – 20.30% and differed significantly ($p < 0.05$) from each other. The fat content of sample Wmc 3 (20.30%) was significantly higher as compared to all the samples produced. However, sample Wf 1 (control sample) had the lowest fat content. This finding is similar to a previous study on biscuits produced from wheat, maize, almond and coconut flour, which shows that the control sample (wheat only) had the lowest fat content (Makinde et al., 2018). Also, Bello et al. (2020) reported a similar trend of fat content although the biscuits were produced from wheat, unripe plantain and fluted pumpkin seed. According to Ojinnaka et al. (2013), the fat content has a significant effect on the keeping quality of food products. Excess fat content may lead to rancidity and unpleasant odour in food (Vieira et al., 2015). The fibre content of the biscuit samples differed significantly ($p < 0.05$) from each other and ranged from 0.97 – 4.85%. Sample Wmc 8 (4.85%) recorded the highest value whereas sample Wmc 2 (2.87%) obtained the least fibre content. Values obtained for the fibre content in this study were above the acceptable levels (1.6 - 2.8%) in food as reported by FAO/WHO, 1971. The fibre contains insoluble materials which can reduce constipation by increasing bowel movement. The carbohydrate content of the biscuit samples ranged from 56.04 – 68.27%.

Table 3. Proximate Composition of Biscuit Samples Produced from Different Flour Blends

| Sample | Moisture (%) | Ash (%) | Protein (%) | Fat (%) | Fibre (%) | Carbohydrate (%) | Energy (Kcal/100 g) |
|--------|---------------------------------------|---------------------------------------|---------------------------|--|---------------------------------------|---------------------------|----------------------------|
| Wf 1 | 3.92 ± 0.03 ^a | 0.99 ± 0.01 ^c | 11.19 ± 0.03 ^c | 16.24 ± 0.04 ^c | 3.97 ± 0.02 ^d | 66.96 ± 0.02 ^a | 458.76 ± 0.32 ^d |
| Wmc 2 | 3.65 ± 0.03 ^a | 1.05 ± 0.02 ^b ^c | 14.59 ± 0.02 ^a | 20.21 ± 0.04 ^a | 2.87 ± 0.03 ^c | 57.63 ± 0.03 ^c | 470.77 ± 0.29 ^b |
| Wmc 3 | 3.50 ± 0.06 ^a | 1.15 ± 0.03 ^b ^c | 14.56 ± 0.03 ^a | 20.30 ± 0.03 ^a | 3.45 ± 0.03 ^b | 57.04 ± 0.03 ^c | 468.68 ± 0.31 ^c |
| Wmc 4 | 3.37 ± 0.03 ^a ^d | 1.23 ± 0.01 ^b | 14.53 ± 0.02 ^a | 20.06 ± 0.04 ^a ^b | 3.89 ± 0.02 ^b | 56.92 ± 0.02 ^d | 466.25 ± 0.35 ^c |
| Wmc 5 | 3.27 ± 0.04 ^a ^b | 1.31 ± 0.03 ^b | 14.48 ± 0.03 ^a | 19.96 ± 0.03 ^b | 4.14 ± 0.03 ^a ^b | 56.84 ± 0.03 ^d | 464.92 ± 0.27 ^c |
| Wmc 6 | 3.12 ± 0.04 ^b | 1.42 ± 0.03 ^b | 13.40 ± 0.04 ^b | 19.81 ± 0.03 ^b | 4.37 ± 0.04 ^a | 57.88 ± 0.03 ^c | 483.41 ± 0.25 ^a |
| Wmc 7 | 3.05 ± 0.02 ^b | 1.54 ± 0.02 ^a | 13.33 ± 0.03 ^b | 19.55 ± 0.05 ^b | 4.62 ± 0.05 ^a | 57.91 ± 0.04 ^c | 458.03 ± 0.14 ^d |
| Wmc 8 | 2.90 ± 0.02 ^c | 1.57 ± 0.02 ^a | 13.24 ± 0.04 ^b | 19.38 ± 0.02 ^b ^c | 4.85 ± 0.03 ^a | 58.06 ± 0.03 ^b | 459.62 ± 0.18 ^d |

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

Wf 1= 100% WF (Control); Wmc 2= 80% WF: 10%MF :10% CF; Wmc 3= 70% WF : 20%MF :10% CF; Wmc 4= 60% WF: 30%MF :10% CF Wmc 5= 50% WF : 40%MF :10% CF; Wmc 6= 40% WF : 50%MF :10% CF; Wmc 7= 30% WF : 60%MF :10% CF; Wmc 8= 20% WF : 80%MF :10% CF. Where; WF= Wholewheat flour, MF = Maize flour, CF = Cashew nut flour

However, the carbohydrate content of Sample Wf 1 (66.69%) was significantly higher as compared to all the samples. Sample Wmc 4 (56.84%) had the least carbohydrate content. The range of carbohydrate content obtained in this study falls within the reported carbohydrate content of cookies ranges of between 54.70 – 73.02g/100g (Raihan and Saini 2017; Ashraf et al., 2018; Bello et al., 2020). In this study, it has been observed that the carbohydrate content of the biscuit samples decreased with the supplementation of 10% cashew nut and varying levels of maize flour. This corroborates with the previous studies on the production of biscuits using composite flour where a relative decrease in carbohydrate content of biscuits was observed with the addition of oat, sorghum and amaranth flour (Raihan and Saini, 2017). Again, the increment of germinated fluted pumpkin levels in cookies (Bello et al., 2020), Also, a decrease in carbohydrate content of cookies and bread samples were observed with the increment of cashew-apple residue to wheat flour (Ebere et al., 2015) and cashew flour to wheat flour (Badje et al., 2018).

The energy value of the biscuit samples ranged from 457.68 – 470.80 Kcal/100g and differed significantly ($p<0.05$) from each other. The energy value of sample Wmc 2 (470.80 Kcal/100g) was significantly higher compared to other samples, while sample Wf 1 (457.68 Kcal/100g) had the lowest energy value. According to Protonotariou et al. (2016), biscuits contain over 400 calories per 100 g which is in agreement with the range obtained in this study. This is also in agreement with a previous study reported by Adeyeye, (2016) where the energy value falls within the range of 378 – 489Kcal/100g. Also, a similar trend of energy value was reported by Giwa and Ikujenlola, (2010).

3.3 Physical properties of biscuits.

Table 4 shows the physical properties of biscuits produced from Wheat-Maize-cashew nut flour blends. The weight of the biscuits ranged from 15.25 – 17.36g. A significant difference ($p<0.05$) exists between the physical parameters of biscuit samples. The weight of sample Wmc 8 was significantly higher as compared to all the biscuit samples produced while Sample Wmc 2 (15.25g) had the least weight. The weight of the biscuit sample increased with the increase of maize flour.

Table 4. Physical Properties of Biscuit Samples Produced from Different Flour Blends

| Sample | Weight (g) | Width (mm) | Thickness (mm) | Spread ratio |
|--------|---------------------------|---------------------------|---------------------------|--------------------------|
| Wf 1 | 16.19 ± 0.03 ^d | 52.36 ± 0.04 ^a | 9.57 ± 0.02 ^h | 5.47 ± 0.02 ^a |
| Wmc 2 | 15.25 ± 0.05 ^h | 51.88 ± 0.03 ^b | 10.48 ± 0.03 ^g | 4.95 ± 0.02 ^b |
| Wmc 3 | 15.60 ± 0.06 ^g | 51.73 ± 0.05 ^c | 10.75 ± 0.04 ^f | 4.81 ± 0.01 ^c |
| Wmc 4 | 15.92 ± 0.05 ^f | 51.53 ± 0.04 ^d | 10.84 ± 0.03 ^e | 4.75 ± 0.01 ^d |
| Wmc 5 | 16.08 ± 0.04 ^e | 51.37 ± 0.03 ^e | 10.95 ± 0.02 ^d | 4.70 ± 0.01 ^e |
| Wmc 6 | 16.42 ± 0.04 ^c | 51.19 ± 0.05 ^f | 11.03 ± 0.02 ^c | 4.64 ± 0.01 ^f |
| Wmc 7 | 17.03 ± 0.03 ^b | 50.83 ± 0.05 ^g | 11.12 ± 0.01 ^b | 4.57 ± 0.01 ^g |
| Wmc 8 | 17.36 ± 0.03 ^a | 50.54 ± 0.06 ^h | 11.27 ± 0.02 ^a | 4.48 ± 0.01 ^h |

Data are Mean±SD (n=3). Mean values bearing similar superscripts are not significantly different ($p < 0.05$). Wf 1= 100% WF (Control);
 Wmc 2 = 80% WF : 10%MF :10% CF;

Wmc 3 = 70% WF : 20%MF :10% CF; Wmc 4 = 60% WF : 30%MF :10% CF

Wmc 5 = 50% WF : 40%MF :10% CF; Wmc 6 = 40% WF : 50%MF :10% CF;

Wmc 7 = 30% WF : 60%MF :10% CF; Wmc 8 = 20% WF : 80%MF :10% CF

Where; WF= Wheat flour, MF = Maize flour, CF = Cashew nut flour

Furthermore, the results show a significant difference ($p < 0.05$) in the width of the biscuit which ranged from 50.54 – 52.36mm. However, sample Wf 1 had the highest width while sample Wmc 8 had the least width. In this study, the width of the sample increased with an increase in the supplementation of wheat flour with maize flour. Spread ratio values of the biscuit samples decreased with an increase in maize flour. The spread ratio of the biscuits ranged from 4.48 – 5.47 whereas sample Wmc 8 had the least spread ratio. Gaines (1990) showed that the spread ratio determines the quality of the flour which depends on the values of the thickness and diameter/width of the product. This is in agreement with a previous study that reported the addition of cashew-apple fibre to wheat flour which increased the weight and height while a decrease in the diameter and spread ratio of cookie samples was observed (Ebere et al., 2015). Subsequently, Adeyeye, (2016) also reported that the supplementation of wheat flour with sorghum flour decreased the width and spread ratio of cookies. However, the author also reported that the thickness and weight of the cookies decreased with the addition of sorghum flour. Furthermore, Raihan and Saini (2017) also observed a decrease in diameter, spread ratio and an increase in thickness of biscuits when oat, sorghum and amaranth composite flour was added to wheat flour. This could be attributed to the water binding power, internal structure, the particle size of the flours and their capacity to compact (Belorio et al., 2019).

3.4 Sensory evaluation of the biscuit samples.

The sensory properties of the biscuits are shown in Table 5. In this study, supplementation of 10% cashew nut flour and varying levels of maize flour to wheat flour significantly affected ($p < 0.05$) the texture, taste and overall acceptability of prepared biscuit samples. There was a significant difference ($p > 0.05$) in the aroma and colour of the prepared biscuit samples.

Table 5. Sensory Evaluation of Biscuits Produced from Different Flour Blends

| Sample | Colour | Taste | Aroma | Texture | Overall Acceptability |
|--------|--------------------------|---------------------------|--------------------------|----------------------------|---------------------------|
| Wf 1 | 7.80 ± 0.92 ^a | 7.20 ± 1.48 ^{ab} | 6.30 ± 1.57 ^a | 7.70 ± 1.25 ^a | 8.40 ± 0.84 ^a |
| Wmc 2 | 6.70 ± 1.70 ^a | 8.00 ± 1.05 ^a | 7.80 ± 1.23 ^a | 7.50 ± 1.43 ^{ab} | 7.30 ± 0.67 ^{ab} |
| Wmc 3 | 6.30 ± 1.49 ^a | 7.00 ± 1.15 ^{ab} | 6.70 ± 1.25 ^a | 7.10 ± 1.10 ^{abc} | 7.10 ± 0.74 ^{ab} |
| Wmc 4 | 6.40 ± 1.51 ^a | 6.60 ± 1.07 ^{ab} | 6.70 ± 0.82 ^a | 7.00 ± 1.05 ^{abc} | 6.90 ± 1.73 ^{ab} |
| Wmc 5 | 6.20 ± 1.75 ^a | 6.50 ± 1.35 ^{ab} | 6.40 ± 1.65 ^a | 6.70 ± 0.97 ^{abc} | 6.70 ± 1.34 ^{ab} |
| Wmc 6 | 6.00 ± 1.94 ^a | 6.40 ± 1.65 ^{ab} | 6.20 ± 1.48 ^a | 6.50 ± 1.08 ^{abc} | 6.70 ± 1.42 ^{ab} |
| Wmc 7 | 6.00 ± 1.70 ^a | 5.90 ± 2.08 ^b | 6.20 ± 0.90 ^a | 6.00 ± 1.15 ^{bc} | 6.30 ± 1.74 ^{ab} |
| Wmc 8 | 5.40 ± 1.78 ^a | 5.70 ± 1.70 ^b | 5.80 ± 1.62 ^a | 5.50 ± 1.35 ^c | 5.70 ± 1.16 ^b |

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

Wf 1= 100% WF (Control); Wmc 2= 80% WF : 10%MF :10% CF;
Wmc 3= 70% WF : 20%MF :10% CF; Wmc 4= 60% WF : 30%MF :10% CF
Wmc 5= 50% WF : 40%MF :10% CF; Wmc 6= 40% WF : 50%MF :10% CF;
Wmc 7= 30% WF : 60%MF :10% CF; Wmc 8= 20% WF : 80%MF :10% C

The colour mean scores of the biscuit samples ranged from 5.40 - 7.80. Considering the colour, sample Wf 1 had the highest score while sample Wmc 8 obtained the least score. Generally, the biscuits produced from wheat flour supplemented with cashew nut flour and various levels of maize flour had a darker colour than the control biscuits. This is in agreement with the previous study who reported an increase in dark colour with the level of supplementation which could be due to the protein content which is adequate for Maillard reaction to take place and are very common and desirable in baked products (Ikuomola et al., 2017). Regarding the texture, sample Wf 1 was significantly higher ($p > 0.05$) than all the samples while sample Wmc 8 had the lowest score which ranged from 5.50 – 7.70. It has also been observed that the texture of the biscuit decreases with an increase in the supplementation of wheat flour with maize flour. The taste scores of the biscuit samples ranged from 5.70 – 8.00, however, sample Wmc 2 recorded the highest and differed significantly ($p < 0.05$) from all the samples while sample Wmc 8 had the least taste score. The aroma of the biscuit samples ranged from 5.80 – 7.80. Furthermore, a significant difference ($p < 0.05$) existed between the aroma of the biscuits where sample Wmc 2 recorded the highest while sample Wmc 8 had the least score. Among all the biscuit samples produced, the overall acceptability score of the biscuit samples ranged from 5.70 – 8.40. Sample Wf 1 was significantly higher as compared to all the samples while sample Wmc 8 had the least overall acceptability score. The lower acceptable scores of the biscuits supplemented with maize and cashew nut flour could be due to the dark colouration. In this study, although the biscuit supplemented with 10% cashew nut flour and 10% maize flour (Wmc 2) had a higher aroma and taste score compared to the control biscuits sample, however, it is not the most acceptable sample. The sensory evaluation showed that although there was a significant ($p < 0.05$) increase in the proximate composition of the biscuit samples, the overall acceptability of biscuit samples decreased with increasing levels of maize flour.

4. Conclusion

In conclusion, the study showed that acceptable biscuits from the blends of cashew nut, wheat and maize flour with improved nutritional quality and high dietary fibre content could be produced. The results from this study showed that supplementation of 10% cashew nut and varying levels of maize (10, 20, 30, 40, 50, 60 and 70%) flour to wheat flour increased the nutritional values of biscuit samples produced. It is clear that such effort might lead to increased utilization of cashew nuts flour and the production of cashew nuts will be encouraged. Furthermore, the high protein content in cashew nut flour incorporated biscuits could be used to address the problem of prevalence of protein-energy malnutrition in many communities.

Moreover, the high level of dietary fibre of the biscuits would be beneficiary to the health of consumers. Biscuits produced from wheat supplemented with maize and cashew nut flour will help reduce the country's dependency on the importation of wheat grain.

References

Abdulrahman, AA. and Kolawole, OM. 2006. Traditional preparations and uses of maize in Nigeria. *Ethnobotanical Leaflets*, 10: 219-227.

Adepoju, AB., Coker, OJ. and Adetula, OA. 2019. Effects of processing methods on the proximate and physicochemical properties of flour and oil of cashew nut. *Nigerian Journal of Nutritional Sciences*, 40: 87-90.

Adeyeye, SAO. 2016. Assessment of quality and sensory properties of sorghum–wheat flour cookies. *Cogent Food and Agriculture*, 2: 1-10.

Afzal, M., Nasir, Z., Bashir, MH. And Khan, BS. 2009. Analysis of list plant resistance in some genotypes of maize against *Chilo Partellus (Swinhoe) (Pyralidae: Lepidoptera)*. *Pakistan Journal of Botany*, 41: 421-428

Akinhanmi, TF., Atasie, VN. and Akintokun, PO. 2008. Chemical composition and physicochemical properties of cashew nut (*Anacardium occidentale*) oil and cashew nut shell liquid. *Journal of Agricultural, Food and Environmental Sciences*, 2: 1-10.

AOAC. 2005. *Official Methods of Analysis of AOAC International*. 18th ed. Gaithersburg (MD): AOAC International. Available: <http://www.eoma.aoac.org>. Accessed 10 July 2022

Aremu, MO., Olonisakin, A., Bako, DA., and Madu, PC. 2006. Compositional studies and physicochemical characteristics of cashew nut (*Anarcadium occidentale*) flour. *Pakistan Journal of Nutrition*, 5: 328-333.

Ashraf, U., Bandral, JD., Sood, M., Sofi, S., Rafiq, S. and Sharma, S. 2018. Effect of replacement of wheat flour with apricot powder on nutritional and sensory quality of nutcrackers. *The Pharma Innovation Journal*, 7: 695-701.

Ayo, JA., Ayo, VA., Nkama, I. and Adeworie, R. 2007. Physicochemical, *invitro* digestibility and organoleptic evaluation of acha-wheat biscuit supplemented with soybean flour. *Nigerian Food Journal*, 25: 15-17.

Babiker, EE., Ozcanb, MM., Ghafoora, K., Al Juhaimia, F., Ahmeda, IAM. and Almusallama, IA. 2021. Bioactive compounds, nutritional and sensory properties of cookies prepared with wheat and tiger nut flour. *Food Chemistry*, 349: 1-8.

Badje, DS., Soro, D., Yeo, MA. and Koffi, EK. 2018. Physico-chemical, functional and sensory properties of composite bread prepared from wheat and defatted cashew (*Anacardiumoccidentale L.*) kernel flour. *International Journal of Environmental and Agriculture Research*, 4: 88-98.

Belorio, M., Sahagún, M. and Gómez, M. 2019. Influence of flour particle size distribution on the quality of maize gluten-free cookies. *Foods*, 8: 3.

Bello, FA., Akpan, ME. and Sodipo, MA. 2020. Physicochemical and sensory properties of cookies produced from wheat, unripe plantain and germinated fluted pumpkin seed composite flour. Food Science and Quality Management, 9: 36-43.

Bilge, G., Sezer, B., Eseller, KE., Berberoglu, H., Koksel, H. and Boyaci, IH. 2016. Ash analysis of flour sample by using laser-induced breakdown spectroscopy. Spectrochimica Acta Part B: Atomic Spectroscopy, 124: 74-78.

Caleja, C., Barros, L., Antonio, AL., Oliveira, MBP. and Ferreira, IC. 2017. A comparative study between natural and synthetic antioxidants: Evaluation of their performance after incorporation into biscuits. Food Chemistry, 216: 342-346.

Caponio, F., Summo, C., Delcuratolo, D. and Pasqualone, A. 2006. Quality of the lipid fraction of Italian biscuits. Journal of the Science of Food and Agriculture, 86: 356-361.

Carr, TW., Balkovič, J., Dodds, PE., Folberth, C., and Skalský, R. 2021. The impact of water erosion on global maize and wheat productivity. Agriculture, Ecosystems and Environment, 322: 107655.

Chauhan, A., Saxena, DC. and Singh, S. 2015. Total dietary fibre and antioxidant activity of gluten free cookies made from raw and germinated amaranth (*Amaranthus spp.*) flour. LWT - Food Science and Technology, 63: 939-945.

Dabels, N., Igbabul BD., Amove, J. and Iorliam, B. 2016. Nutritional composition, physical and sensory properties of cookies from wheat, acha and mung bean composite flours. International Journal of Nutrition and Food Sciences, 5: 401-406.

Dankwa, KO. and Liu, Y. 2017. Evaluating the nutritional and sensory quality of bread, cookies and noodles made from wheat supplemented with root tuber flour. British Food Journal, 119: 895-908.

Dhanavath, S. and Prasada Rao, UJS. 2017. Nutritional and nutraceutical properties of *Triticumdicoccum* wheat and its health benefits: An overview. Journal of Food Science, 82: 2243-2250.

Dotsey, P. 2009. The use of cocoyam, cassava and wheat flour composite in the production of rock cakes. HND dissertation, Cape Coast Polytechnic, Cape Coast, Ghana, pp. 7-40.

Ebere, CO., Emelike, NJT. and Kiin-Kabari, DB. 2015. Physico-chemical and sensory properties of cookies prepared from wheat flour and cashew-apple residue as a source of fibre. Asian Journal of Agriculture and Food Sciences, 3: 213-218.

Emelike, NJT., Barber, LI., and Ebere, CO. 2015. Proximate, mineral and functional properties of defatted and undefatted cashew (*Anacardium occidentale Linn.*) kernel flour. European Journal of Food Science and Technology, 3: 11-19.

FAO, 2014. FAOSTAT database: Food and Agriculture Organization of the United Nations, National Production Statistics Nigeria. FAO, Rome.

FAO/WHO, 1971. Joint ad hoc expert committee. WHO Technical Report No. 22, FAO nutrition meeting report series No. 52, energy and protein requirements, WHO, Geneva and FAO, Rome.

Gaines, CS. 1990. Influence of chemical and physical modification of soft wheat protein on sugar-snap cookie dough consistency, cookie size and hardness. *Cereal Chemistry*, 67: 73 -77

Giwa, EO. and Ikujenlola, AV. 2010. Quality characteristics of biscuits produced from composite flours of wheat and quality protein maize. *African Journal of Food Science and Technology*, 1: 118-119.

Hussain S, Anjun FM, Butt MS and Sheikh MA. 2008. Chemical compositions and functional properties of flaxseed flour. *Sarhad Journal of Agriculture*, 24: 649-653

Ibidapo, PO., Osibanjo, AA., AsiruWahab, B., Kayode, OF., Ojo, OE. and Elemo, GN. 2019. Proximate composition and bread making performance of selected wheat varieties grown in Nigeria. *Nigerian Food Journal*, 36: 88-95.

Ikuomola, DS., Otutu, OL. and Oluniran, DD. 2017. Quality assessment of cookies produced from wheat flour and malted barley (*Hordeum vulgare*) bran blends. *Cogent Food and Agriculture*, 3: 1293471.

Klunklin, W. and Savage, G. 2018. Biscuits: A substitution of wheat flour with purple rice flour. *Advances in Food Science and Engineering*, 2: 81- 97.

Lima, JR and Duarte EA. 2006. Pastas de castanha de caju com incorporação de sabores. *Pesquisa Agropecuária Brasileira*, 41: 1333-1335.

Makinde, FM. and Taibat, AA. 2018. Quality characteristics of biscuits produced from composite flours of wheat, corn, almond and coconut. *Annals of Food Science and Technology*, 19: 216-225.

Marero, M., Payumo, EM., Librado, EC., Lainez, W., Gopez, MD. and Homma, S. 1989. Technology of weaning food formulations prepared from germinated cereals and legumes. *Journal of Food Science*, 53: 1391-1395.

Kaur, M., Singh, V. and Kaur, R. 2017. Effect of partial replacement of wheat flour with varying levels of flaxseed flour on physicochemical, antioxidant and sensory characteristics of cookies. *Bioactive Carbohydrates and Dietary Fibre*, 9: 14-20

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.

Ndife, J., Kida, F. and Fagbemi, S., 2014. Production and quality assessment of enriched cookies from whole wheat and full fat soya. *European Journal of Food Science and Technology*, 2: 19-28.

Obinna-Echem, PC. and Robinson, ES., 2019. Proximate composition, physical and sensory properties of biscuits produced from blends of maize (*Zea mays*) and tiger nut (*Cyperus esculentus*) flour. *Sky Journal of Food Science*, 7: 30-36.

Ojinnaka, MC. and Agubolum, FU. 2013. Nutritional and sensory properties of cashew nut - wheat based cookies. *American Journal of Food and Nutrition*, 3: 127-134.

Ojinnaka MC., Ihemeje, A. and Ugorji CO. 2016. Quality evaluation of cookies produced from African breadfruit, wheat and pigeon pea flour blends. *Agriculture and Biology Journal of North America*, 3: 101-106.

Oladapo AS., Adepeju, AB., Akinyele, AA. and Adepeju, DM. 2017. The Proximate, functional and anti-nutritional properties of three selected varieties of maize (yellow, white and pop Corn) flour. *International Journal of Scientific Engineering and Science*, 1: 23-26.

Protonotariou, S., Batzaki, C., Yanniotis, S. and Mandala, I. 2016. Effect of jet milled whole wheat flour in biscuits properties. *LWT - Food Science and Technology*, 74: 106-113.

Raihan, M. and Saini, CS. 2017. Evaluation of various properties of composite flour from oats, sorghum, amaranth and wheat flour and production of cookies thereof. *International Food Research Journal*, 24: 2278-2284.

Świeca, M., Gawlik-Dziki, U., Dziki, D. and Baraniak, B. 2017. Wheat bread enriched with green coffee – In vitro bioaccessibility and bioavailability of phenolics and antioxidant activity. *Food Chemistry*, 221: 1451-1457.

Srivastava, S., Genitha, TR. and Yadav, V. 2012. Preparation and quality evaluation of flour and biscuit from sweet potato. *Journal of Food Processing and Technology*, 3: 1-5.

Sule, El., Umoh, VJ., Whong, CMZ., Abdullahi, IO. and Alabi, O. 2014. Chemical and nutritional value of maize and maize products obtained from selected markets in Kaduna State, Nigeria. *African Journal of Food Science and Technology*, 5: 100-104.

Topping, D. 2007. Cereal complex carbohydrates and their contribution to human health. *Journal of Cereal Science*, 46: 220-229.

Vieira, SA., McClements, DJ. and Decker EA. 2015. Challenges of utilizing healthy fats in foods. *Advances in Nutrition*, 6: 309S-317S.