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Quality Evaluation of Wheat and Defatted Cashew Nut-Based Cookies

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ABSTRACT

The effect of substituting defatted cashew nut flour for wheat flour on the functional properties of wheat and defatted cashew nut flour blends, and cookies quality were studied. The bulk density, water absorption, oil absorption, foaming and emulsion capacities of the blends ranged from 0.68 to 0.74 g/cm^3, 1.05 to 1.10 g/g, 0.98 to 2.07 g/g, 7.51 to 11.43% and 58.67 to 73.33% respectively. Peak viscosity, trough viscosity, breakdown viscosity, set back viscosity, final viscosity, pasting temperature and peak time ranged from 148.05 to 231.30 RVU, 112.55 to 152.60 RVU, 35.50 to 78.70 RVU, 178.60 to 267.05 RVU, 66.05 to 114.45 RVU, 86.38 to 89.65 °C and 5.53 to 6.05 min respectively. Moisture, protein, fat, fibre, ash, carbohydrate and energy value ranged from 12.01 to 12.62 %, 13.00 to 28.00 %, 16.49 to 22.96%, 0.10 to 1.63%, 1.00 to 1.97%, 34.32 to 56.43% and 426.13 to 455.92 kcal 100/g, respectively. Mineral contents (calcium, magnesium, iron, zinc and phosphorus) increased with addition of defatted cashew nut flour. The result of the sensory evaluation showed that substitution of up to 20% cashew nut flour is generally acceptable. The addition of defatted cashew nut flour increased significantly the ferric reducing antioxidant power, 1, 1-dipenyly-2-picryl-hdrazil (DPPH) and 2, 2-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid (ABTS) and total phenolic content of composite the cookie compared to control.

Keywords: Defatted cashew nut, functional properties, physicochemical properties, sensory attributes cookies.

1.0 Introduction

There is an ever-increasing demand for handy, ready-to-eat (RTE) snacks prepared from wheat flour, partly or wholly substituted with either cereals, legumes or nuts to improve the nutritional quality (Awolu *et al.*, 2015; Awolu *et al.*, 2016). Foods are nowadays not only eaten to gratify and make available needed nutrients for human, but also to reduce diet-associated diseases and nutrition deficiency as well as to improve human well-being. Research experts are encouraging the use of diverse food ingredients/crops to formulate purposeful foods (Takachi *et al.*, 2008). Plant protein plays an important role in the human diet especially in developing countries where protein and caloric malnutrition are prevalent particularly among women and children. Due to insufficient supply of protein in baked foods, there have been frequent studies on unconventional sources of protein for use as both nutritional supplements and functional ingredients.

Cashew nut (*Anacardium occidentale*) is a kidney like shaped with a crunchy texture and butter flavoured nut. Cashew nuts are rich sources of healthy lipids (43-49%) and protein (20-39%) (Akinhanmi and Akintokun, 2008). Cashew nut is also rich in minerals such as potassium, calcium, sodium, phosphorus, zinc, magnesium and iron (Akinhanmi and Akintokun, 2008). Cashew nut is of great economic importance due to its high demand for exportation. However, cashew nuts are still discarded locally after the consumption of the apple. They are also underexploited in the food and confectionary industries.

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Cookies are nutritious appetizers made from inedible dough that is converted into an appealing product via heat in an oven (Anozie *et al.*, 2014). They are widely consumed by all ages as snack. This can be attributed to its relatively cheap, ready-to-eat convenient quality. Cookies have been suggested as an improved use of composite flour due to their ready-to-eat form, broad eating, long shelf life and a better keeping quality compared to most baked products. Presently, cookies are regarded as the most fashionable snack amongst end users as a good trace of proteins, carbohydrates and dietary fibre (Bala *et al.*, 2015).

Snacks products such as biscuits and cookies have been formulated from blends of cassava flour/ cashew apple powder (Ogunjobi and Ogunwolu, 2010), whole wheat and full fat soya (Ndife *et al.*, 2014), wheat flour/cashew apple residue as a source of fibre in cookie preparation (Emelike *et al.*, 2015) and composite flour of plantain/bambara groundnut protein concentrate (Kiin-Kabari and Giami, 2015). To the best of our knowledge, cookies made from wheat and defatted cashew nut flour has not been reported. Hence, the aim of this research was to investigate the effect of defatted cashew nut flour on the functional, physicochemical, sensory and antioxidant properties of wheat-based cookies.

2.0 Materials and Methods

Matured cashew nuts were procured from Olam farm, Ilorin Kwara State. Wheat flour (Golden penny) and other ingredients that were used for cookies production were purchased from Kure Ultramodern Market, Minna, Niger State, Nigeria.

2.1 *Sample preparation*

2.1.1 *Preparation of defatted cashew nut flour*

Defatted cashew nut flour was prepared according to the method described by Emelike *et al.* (2015) with modification. The cashew nut was milled using the dry cup of Phillips blender (Phillips, Model HR 1702 Germany). The defatted cashew nut flour was dried in an air-draft oven at 50 °C for 20 min to reduce the moisture content and to condition the fat molecules of the flour. The oil was partially extracted by solvent extraction with acetone in continuous Soxhlet extraction apparatus for 1 h. The flour produced was air-dried for 6 h. The defatted cashew nut flour was milled, sieved (Phillips, Model HR 1702 Germany) and stored in plastic jars with lid at 4°C prior to functional analysis and production of cookies.

2.2 *Formulation of composite flour blends*

Wheat flour (WF) and defatted cashew nut flour (CNF) were blended at different proportions (100:0, 95:5, 90:10, 85:15 and 80:20%) while 100% wheat flour served as control.

2.3 *Determination of functional properties of flour blends*

Bulk density and water absorption capacity (WAC) for each formulated sample was determined as described by Onimawo and Akubor (2012). Oil absorption capacity (OAC) was be determined using the method of AOAC (2005). Foaming and emulsion capacities were determined by the methods of AOAC (2006). Water solubility index and swelling power at temperature range of 50-80 °C were determined by methods described by AOAC (2005) and Adeboye and Singh (2008) respectively.

2.4 *Determination of pasting properties of the flour blends*

The pasting characteristics of the flour samples were determined using rapid visco analyzer (Newport Scientific Pty. Ltd., Warrie-wood NSW 2102, Australia) according to the AACC method (2000). About 2.5 g of flour samples were weighed into a dried empty canister; then 25 mL of distilled water was dispensed into the canister containing the sample. The suspension was thoroughly mixed and the canister was fitted into the rapid visco analyzer. Each suspension was kept at 50 °C for 1 min and then heated up to 95 at 12.2 °C min^{-1} and held for 2.5 min at 95 °C. It was then cooled to 50 at 11.8 °C min^{-1} and kept for 2 min at 50 °C. The peak viscosity, trough viscosity, breakdown viscosity, final viscosity, setback viscosity, peak time and pasting temperatures were expressed in terms of Rapid Visco Units (RVU), equivalent to 10 centipoises.

2.5.4 Cookie production

The cookies were prepared following method reported by Chinma and Gernah (2007). Ingredients used were 49.5 % flour, 20 % margarine, 20 % sugar, 10% beaten whole egg and 0.5 % baking powder. The flour, sugar and baking powder were manually mixed in a glass bowl. The margarine and beaten whole egg were well creamed for 1 min, and then the dried ingredients were added at once and mixed for another 1 min to form dough. The dough was rolled out on the table to a uniform thickness using a rolling pin and cut with a 72 mm diameter cookie cutter. The cookies were placed on baking trays, baked at 170 °C for 20 min in the oven. Following baking, the cookies was cooled at ambient temperature, packaged in polyethylene bags, sealed and stored in plastic containers until needed.

Table 1: Functional properties of blends of wheat/partially defatted cashew nut flours

Parameters	100WF	95WF5CNF	90WF10CNF	85WF15CNF	80WF20CNF
Bulk density (g/cm^3)	0.68±1.43^a	0.70±0.02^a	0.71±0.06^a	0.72±0.01^a	0.74±0.01^a
Water absorption capacity (g/g)	1.05±0.05^a	1.05±0.05^a	1.10±0.00^a	1.05±0.05^a	1.10±0.00^a
Oil absorption capacity (g/g)	2.07±0.06^a	1.67±0.21^b	1.67±0.76^b	0.98±0.03^c	1.07±0.06^c
Foaming capacity (%)	10.46±2.47^b	9.80±1.96^{ab}	7.51±0.57^c	11.43±0.57^a	11.43±0.57^a
Emulsion capacity	58.67±8.08^e	61.30±10.58^d	64.43±5.09^c	73.33±3.35^a	71.10±6.97^b
Swelling capacity (50°C	5.72±0.01^d	5.56±0.01^d	6.02±0.01^c	6.31±0.01^b	7.02±0.01^a
Swelling capacity (60°C)	6.46±0.01^d	7.23±0.01^c	7.65±0.61^a	6.87±0.01^c	7.65±0.61^a
Swelling capacity (70°C	8.12±0.01^c	7.83±0.01^d	7.84±0.01^d	8.73±0.01^b	8.96±0.01^a
Swelling capacity (80°C)	9.16±0.07^c	8.23±0.01^e	9.35±0.01^b	10.02±0.01^a	8.96±0.01^a
Solubility index (50°C)	4.23±0.01^d	4.14±0.01^e	5.13±0.01^c	6.02±0.01^b	6.09±0.01^a
Solubility index (60°C)	5.32±0.01^e	6.35±0.01^b	5.75±0.01^d	6.76±0.01^a	6.27±0.01^c
Solubility index (70°C)	6.23±0.01^d	6.58±0.01^c	4.24±0.01^e	7.13±0.01^a	6.67±0.01^b
Solubility index (80°C)	7.72±0.01^c	5.93±0.01^e	7.87±0.01^b	8.16±0.07^a	7.19±0.01^d

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$).

100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour);

85WF15CNF (85% wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour)

2.6 Determination of physical properties of cookies produced from wheat/partially defatted cashew nut flour blends

Cookies diameter (mm) and thickness (mm) were determined using vernier calliper, spread ratio was calculated as diameter/thickness and colour (L*, a*, b*) were estimated for different blends of cookies as suggested by Hussein *et al.* (2006). The average of three random readings for each sample was taken and was considered as the mean value for physical analysis of cookies.

2.7 Determination of chemical composition of cookies produced from wheat/partially defatted cashew nut flour blends

Moisture, protein, fat, ash and fibre contents of cookies were determined according to methods described by AOAC (2005). Carbohydrate content was calculated by difference (100 - % moisture + % protein + % fat + % ash + % crude fibre). The food caloric value was estimated from Atwater factors (protein x 4 + carbohydrate x 4 + fat x 9). AOAC (2005) method was used for determination of some mineral elements using atomic absorption spectrophotometer (Perkin-Elmer 2380, USA, 1976). From stock solution of 1000 ppm, working standard solutions of the elements (BDH England) was prepared at 100 ppm by dilution. The elements determined include: magnesium, calcium, zinc, phosphorus and iron.

2.8 Sensory evaluation of cookies produced from wheat/partially defatted cashew nut flour blends

The cookies produced from the flour blends of wheat and partially defatted cashew nut were subjected to sensory evaluation. Quality attributes evaluated were taste, colour, texture, aroma, appearance and overall acceptability. A semi-trained twenty-member panel consisting of Food Science and Technology students of the Federal University of Technology, Minna was used. The samples were presented in codes. Potable water was made available to the panelists in rinsing their mouth after each tasting to prevent interference in taste. A 9-point Hedonic scale (where 9= like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 3= dislike moderately, 2= dislike very much and 1= dislike extremely).

2.9 Determination of antioxidant properties of cookies.

The antioxidant properties of the most acceptable cookie (80WF20CNF) sample and the control following sensory evaluation were analyzed.

An extract was prepared for antioxidant assay of cookie samples. A 0.2 g of each cookie samples was extracted twice with 4 ml of 80 % methanol. Each time, the mixture was shaken on a shaker for 2 hours at room temperature. The mixture was centrifuged at 2000 × g for 10 minutes. The supernatants were collected and mixed together. The residues were discarded and the supernatants labelled as the stock solutions. The supernatants were stored at 4 °C.

Ferric reducing antioxidant power assay (FRAP) was determined using the method of Beta *et al.* (2005) while free radical scavenging activity measured by 1.1-diphenyl -2-picryl hydrazil (DPPH) was determined according to the method described by Silva *et al.* (2007). Total phenolic content was determined using the Folin-Ciocalteau method described by Ruthairat *et al.* (2011) while ABTS was analyzed as determined by Thaipong *et al.*, 2006).

Table 2: Pasting properties of wheat and defatted cashew nut flour blends

Parameters	100WF	95WF5CNF	90WF10CNF	85WF15CNF	80WF20CNF
Peak (RVU)	231.30±0.40^{a}	220.01±1.41^{b}	156.50±0.71^{d}	157..30±1.41^{c}	148.05±0.40^{e}
Trough (RVU)	152.60±0.35^{a}	152.30±0.35^{a}	118.45±0.71^{c}	120.40±1.41^{b}	112.55±0.71^{d}
Breakdown (RVU)	78.70±0.04^{a}	67.75±0.71^{b}	38..20±0.04^{c}	36.90±0.04^{d}	35.50±0.04^{e}
Final viscosity (RVU)	267.05±0.70^{a}	261.05±0.71^{a}	191.60±0.04^{b}	195.75±0.71^{b}	178.60±1.41^{c}
Setback (RVU)	114.45±0.71^{a}	108.75±0.71^{b}	73.15±0.71^{d}	75.35±0.71^{c}	66.05±0.71^{e}
Pasting temperature (°C)	87.20±0.04^{bc}	86.38±0.00^{c}	89.40±0.81^{a}	88.05±0.08^{b}	89.65±0.07^{a}
Peak time (min)	6.05±0.71^{a}	5.88±0.00^{b}	5.65±0.81^{c}	5.61±0.08^{c}	5.53±0.07^{a}

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$). 100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour); 85WF15CNF (85% wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour)

2.10 Statistical analysis

Data obtained from the study were subjected to statistical analysis (Statistical Packaging for Social Science version 22) using a one-way analysis of variance (ANOVA). Duncan New Multiple Range Test was used to separate the means where significant differences ($p<0.05$) existed.

3.0 Results and Discussion

3.1 Functional properties of wheat-cashew nut flour blends

The functional properties of wheat and defatted cashew nut flour blends are presented in Table 1. There was no significant difference in the bulk density and water absorption capacity of flour blends. The bulk density of the flour samples ranged from 0.68 gcm^{-3} to 0.74 gcm^{-3} for 80WF20CNF and 100WF, respectively while water absorption capacity ranged from1.05 g/mL and 1.10 g/mL. The values of the bulk densities recorded in this study are similar to those reported by Akubor and Badifu (2004). Bulk density plays an important role in packaging and transportation of food products. It is also closely related to porosity of materials due to surface properties (Milson and Kirk, 1980). Oil absorption capacity of the flour samples ranged from 0.98 g/mL to 2.07 g/mL. There was significant decrease in the oil absorption capacity with the addition of defatted cashew nut flour except for sample 85WF15CNF. The decrease in oil absorption could be attributed to an increase in fat content of defatted cashew nut flour compared to 100% wheat flour. Similar trend was reported for wheat/bambara nut flour blends (Olaoye *et al.*, 2018). Foaming capacity ranged from 7.51 to 11.43%. It was observed that the 85WF15CNF and 80WF20CNF flour blends were not significantly different from each other. The increase in foaming capacity may be due to the high protein nature of cashew nut. Similar trend was recorded for emulsion capacity ranged from 58.67 to 73.33%. High emulsion capacity is an indication of good flavour binder. This can be useful in the production of low-fat bakery products as flavour carriers. The swelling capacity and solubility index of the flour samples were temperature dependent.. It was observed the swelling capacity increased as the temperature increased for each flour sample and also increased with increase in cashew nut flour addition. A contrary result was recorded for wheat/bambara nut flour blends which decreased from 6.65 to 5.42%. Swelling capacity brings about the expansion accompanying spontaneous uptake of solvent solubility index also significantly increased ($P<0.5$) at each temperature. Solubility index indicates the amount of water soluble solids per unit weight of the sample. It is an index of protein functionality such as denaturation. Higher solubility brings about higher functionality of the protein in a food (Adebowale *et al.,* 2008).

3.2 Pasting properties of wheat and cashew nut flour blends

Pasting properties are important in predicting the functionality of flour and their applications in the food system (Alimi *et al.,* 2016). The pasting properties of wheat flour decreased with the substitution of defatted cashew nut flour (Table 2). The 100WF flour sample had the highest peak viscosity (231.30 RVU) while the lowest value was recorded for 80WF20CNF (148.05 RVU). This might be attributed to the high starch content in the 100% wheat flour compared to the composite blends. Similar trend was recorded for Trough viscosity (112.50 to 152.60 RVU), breakdown viscosity (355.00 to 787.00 RVU), final viscosity (178.60 to 267.05 RVU) and set back viscosity (66.05 to 114.45 RVU). The decrease in pasting viscosities may be ascribed to the variation in chemical constitution of starch structure (Radley, 1976). The rheological activity of dough has been stated to depend on its flour composition. Pasting temperature increased significantly ($p <0.5$) with increase in defatted cashew nut flour substitution. The highest temperature was recorded for 80WF20CNF (89.70 °C) while the 95WF5CNF had the lowest temperature (86.40 °C). The peak time also decreased from 6.05 to 5.53 min as the level of defatted cashew nut flour increased in the blend.

Table 3: Phys

Parameters
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Thickness(cm)
Spread ratio
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Table 3: Physical properties of cookies prepared from wheat and defatted cashew nut flour blends

Parameters	100WF	95WF5CNF	90WF10CNF	85WF15CNF	80WF20CNF
Diameter(cm)	7.33±1.26^{a}	7.32±0.63^{a}	7.32±0.76^{a}	7.28±0.58^{a}	7.32±0.58^{a}
Thickness(cm)	1.48±0.29^{ab}	1.48±0.76^{ab}	1.85±1.32^{c}	1.43±1.15^{a}	1.65±0.50^{b}
Spread ratio	4.95±0.04^{bc}	4.90±0.29^{c}	3.90±0.27^{a}	5.10±0.41^{c}	4.40±0.14^{ab}
L	86.32±0.01^{a}	86.13±0.01^{b}	75.6±0.01^{d}	74.78±0.02^{e}	80.04±0.01^{c}
a	5.84±0.01^{c}	3.35±0.01^{e}	6.98±0.01^{b}	5.51±0.03^{d}	8.54±0.01^{a}
b	4.15±0.04^{d}	2.80±0.06^{e}	4.66±0.01^{c}	6.25±0.01^{b}	7.55±0.01^{a}

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$). 100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour); 85WF15CNF (85% wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour); L*=Brightness; a*=redness; b*=yellowness.

3.3 Physical properties of cookies

The physical properties of the cookie samples are presented in Table 3. The diameter of the cookie samples ranged from 7.28 to 7.38 cm. There was no significant difference among the samples. The diameter values obtained from this study are higher than those reported by Chinma and Gernah (2007) for cookies made from cassava/soyabean/mango flours. The thickness of the cookies varied between 1.43 and 1.85 cm. Cookies thickness increased slightly with the addition of defatted cashew nut flour. This could be as a result of the swelling and binding of cookie components due to water absorption. Similar results were reported by Chinma and Gernah (2007). However, the values were higher than those reported by Adeoye *et al.* (2018) for wheat and false yam cookies. The spread ratio decreased with increase in defatted cashew nut flour substitution. Colour is one of the major sensory qualities of baked products. The golden brown appearance of baked products is mostly desirable by consumers. The colour L*, a* and b* values of the cookie samples were significantly different from each other. Colour L* which is an indication of lightness to darkness ranged from 74.78 (85WF15CNF) to 86.32 (100WF). This increase might be attributed to the increase in protein content from the defatted cashew nut flour used, which could have led to more intense browning (Maillard) reaction. Brown pigment occurs as non-enzymatic browning (Maillard and caramelization) evolve (Pereira *et al.*, 2013). The positive values of a* and b* demonstrates that the cookie samples have reddish and yellowish shades.

3.4 Chemical composition of cookies

The chemical composition of the cookie samples are presented in Table 4. The moisture contents of the cookie samples ranged from 12.01 to 12.62%. The 90WF10CNF cookie sample had the highest moisture content while the 100WF had the lowest. The moisture content are within the range (< 13%) reported to have no adverse effect on the quality attributes of the products. Low moisture content in confectionaries reduces the chances of microorganism proliferation and guarantee good shelf stability if stored inside appropriate packaging material under good environmental condition (Sanni *et al.*, 2006; Ayo *et al.*, 2007). Protein content of cookie samples ranged from 13 to 28%. Cookies made from 80WF20CNF had the highest value while 100WF had the lowest. The values generated from this study are quite higher than those reported for wheat/germinated sesame cookies (15.18-18.80%) (Olagunju and Ifesan, 2013); sorghum-wheat biscuits (7.06-11.84%) (Adebowale *et al.*, 2012); wheat-African breadfruit cookies (11.06-13.24%) (Akubor and Badifu, 2004); cassava-soya bean-mango cookies (6.83-16.60%) (Chinma and Gerbah, 2007). The increase in protein content with increased substitution level of cashew nut flour might be due to the higher protein content in cashew nut flour. Aremu *et al.* (2006) reported 25.30% protein content in defatted cashew nut flour. This corroborated the findings of Omosuli *et al.* (2009) who reported 27.31% protein content in cashew nut flour. Cashew nut flour has been reported to have well balanced amino acid profile (Aremu *et al.*, 2006). The fat content of cookies ranged from 16.49 to 22.96%. The 80WF20CNF cookie samples had the highest fat content while the 100WF cookie sample had the lowest value. The high content of fat may also be attributed to the higher fat content in cashew nut. Cashew nut flour is rich in good fat (unsaturated fatty acids) which is good for membrane structure (Aremu *et al.* (2006). These authors reported that cashew nut flour had 36.70% fat content. The 80WF20CNF had the highest fibre (1.63%) while the 100WF had the lowest value (0.10%). The fibre values obtained is higher than those reported (0.48-0.78%) by Olagunju and Ifesan (2013) for wheat-sesame seed cookies. The 100WF cookie samples had the highest (1.97%) ash content while 95WF5CNF and 90WF10CNF had the lowest (1.00%). There was no significant difference (P>0.5) among the samples. The carbohydrate contents of the cookie samples ranged from 34.32 to 56.43%. The 100WF cookie sample had the highest value while 80WF20CNF cookie sample had the lowest value. The carbohydrate content decreased with increase in cashew nut flour addition. The values obtained from this study are similar to those reported by Olagunju and Ifesan (2013) and Alobo (2001). This cookie can be recommended for those looking at low gluten snacks. The energy value of the cookies ranged from 426.13 to 4.55.92 kCal 100 g^{-1}, 80WF20CNF cookies having the highest value while 100WF cookie had the lowest value.

Table 4: Chemical composition of cookies prepared from wheat and defatted cashew nut flour blends

Parameters	100WF	95WF5CNF	90WF10CNF	85WF15CNF	80WF20CNF
Moisture (%)	12.01±0.01^{c}	12.39±0.01^{b}	12.60±0.02^{a}	12.40±0.01^{b}	12.62±0.02^{a}
Protein (%)	13.00±0.01^{e}	17.52±0.02^{d}	22.10±0.26^{c}	24.12±0.02^{a}	28.00±0.01^{a}
Fat (%)	16.49±0.01^{d}	21.06±0.05^{c}	22.49±0.01^{b}	22.93±0.06^{a}	22.96±0.03^{a}
Crude fibre (%)	0.10±0.00^{c}	0.50±0.02^{b}	1.52±0.05^{a}	1.51±0.01^{a}	1.63±0.03^{a}
Ash (%)	1.97±0.09^{a}	1.00±0.00^{c}	1.00±0.00^{c}	1.50±0.00^{b}	1.47±0.57^{b}
Carbohydrate (%)	56.43±0.02^{a}	47.53±0.02^{b}	40.49±0.27^{c}	37.54±0.00^{d}	34.32±0.29^{e}
Energy value (Kcal 100 g^{-1})	426.13±0.03^{c}	449.74±0.41^{b}	452.77±0.09^{a}	453.01±0.36^{a}	455.92±0.24^{a}
Calcium (mg/100 g)	43.10±0.50^{d}	66.41±0.10^{c}	85.55±0.32^{b}	103.11±0.38^{a}	107.78±0.37^{a}
Iron (mg/100 g)	2.03±0.93^{d}	2.85±0.04^{c}	3.52±0.03^{b}	3.63±0.03^{b}	3.85±0.07^{a}
Zinc (mg/100 g)	0.72±0.02^{e}	1.15±0.02^{d}	1.35±0.01^{c}	1.46±0.31^{b}	1.57±0.06^{a}
Magnesium (mg/100 g)	75.97±0.17^{e}	103.56±0.03^{d}	113.13±0.27^{c}	115.54±0.37^{b}	118.73±0.06^{a}
Phosphorus (mg/100 g)	240.65±0.53^{e}	300.54±0.30^{d}	315.48±0.85^{c}	319.57±0.9^{b}	322.63±0.19^{a}

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$).
100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour); 85WF15CNF
(85%wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour)

The mineral contents of the cookie samples such as calcium, iron, zinc, magnesium and phosphorus ranged from 43.10 to 107.78 mg/100 g, 2.03 to 3.85 mg/100 g, 0.72 to 1.57 mg/100 g, 75.97 to 115.73 mg/100 g and 240.65 to 322.63 mg/100 g respectively. There was a steady increase in the mineral elements for all the cookie samples as the level of cashew nut flour substitution increased.

Table 5: Sensory characteristics of cookies of cookies prepared from wheat and defatted cashew nut flour blends

Parameter	100WF	95WF5CNF	90WF10CNF	85WF15CNF	80WF20CNF
Taste	7.05^{a}±1.43	6.40^{c}±1.43	6.15^{b}±1.95	6.50^{b}±1.88	6.95^{a}±1.32
Texture	6.45^{c}±1.40	6.55^{b}±1.47	5.90^{d}±1.86	6.45^{c}±1.93	6.80^{a}±1.74
Aroma	7.10^{b}±1.48	6.60^{c}±1.40	6.70^{c}±1.59	6.05^{d}±1.76	7.40^{a}±1.43
Colour	7.45^{a}±0.69	7.20^{a}±0.83	7.40^{a}±1.23	7.40^{a}±1.47	7.45^{a}±1.10
Appearance	7.00^{c}±1.08	7.15^{c}±0.88	7.30^{b}±0.87	7.10^{c}±1.12	7.50^{a}±1.24
Overall acceptability	7.40^{a}±1.35	6.95^{b}±1.05	6.80^{c}±1.28	6.70^{d}±1.42	7.40^{a}±1.85

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$). 100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour); 85WF15CNF (85% wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour)

3.5 Sensory characteristics of cookies

The sensory characteristics of cookies made from composite blends are presented in Table 5. The sensory scores for taste ranged from 6.15 (90WF10CNF) to 7.05 (100WF). There was significant difference between the control sample (100WF) and other cookie sample except for 80WF20CNF cookie sample. It was established that the substitution of defatted cashew nut flour up to 20% conferred insignificant difference ($p>0.05$) in the taste of the cookies compared to the control. The texture score of the cookie samples ranged from 5.90 to 6.80. The 80WF20CNF cookie sample had the highest sensory score for taste (6.80) and significantly different from the control and the rest of the composite flour cookies. The sensory score for aroma of cookie samples ranged from 6.05 to 7.40. The 80WF20CNF cookie sample recorded the highest value (7.40) which translates to like slightly while 85WF15CNF recorded the lowest value (6.05) which translates to neither like nor dislike. Colour scores for the cookie samples ranged from 7.20 to 7.45. There was no significant difference ($p>0.5$) among the cookie sample. The appearance score for the cookie samples ranged from 7.00 to 7.50. The 80WF20CNF cookie sample had the highest score for appearance while the lowest score was recorded for 100WF cookie sample. The values obtained for overall acceptability ranged from 6.70 to 7.40. There was no significant difference between the control sample (100WF) and the 80WF20CNF cookie sample. The most accepted cookie sample by the panellist was the cookie made from blends of 80WF20CNF flour. This implies that substitution of wheat flour with defatted cashew nut flour up to 20% will have no adverse effect on the overall acceptability of cookies.

Table 6: Antioxidant properties of cookies prepared from wheat and defatted cashew nut flour blends

Antioxidant Properties	100WF	80WF20CNF
TPC (mgGAE/g sample)	1.57^{b}±0.05	2.83^{a}±0.03
DPPH (μmol TE/g sample)	35.00^{b}±2.21	68.77^{a}±0.33
FRAP (μmol TE/100 g sample)	100.29^{b}±1.41	423.55^{a}±0.30
ABTS (mg Trolox/g sample)	79.91^{b}±1.66	199.61^{a}±0.28

Values are mean ±standard deviation of duplicate determination. Mean in the same row with different superscript are significantly different ($p < 0.05$). 100WF (100% wheat flour); 95WF5CNF (95% wheat flour and 5% cashew nut flour); 90WF10CNF (90% wheat flour and 10% cashew nut flour); 85WF15CNF (85% wheat flour and cashew nut flour); 80WF20CNF (80% wheat flour and 20% cashew nut flour)

3.6 Antioxidant properties of cookies

The antioxidant properties of the control (100WF) and most accepted cookie sample (80WF20CNF) were determined in terms of total phenolic content, ferric reducing antioxidant power (FRAP), free radical scavenging activity using 1,1-dipenyly-2-picryl-hdrazil (DPPH) and 2,2-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid assay (ABTS). The value of total phenolic content of 100WF cookie sample was recorded as 1.57mgGAE/g sample while the 80WF20CNF cookie sample was 2.83mg GAE/g sample. Free radical scavenging power (DPPH) was 35.00 μmol TE/g sample for 100WF cookies and 68.77 μmol TE/g sample for 80WF20CNF; while FRAP was recorded as 100.29 μmol TE/100g sample for 100WF and 423.55 μmol TE/100g sample for 80WF20CNF. The value of the ABTS was recorded as 79.91 (mgTrolox/g sample) for 100WF and 199.61 (mgTrolox/g sample) for 80WF20CNF. The higher antioxidant activity in the latter may be attributed to the higher antioxidant content of the cashew nut flour compared to wheat flour. It could also be attributed to the formation of dark colour pigment during baking process as a result of Maillard reaction. Brown pigments could have antioxidant activity (Manzocco *et al.*, 2000; Xu *et al.*, 2008).

4.0 Conclusion

The addition of defatted cashew nut flour increased the protein, mineral and antioxidant properties of wheat-based cookies. Substitution of wheat flour with 20 % cashew nut flour is recommended for the production of acceptable and protein-enriched cookies with high antioxidant property.

References

AACC (2000). Approved Methods of the AACC International Methods 44-17, 76-13, 08-16, 32-40 and 35-05 (10th ed.), The Association of American Cereal Chemists, St. Paul, MN.

Adebowale, A.A., Sanni, L.O. and Onitilo, M.O. (2008). Chemical composition and pasting properties of tapioca grits from different cassava varieties and roasting methods. *African Journal of Food Science*, 2 (7): 077-082.

Adebowale, A.A., Adegoke, M.T., Sanni, S.A., Adegunwa, M. O. and Fetuga, G.O. (2012). Functional properties and biscuit making potentials of sorghum-wheat flour composite. *American Journal of Food Technology*, 7(6): 372-379

Adeoye, O., Akanbi, C.T. and Igene, J.O. (2018). Quality of cookies produced from blends of false yam (*Icacina tricachantha*) and wheat flours. *Nigerian Food Journal* 36 (1): 74-85

Akinhanmi, T.F., Atasie, V.N. and Akintokun, P.O. (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): 1-10.

Akubor, P.I. and Badifu, G.I. (2004). Chemical composition, functional properties and baking potential of African breadfruit kernel and wheat flour blends. *International Journal of Food Science and Technology*, 39 (2): 223-229.

Alimi, B.A. and Workneh, T.S. (2016). Consumer awareness and willingness to pay for safety of street foods in developing countries: A review. *International Journal of Consumer Studies*, 40 (2): 242-248.

Alobo, A.P. (2001). Effect of Sesame Seed flour on millet biscuit characteristics. *Plant Foods for Human Nutrition*, 56: 195-200.

Anozie, G.O., China, M.A. and Beleya, E.A. (2014). Sensory evaluation and proximate composition of snacks produced from composite flour of *Dioscorea alata* and *Telfaira occidentalis* seed flours. *Journal of Home Economic Research*, 20: 100-108.

AOAC (2000). Official methods of analysis of AOAC international (17thed.). Gaitherburg. AOAC International Inc., USA.

AOAC (2005). Official methods of analysis of AOAC International (17th ed.). Gaitherburg. AOAC International Inc., USA.

AOAC (2006). International Guidelines for Laboratories Performing Microbiological and Chemical Analyses of Food and Pharmaceuticals, Association of Official Analytical Chemists.

Apotiola, Z.O., and Fashakin, J.F. (2013). Evaluation of cookies from wheat flour, soybean flour and cocoyam flour blends. *Food Science and Quality Management*, 14: 17-21.

Aremu, M.O., Olonisakin, A., Bako, D.A. and Madu P.O. (2006). Compositional studies and physicochemical characteristics of cashew nut (Anacardium occidentale) flour. *Pakistan Journal of Nutrition*, 5 (4): 328-333.

Aroyeun S.O (2009). Utilization of cashew kernel meals in the nutritional enrichment of biscuit. *African Journal of Food Science*, 3 (10): 316-319

Awolu, O.O., Oluwaferanmi, P.M., Fafowora, O.I., and Oseyemi, G.F. (2015). Optimization of the extrusion process for the production of ready-to-eat snack from rice, cassava and kersting's groundnut composite flours. *LWT-Food Science and Technology*, 64(1): 18-24.

Awolu, O.O., Osemeke, R.O. and Ifesan, B.O.T. (2016). Antioxidant, functional and rheological properties of optimized composite flour, consisting wheat and amaranth seed, brewers' spent grain and apple pomace. *Journal of Food Science and Technology*, 53(2): 1151-1163.

Ayo, J.A., Ayo, V.A., Nkama, I., and Adewori, R. (2007). Physiochemical, in-vitro digestibility and organoleptic evaluation of. *Nigerian Food Journal*, 25(1): 77-89.

Bala, A., Gul, K. and Riar, C.S. (2015). Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. *Cogent Food and Agriculture*, 1(1): 1019815.

Beta, T., Nam, S., Dexter, J.E. and Sapirstein, H.D. (2005). Phenolic content and antioxidant activity of pearled wheat and roller-milled fractions. *Cereal Chemistry*, 82: 390-393.

Chinma, C.E., and Gernah, D.I. (2007). Physicochemical and sensory properties of cookies produced from cassava/soyabean/mango composite flours. *Journal of Food Technology*, 5 (3): 256-260.

Emelike, N.J.T., Barber, L.I. and Ebere, C.O. (2015). Proximate, mineral and functional properties of defatted and undefatted cashew (Anacardium occidentale Linn.) kernel flour. *European Journal of Food Science and Technology*, 3 (4): 11-19.

Hussein, H.M., Hussein, M.M. and El-Damohery, S.T. (2006). The effect of natural formulated functional biscuits on elderly bone health. *Journal of Medical Science*, 6: 937-943.

Kiin-Kabari, D.B. and Giami, S.Y. (2015). Physico chemical properties and in-vitro protein digestibility of non-wheat cookies prepared from plantain flour and bambara groundnut protein concentrate. *Journal of Food Research*, 4 (2): 78.

Manzocco, L., Calligaris, S., Mastrocola, D., Nicoli, M.C. and Lerici, C.R. (2000). Review of non-enzymatic browning and antioxidant capacity in processed foods. *Trends in Food Science and Technology*, 11 (9-10): 340-346.

Milson, T.S and Kirk, P.C (1980). Legumes in human nutrition. *Food and Agriculture Organisation Nutrition Studies*, 19: 223-235

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 (1): 19-28.

Ogunjobi, M.A.K. and Ogunwolu, S.O. (2010). Physicochemical and sensory properties of cassava flour biscuits supplemented with cashew apple powder. *Journal of Food Technology*, 8 (1): 24-29.

Olagunju, A.I. and Ifesan, B.O.T. (2013). Nutritional composition and acceptability of cookies made from wheat flour and germinated sesame (*Sesamum indicum*) flour blends. *Current Journal of Applied Science and Technology*, 3 (4): 702-713.

Olaoye, O.A, Lawrence, I.G. and Animasahun, A.K. (2018). Functional and pasting of flour blends from Wheat and bambara nut and their brad making potential. *Nigerian Food Journal*, 36 (1): 1-11

Omosuli, S.V., Ibrahim, T.A. and Oloye, D. (2009). Proximate and mineral composition of roasted and defatted cashew nut flour. *Pakistan Journal of Nutrition*, 8 (10): 1649-1651.

Onimawo, I.A. and Akubor, P.I. (2012). *Food Chemistry (Integrated approach with biochemical background)*. Agbowo, Ibadan, Nigeria: Joytal Printing Press.

Radley, M. (1976). The development of wheat grain in relation to endogenous growth substances. *Journal of Experimental Botany*, 27 (5): 1009-1021.

Ruthairat, B., Busaba, P. and Narong, S. (2011). Preparation of dry reconstituted liposomal powder by freeze-drying at room temperature. *Journal of Liposome Researches*, 21 (1): 28- 37.

Sanni, L.O., Adebowale, A.A., Filani, T.A., Oyewole, O.B. and Westby, A. (2006). Quality of flash and rotary dried fufu flour. *Journal of Food Agriculture and Environment*, 4: 74-78.

Takachi, R., Inoue, M., Ishihara, J., Kurahashi, N., Iwasaki, M., Sasazuki, S., Iso, H., Tsubono, Y., Tsugane, S. and JPHC Study Group, (2007). Fruit and vegetable intake and risk of total cancer and cardiovascular disease: Japan Public Health Center-Based Prospective Study. *American Journal of Epidemiology*, 167 (1): 59-70.

Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L. and Byrne, D.H., (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. *Journal of Food Composition and Analysis*, 19 (6/7): 669-675.

Xu, G., Liu, D., Chen, J., Ye, X., Ma, Y. and Shi, J. (2008). Juice components and antioxidant capacity of citrus varieties cultivated in China. *Food Chemistry*, 106 (2): 545-551.