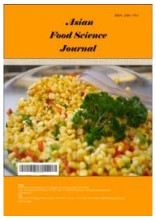

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Production and Quality Evaluation of Cookies from Wheat, Defatted Peanut and Avocado Composite Flour

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Authors' contributions

This work was carried out in collaboration among all authors. Author IAN designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Authors MTU and MOE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

In this study, carried out at Makurdi Nigeria, peanuts and avocado pulp were processed into flours and blended with refined wheat flour in proportions 100:0:0, 95:5:0, 90:5:5, 85:10:5, 80:10:10 and 75:15:10. The functional properties of the flour blends were determined. Cookies were made using the creaming method from these flour blends with one hundred per cent wheat flour serving as control. The physico-chemical and sensory properties of cookies from wheat/defatted peanut/avocado flour were determined using standard analytical methods. The functional properties of the flour blends increased with increasing substitution of wheat flour with defatted peanut flour and avocado flour. The enriched cookies were found to have higher protein, energy, vitamin and mineral content as compared to refined wheat cookies. The protein content increased from 15% in the control sample to 26.64% in the sample F which is the sample with the highest substitution of wheat flour. Magnesium content increased from 173.37 mg/100 g in the control sample to 221.36 mg/100 g in sample F. There was no significant difference in the dietary fibre

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content of the enriched cookies as compared to the control. Substitution with peanut flour and avocado flour did not alter the physical properties of the cookies. The sensory scores for all the cookies enriched with defatted peanuts flour and avocado flour were above average 4.5. Sample C, with 5% peanut flour and 5% avocado flour had the best sensory attributes among the supplemented cookies at 5% level of significance and compared favourably with the control cookies. Thus cookies made from wheat, defatted peanut and avocado composite flour at an optimal substitution level of 90;5;5 can be regarded as a suitable balanced meal.

Keywords: Cookies; defatted peanut flour; avocado flour; proximate composition.

1. INTRODUCTION

Cookies are baked foods made majorly from flour, sugar and fat. They are usually small, flat and sweet [1] and are highly enjoyed by people of all ages especially children. Cookies are one of the best known quick snack products [2]. Cookies are described as nutritive snacks produced from unpalatable dough that is transformed into an appetizing product through the application of heat in an oven [3]. They are popular examples of ready-to-eat snacks that possess several attractive features including wide consumption, more convenience, long shelf-life and the ability to serve as vehicles for important nutrients [4]. Cookies are generally made with low protein wheat flour (7-9%). The cookie dough has higher fat content. The fat coats the flour particles, and this inhibits the hydration of the proteins and the formation of a gluten web and hence the cookies have a short texture [5].

Wheat (*Triticum aestivum L.*) flour is the major raw material employed in many baking processes [6]. Flour used in making cookies is basically from wheat or composite flour (CF) which forms the basic ingredients of bakery products like bread, rolls, cakes, cookies and others [7]. The suitability of wheat in the production of many confectionary products is as a result of good intrinsic viscoelastic properties of the wheat protein. However wheat like other cereals is deficient in some essential amino acids like lysine, threonine and tryptophan and therefore needs to be complemented with legumes to boost the amino acid content. The cookies available in market are prepared from wheat flour which lacks good quality protein because of its deficiency in lysine and threonine and tryptophan. In order to increase the nutritional value of cookies as well as the other micronutrients and health-promoting phytochemicals, composite flours or fortified flour can be used [8].

Composite flours may be considered firstly as blends of wheat and other flours for the production of leavened breads, unleavened baked products, pastas, porridges and snack foods. Using blends, called composite flours of wheat and other flours for biscuit making has always occurred in times of scarcity of wheat, from climatic or economic causes.

Peanuts or groundnut (*Arachis hypogea*) like many other legumes has also been used for the protein-content improvement of wheat-based confectioneries. They are a good complement to wheat in composite flour production in order to boost its protein content. As a legume rich in essential amino acid lysine, peanuts are a good complement to wheat in composite flour production. According to [9], wheat/groundnut protein concentrate flour blends showed good functional and pasting properties indicating that the blends of wheat and peanuts can be used in the production of bread, cakes, biscuits, pancakes, and other baked products. Peanut flour is defatted in this study in order to limit the fat content of the cookies so as to prevent oxidative rancidity overtime. In addition, defatting peanut flour increases its protein content.

The avocado (*Persea americana*) is to be considered a ‘complete’ food as it provides in excess of 25 essential nutrients, including: Pro-vitamin A, vitamins B, D, C, E and K, iron, copper, phosphorus magnesium, and potassium. Avocados also provide protein; soluble fiber and beneficial phytochemicals such as beta-sitosterol, glutathione and lutein. Avocado’s high-fat content (13-24%) consists largely of the healthy monounsaturates, namely oleic acid and linoleic acid. Despite these beneficial properties of avocado, they are highly perishable and rot easily after ripening. Most of the avocados harvested therefore become wasted if not consumed immediately. Avocado is an energy fruit with high nutritional value and is considered as a major tropical fruit. Unlike other fruits, it is rich in protein and contains fat-soluble vitamins which are also lacking in other fruits. It contains different oil levels in the pulp, and it is particularly rich in heart-healthy monounsaturated fatty acids like oleic acid and linoleic acid [10]. In addition, this fruit has been recognizedas a super-food for its health benefits, especially due to the compounds present in the lipid fraction, such as omega fatty acids, phytosterols, tocopherols, and squalene [9,10]. Avocado flour (AF) therefore can also be used to improve the vitamin and dietary fiber content of wheat based cookies.

The incorporation of avocado flour in combination with wheat flour and defatted peanut flour (DPF) into cookies will enhance the dietary fiber and micronutrient content of the cookies and also help curb the post-harvest losses of avocado.

2. MATERIALS AND METHODS

2.1 Procurement of Raw Materials

Dangote wheat flour, dried peanuts and unripen avocado pears were purchased from Wadata market Makurdi, Nigeria. Other ingredients such as skimmed milk, margarine, granulated refined sugar, and flavoring agents were purchased from Sudoo pee supermarket, Makurdi, Nigeria. All reagents used were of analytical grad. Blank samples were prepared along with other samples and used to correct measured samples.

2.2 Preparation of Flour

Dried peanuts (*Arachis hypogea*) were first sorted to remove extraneous materials. The nuts were toasted in an oven at 150°C for 30 min and allowed to cool to room temperature. Heat treatment applied to legumes improves their texture, palatability and nutritive value by the gelatinization of starch, denaturation of proteins, increased nutrient availability and inactivation of heat labile toxic compounds and other enzyme inhibitors [11]. They were then skinned, milled and defatted using a soxhlet solvent extractor and the resulting cake was desolventised by toasting in an oven, pulverized and sieved to obtain a fine powder almost void of fats and rich in protein called defatted peanut flour.

Unripen avocado pears (*Persea americana*) were kept for a few days to ripen. The ripe pears were peeled and the flesh was sliced thinly and oven dried at 60° for 36 h. The dehydrated avocado chips were then be blended using a kitchen blender and the resulting powder sieved to obtain fine avocado flour.

2.3 Preparation of Composite Flour Blends

Composite flour was prepared from Wheat flour (WF), defatted peanut flour (DPF) and avocado flour (AF) at different levels (Table 1). Cookies were prepared according to the method described previously [12] as indicated in Table 2.

Table 1. Composition of flour blends

Samples	Wheat: peanuts: avocado flour ratio
A	100:0:0
B	95:5:0
C	90:5:5
D	85:10:5
E	80:10:10
F	75:15:10

Table 2. Recipe for the formulation of cookies from wheat defatted peanut and avocado flour blends

Component	Cookies composition
Flour (g)	100
Margarine (g)	30
Sugar (g)	30
Milk (g)	10
Flavoring agent (g)	1
Salt (g)	1
Water (mL)	10

2.4 Methods

The cookies were preparedusing the recipe shown in Table 2. by creaming method. Hydrogenated fat and sugar were creamedusing a Kenwood mixer (United Kingdom) for 2 min to a uniform consistency. The flour, required amount of water (about 10 mL), salt and flavoring agent were added to creamed mixture and kneaded for 10 min to obtain homogeneous dough. The dough was rolled out into a sheet of uniform thickness (about half inch) and was cut into desired shape using a cookie cutter. The cut pieces were placed on a baking tray and transferred into a baking oven at 180°C for 25 min till baked. The well baked cookies were removed from the oven, placed on a clean rack to cool to room temperature, packaged in polythene bags and stored at room temperature for further analyses.

2.5 Analytical Methods

2.5.1 Functional properties of flour blends analysis

i. Bulk density

The bulk density of the flour samples were determined by the method described by Onwuka [13] by weighing 50 g of the sample into 100 mL graduated cylinder, then, gently tapping the bottom several times on a laboratory bench, until no further diminution of the sample level. The final volume was expressed as g/mL [13]

$$\text{Bulk density } (^{\text{g}}/_{\text{mL}}) = \frac{\text{weight of sample (g)}}{\text{volume of sample (mL)}} \quad (1)$$

ii. Water absorption capacity/oil absorption capacity

The AOAC method was used, [14]. One gram of flour was weighed into a graduated conical flask and 10 mL of water or oil was added to the weighed sample and mixed well. The sample was allowed to stand at room temperature for 30 min and then centrifuged at 5000 rpm for 30 min. The supernatant was carefully decanted and measured to know the volume of the free water or oil. The absorption capacity was expressed as grams of oil or water absorbed per gram of sample or in percentage. Calculation: Water absorption capacity of the sample was calculated as:

$$WAC\left(\frac{g}{g}\right) = (V_1 - V_2) \times \text{density of water (1g/mL)} \quad (2)$$

Where V_1=initial volume of distilled water added, V_2= volume of supernatant decanted

iii. Gelatinization temperature

This was done according to the procedure given in [15]. One gram of each sample was suspended in test tubes; 10 mL of water will be added. The sample was heated slowly in a boiling water bath with continuous stirring, until it formed a gel and 30 sec after gelatinization was visually noticed, the temperature of the samples were taken as the gelatinization temperature.

iv. Wettability

The AOAC [14] method was used. The samples were weighed and in each case, 1 g was introduced into 25 mL graduated measuring cylinder with a diameter of 1 cm and a stopper was placed over the open end of the cylinder. The mixture was then inverted and clamped at a height of 10 cm from the surface of a 600 mL beaker containing 500 mL of distilled water. The finger was removed to allow the test sample to be dumped. The wettability was taken as the time required for the sample to become completely wet.

v. Foam capacity

Foaming capacity and stability of the powdered (flour) samples was studied according to [15] method. Two grams of the samples were weighed from each of the sample and blended with 100 mL of distilled water using warring blender (mixer) and the suspension was whipped at 1600 rpm (revolution per min) for 5 min. The mixture was then poured into a 100 mL measuring cylinder and its volume was recorded after 30 sec.

$$\text{Foam capacity(\%)} = \frac{\text{V2} - \text{V1}}{\text{V1}} \times 100 \quad (3)$$

Where V1=volume of foam before whipping, V2= volume of foam after whipping

vi. Swelling index

Three grams of each of the sample was transferred into clean, graduated (50 mL) cylinder and the volume noted. Distilled water (30 mL) was added to the flour sample; the cylinder was swirled and allowed to stand for 60 min while change in volume (swelling) was recorded every 15 min. The swelling power of the sample was calculated as a multiple of the original volume as described by [15].

2.5.2 Anti-nutritional factors in flour samples and cookies

i. Phytates

The phytic acid content was estimated using the Yong and Greaves method as described in [12,16]. 0.2 g of the sample was weighed into 250 mL conical flask. It was soaked in 100,0 mL of 20% hydrochloric acid (HCl) for 3 h, the sample was then filtered. 50,00 mL of the filtrate was placed in a 250 mL beaker and 100,0 mL distilled water added to the sample. Then 10, 00 mL of 0.3% ammonium thiocyanate solution was added as indicator and titrated with standard iron (III) chloride solution which contained 0.00195 g iron per 1 mL.

Calculation:

$$\text{Phytates} = \frac{\text{Titre value} \times 0{,}00195 \times 1.19 \times 100}{2} \quad (4)$$

ii. Saponins

Saponins determination was done using the method described by [12]. 5 g of the sample was put into 20% acetic acid in ethanol and allowed to stand in water bath at 50°C for 24 h. This was filtered and the extract was concentrated using a water bath to one-quarter of the original volume. Concentrated NH_4OH was added drop-wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitate was collected by filtration and weighed. The saponin content was weighed and calculated in percentage of sample analyzed.

$$\%\ \text{Saponin content} = \frac{(\text{weight of filter paper+residue}) - \text{weight of filter paper}}{\text{weight of sample analysed}} \times 100 \quad (5)$$

iii. Trypsin inhibition activity

Trypsin inhibition activity was determined according to the modified procedure of [12]. 0.5 g of sample was extracted with 50, 00 mL of distilled water for 30 min with mechanical shaking at a speed of 200 rpm. 10 mL of the sample suspension was then destabilized by adding an equal volume of assay buffer and vigorously shaking for 2-3 min before filtering through a Whatman No.2 filter paper. The filtrate was then further diluted with water to the point where 1 mL gave 30- 79% trypsin inhibitor. This was done to keep the relative standard deviation (RSD) of trypsin inhibitor activity (TIA) measured within ± 3.5%. A suitable final concentration of the sample was around 0.1 mg of the sample per ml (0.1 mg sample/mL diluted extract), and for heated sample, it is 0.5-1.5 mg/mL. Procedure: The reaction was run at 37°C. Exactly 10 min after adding the trypsin solution, the reaction was stopped by injecting 0.5 mL of 30% acetic acid solution with 1 mL syringe. The absorbance A^S410 nm (Sample reading), was a measure of the trypsin activity in the presence of the sample inhibitors. The reaction was also run in the absence of inhibitors by replacing the sample with 1 ml of water. The corresponding absorbance was symbolized as A^r410 nm (reference reading). Distilled water was then used as a blank. Calculation: Defining a trypsin unit as an A^s410 increase of 0.01 under the conditions of the assay, the trypsin inhibitory activity is expressed in Trypsin units inhibited (TUI) per milligram of the sample and calculated as follows:

$$\text{TUI/mg sample} = \frac{(A^r_{410} - A^s_{410}) * 100\text{mL diluted extract}}{\text{mg sample per mLdiluted extract}} \quad (6)$$

This Trypsin Inhibitory Activity expressed in terms of trypsin units inhibited (TUI) is a measure of the amount of trypsin inhibitor present in any given sample.

iv. Tannin content

This was determined according to the method described by [12]. To 20 g of the crushed sample in a conical flask was added 100 mL of petroleum ether and covered for 24 h. The sample was then filtered and allowed to stand for 15 min so that the petroleum ether evaporated. It was re-extracted by soaking in 100 mL of 10% acetic acid in ethanol for 4 h. The sample was then filtered and the filtrate collected. 25 mL of NH_4OH were added to the filtrate to precipitate the alkaloids. The alkaloids were heated with electric hot plate to remove some NH_4OH still in solution. The remaining volume was measured. 5 mL of this volume was taken and 20 mL of ethanol was added to it. It was titrated with O.IM NaOH using phenolphthalein as indicator until pink end point is reached. Tannin content was then calculated in percentage (C1V1 = C2V2) molarity of the sample analyzed.

Calculation: C1V1 = C2V2

$$\%\ \text{Tannic acid} = \frac{\text{C1} \times 100}{\text{weight of sample analysed}} \quad (7)$$

Where C1 = Conc. Of Tannic acid, C2 = Conc. Of Base, V1 = volume of Tannic acid, V2 = volume of Base used.

2.5.3 Physical characteristics, proximate, and mineral composition

Physical characteristics, proximate, mineral and vitamin composition where carried out according to standard method described by AOAC [14]. The weight of the cookies was taken using an analytical balance, the diameter and thickness were measured using Vernier calipers and the spread ratio was calculated using the equation:

$$\text{spread ratio} = \frac{\text{diameter}}{\text{thickness}} \quad (8)$$

Moisture content was determined by oven-drying method, fat content by soxhlet extraction, ash content by dry ashing, protein content by Kjeldhal method and carbohydrate content was calculated by difference. Analyses of potassium content of the samples was carried out using flame photometry, phosphorus was determined by phosphor-vanado-molybdate method, while the other elements(Mg, Ca, Cu, Zn) were determined after wet digestion of sample ash with an atomic absorption spectrophotometer (AAS, Hitachi Z6100, Tokyo, Japan).

2.6 Sensory Evaluation of Cookies

The basic sensory characteristics considered were, appearance, taste, aroma, crispness and general acceptability as described by [17]. Semi trained panels consisting of both genders 20 judges of different age groups having different eating habits were constituted to evaluate the quality. Samples were served to the panelists in white plates who were asked to rate the acceptability of the product through sense of organs. The cookies were rated on a 9- point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like).

2.7 Statistical Analyses

All analyses were done in triplicates and results were expressed as mean ± standard deviation (SD). The data obtained from the various experiments were recorded during the study and were subjected to Analysis of Variance (ANOVA). Statistical package for social science (SPSS) V21 computer software was used to analyze the data. The significant difference between the means was tested against the critical difference at 5 % level of significance. Separation of means was carried out using Fischer's LSD test.

3. RESULTS AND DISCUSSION

3.1 Functional Properties of Flour Blends

The results obtained from the functional properties of the wheat, defatted peanuts and avocado composite flour blends are shown in Table 3. Sample F had the highest bulk density of 0.616 g/mL while sample E had the lowest 0.534 g/mL. The highest water absorption capacity was observed in sample F, 1.4 g/g while sample A had the lowest 0.98 g/g. The control sample A had the lowest wettability of 31 sec while sample A and F had the highest 57 sec. The control sample A had a significantly higher foam capacity 26.19% than the other samples which ranged from 4.76% to 5.77%. The swelling index was highest in sample D, 25.15 mL and lowest in sample F 17.14 mL. The control sample A had the lowest gelatinization temperature 84°C while sample E had the highest 95°C. Similar results were obtained by [13] who reported that bulk density increased with increasing substitution of wheat flour.

3.2 Anti-Nutritional Properties of Flour Blends and Cookies

The major anti-nutritional factors: Trypsin Inhibitor, tannins, saponins and phytates, were analysed both in the flours and the corresponding cookies and the results are presented in Table 4. The phytate levels in the cookies ranged from 1.16×10^{-4} to 1.16×10^{-3} mg/100 g. These levels are lower than those observed in the corresponding flour blends and are lower than those reported by [18]. The tannin levels in both the flour and cookies samples increased with increasing addition of avocado flour. Saponins levels reduced significantly in cookies from corresponding flour samples. The presence of tannins in the cookies is probably the cause of the bitter taste in some of the cookies. Trypsin inhibition activity values ranged from 1.2 to 2.52 mg/kg, with sample B flour alone having the lowest value. And sample A having the highest. It was observed that anti-nutrient (apart from trypsin inhibitors) levels increased for all substituted samples when compared with the control sample in both flours and cookies at 5% level of significance. However corresponding levels in cookies were significantly lower than in flours due to processing. Previous researchers [19] have reported a similar trend in Trypsin inhibition activity for potato flour supplemented with soybean flour.

Table 3. Functional properties of wheat defatted peanut and avocado flour blends

Flour sample	Bulk density (g/cm^3)	W.A.C (g/g)	Swelling index (%)	Gelatinization temperature (°C)	Foaming capacity (%)	Wettability (sec)
A	0.59±0.00^b	0.98±0.03^a	19.40±0.00^b	84.00±0.50^a	26.19±0.48^d	36.00±1^a
B	0.56±0.02^a	1.33±0.03^d	30.60±0.00^e	88.50±0.50^b	5.24±0.47^{ab}	41.50±0.5^b
C	0.58±0.01^b	1.10±0.00^b	22.90±1.70^c	88.00±0.00^b	7.28±0.49^c	42.00±0.00^b
D	0.55±0.01^a	1.18±0.03^c	24.00±0.00^d	93.00±0.00^d	4.76±0.00^a	51.50±1.50^c
E	0.53±0.01^a	1.10±0.00^b	25.15±0.85^d	95.00±0.00^e	5.77±0.00^b	57.00±0.00^d
F	0.61±0.01^c	1.40±0.00^e	17.14±0.16^a	91.00±0.00^c	5.77±0.00^b	57.00±0.00^d
LSD	0.03	0.04	1.86	0.67	0.79	1.79

Values with the same superscript in the same column are not significantly (P≤<0.05) different. Values are means ± standard deviations of triplicate determinations

Key: LSD = least significant difference

A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

Table 4. Anti-nutritional properties of flour blends and cookies

Sample code	Sample type	Tannins (mg/100 g)	Saponins (mg/100 g)	Trypsin inhibitors (mg/Kg)	Phytates (mg/100 g)
A	Flour	0.33 ± 0.21	0.45 ± 0..01	2.52± 0.11	0.0284 ± 0.02
	Cookies	0.19 ± 0.01^a	0.032 ± 0.002^e	ND	0.00116 ± 0^a
B	Flour	1.26 ± 0.34	0.53 ± 0.03	1.12 ± 0.00	0.03849 ± 0.01
	Cookies	0.47 ± 0.01^d	0.032± 0.002^e	ND	ND
C	Flour	1.26 ± 0.34	0.64 ± 0.01	1.35 ± 0.13	0.02115 ± 0.02
	Cookies	0.47 ± 0.01^d	0.024 ± 0.002^b	ND	0.00116 ± 0^a
D	Flour	1.05 ± 0.01	0.27 ± 0.03	1.64 ± 0.13	0.03201 ± 0.01
	Cookies	0.37 ± 0.03^c	0.03 ± 0.002^d	ND	0.00116± 0^a
E	Flour	0.87 ± 0.02	0.65 ± 0.11	1.87 ± 0.06	0.002546± 0.13
	Cookies	0.4 ± 0.00^c	0.26 ± 0.002^c	ND	0.000116 ± 0^a
F	Flour	0.97 ± 0.01	0.53 ± 0.01	2.72± 0.08	0.02715 ± 0.21
	Cookies	0.36 ± 0.02^b	0.021 ± 0.001^a	ND	0.00116 ± 0^a

Values with the same superscript in the same column are not significantly (P<≤0.05) different. Values are means ± standard deviations of triplicatedeterminations

Key: LSD = least significant difference

A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

3.3 Physical Properties of Cookies Produced from Wheat, Defatted Peanut and Avocado Flour Blends

Results for physical properties of the cookies are presented in Table 5. There was no significant difference observed in the weight of the cookies from the different flour blends at p ≥ 0.05. The cookie diameter ranged from 4.20 cm in sample A control to 4.24 cm in sample F with no significant difference observed. The thickness of the cookies ranged from 1.30 cm for sample (C) to 1.75 cm; cookie sample (B). The spread ratio was found to increase with increasing substitution of wheat with defatted peanut flour and avocado flour. The spread ratio ranged from 2.48 to 3.15 with Sample 100% wheat having the least spread ratio. The increased spread ratio observed in defatted peanut flour and avocado flour substituted cookie samples was due to the difference in the particle sizes [20]. Also, high fat cookies tend to spread more. The spread factor is an indicator of biscuit and cookie quality. It is considered as one of the most important quality parameters of biscuits.

3.4 Proximate Composition of Cookies Produced from Wheat, Defatted Peanut and Avocado Flour Blends

The proximate composition obtained for the flour blends and cookies is presented in Table 6. The moisture content of the flour blends ranged from 9.98% sample F to 11.44% sample (A), with no significant difference between them at $p<0.05$. How ever there was significant difference in moisture content of the cookies with sample D having the highest moisture content of 12.8% and sample F having the lowest moisture content of 5.3%. The crude protein content increased steadily in both flour blends and cookies with increasing substitution of wheat flour with defatted peanut flour and avocado flour. Protein content in cookies ranged from 15% in sample A to 26.64% in sample F. A similar trend was seen in flour blends with 9.16% in sample A and 14.7% in sample F. These results are in agreement with those found in previous studies carried out and reported in [7]. This could be a result of the addition of protein rich defatted peanut flour. The fat content of flour blends ranged from 0.84% sample A to 7.9% in sample F. In the cookie samples fat content ranged from 9.95% to 20.5% with sample A having the lowest fat content and sample F having the highest again .This in in agreement with previous similar works carried out by [11] and also by [21]. The increase in fat content is obviously due to the addition of lipid-rich avocado flour. The fibre content in flour blend ranged from 0.62 to 3.08%. There was no significant difference in fibre content of the cookie samples. The ash content of flour blends ranged from 0.57% sample A to 1.5% sample F. On the contrary in cookies samples sample F had the lowest ash content of 1.23% and sample B had the highest ash content of 1.78%. The total carbohydrate content reduced progressively in both flour blends and cookie samples with increasing substitution of wheat flour with defatted peanut flour and avocado flour. In the flour blends sample A had the highest carbohydrate content of 77.8% while sample F had the lowest 63,76%. The same trends is seen in cookies samples with sample A having 66.7% and sample F having the lowest carbohydrate content of 46.2%. These findings agree strongly with previous works carried out by [7] and which confirm that the carbohydrate content of the cookies reduce as the protein content increase due to the increasing proportions of defatted peanut flour. In the flour blends sample B had the lowest total calorific value of 353.64 kcal/100 g. While sample F had the highest 382.51 kcal/100 g. Similarly in cookie samples sample F had the highest total calorific value 475.47 kcal/100 g while sample D recorded the lowest 414.38 kcal/100 g. This is highly desired especially in famine and war-torn locations were the next meal is not easy to come by High-energy foods tend to have a protective effect in the optimal utilization of other nutrients [22].

3.5 Mineral Composition of Cookies Produced from Wheat, Defatted Peanut and Avocado Flour Blends

The phosphorus content of the cookies as shown in Table 7 increased with increasing substitution of wheat flour with defatted peanut flour and avocado flour. Sample 100% wheat flour had the least phosphorous content of 176.37 mg/100 g and sample F had the highest phosphorus content of 221.36 mg/100 g. The zinc content of the cookies also increased from 6.36 mg/100 g in sample A to 9.95 mg/100 g in Sample F. Zinc is important for protein synthesis and growth. The same increasing trend was observed in potassium content with sample A having the lowest value 698.69 mg/100 ml and sample F having the highest value 925.18 mg/100 g. Magnesium content results recorded the same trend with sample. A having the lowest value 78.55 mg/100 g and sample F having the highest value 98.88 mg/100 g. The results for calcium content also showed an increasing trend with ranging from 198.66 mg/100 g for sample A to 263.36 mg/100 g in sample F. Similarly copper content ranged from 1.05 mg/100 g in sample A to 1.35 mg/100 g in sample F. Similarly copper content increased steadily from sample A sample F. These increasing trends in mineral content are in agreement with previous findings [23] in research works.

Table 5. Physical properties of cookies produced from wheat, defatted peanut and avocado flour blends

Sample	Weight (g)	Diameter (cm)	Thickness (cm)	Spread Ratio
A	14.3±1.43[a]	4.20±0.20[a]	1.70±0.12[bc]	2.48±0.25[a]
B	13.0±0.64[a]	4.06±0.20[a]	1.75±0.18[c]	2.34±0.14[a]
C	12.5±0.84[a]	4.09±0.10[a]	1.30±0.04[a]	3.15±0.08[c]
D	13.7±0.91[a]	4.20±0.05[a]	1.53±0.66[b]	2.74±0.13[b]
E	14.1±1.06[a]	4.20±0.04[a]	1.52±0.08[b]	2,76±0.29[b]
F	13.9±0.69[a]	4.24±0.05[a]	1.46±0.04[a]	2.90±0.04[b]
LSD	5.83	0.83	0.21	0.26

Values with the same superscript in the same column are not significantly (P≤0.05) different. Values are means ± standard deviations of triplicate determinations
Key; LSD = least significant difference
A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

Table 6. Proximate Composition of Cookies Made from Wheat, Defatted Peanut and Avocado composite flour

Cookie samples	Moisture (%)	Protein (%)	Fats (%)	Fiber (%)	Ash (%)	Total carbohydrate (%)	Total calorific value (kCal)
A	6.67±0.41[b]	15.00±0.29[a]	9.95±2.04[a]	0.12±0.07[a]	1.53±0.04[b]	66.74±2.27[f]	416.47±0.22[a]
B	8.4±4.65[c]	21.76±0.03[b]	13.45±1.45[a]	0.13±0.02[a]	1.40±0.04[a]	54.92±6.00[e]	427.88±11.05[a]
C	10.96±2.94[e]	22.57±0.21[c]	13.96±0.31[a]	0.22±0.16[a]	1.78±0.07[b]	50.59±3.12[d]	417.91±10.54[a]
D	12.79±9.3[f]	23.23±0.04[d]	13.85±3.00[a]	0.08±0.01[a]	0.85±0.26[a]	49.19±12.08[c]	414.38±21.14[a]
E	10.76±5.9[d]	24.12±0.00[e]	16.20±0.31[a]	0.17±0.01[a]	0.70±0.51[a]	48.05±6.72[b]	434.49±24.20[a]
F	5.3±1.98[a]	26.64±0.00[f]	20.45±5.87[a]	0.18±0.01a	1.23±0.14[a]	46.20±3.73[a]	475.47±37.94[a]
LSD	0	0.29	25.77	0.67	0.83	1.31	191.72

Values with the same superscript in the same column are not significantly (P≤0.05) different. Values are means ± standard deviations of triplicate determinations
Key; LSD = least significant difference
A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

Table 7. Mineral composition of cookies produced from wheat, defatted peanut and avocado flour blends

Cookies sample	P (mg/100 g)	Zn (mg/100 g)	K (mg/100 g)	Mg (mg/100 g)	Ca (mg/100 g)	Cu (mg/100 g)
A	176.37±0.02^{a}	6,36±0.01^{a}	698.69±0.02^{a}	78.55±0.00^{a}	198.66±0.01a	1.05±0.00^{a}
B	184.15±0.01^{b}	7.13±0.02^{b}	745.27±0.02^{b}	81.28±0.00^{b}	204.54±0.02^{b}	1.15±0.00^{b}
C	188.95±0.00^{c}	7.43±0.01^{c}	811.13±0.01^{c}	83.50±0.00^{c}	277.69±0.01^{c}	1.16±0.01^{b}
D	197.16±0.01^{d}	9.15±0.00^{d}	836.63±0.01^{d}	94.16±0.01^{d}	241.02±0.01^{d}	1.19±0.02^{c}
E	208.54±0.02^{e}	9.86±0.02^{e}	878.88±0.01^{e}	98.76±0.01^{e}	251.30±0.01^{e}	1.25±0.00^{d}
F	221.36±0.01^{f}	9.95±0.00^{f}	925.18±0.01^{f}	98.88±0.02f	263.36±0.01^{f}	1.35±0.01^{e}
LSD	0.03	0.02	0.02	0.02	0.02	0.02

Values with the same superscript in the same column are not significantly (P≤0.05) different. Values are means ± standard deviations of triplicate determinations
Key: LSD = least significant difference
A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

Table 8. Sensory attributes of cookies produced from wheat, defatted peanut and avocado flour blends

Sample	Appearance	Aroma	Taste	Crispness	General acceptability
A	7.10±0.99^{b}	7.46±0.96^{b}	7.20±0.74^{c}	7.40±0.80^{a}	7.25±0.99^{c}
B	7.05±1.24^{b}	7.15±1.23^{b}	7.50±o.97^{c}	7.56±0.92^{a}	7.77±1.18^{c}
C	7.20±1.12^{b}	6.75±0.94^{b}	5.90±1.33^{b}	7.25±1.73^{a}	6.80±1.02^{bc}
D	6.50±0.74^{a}	6.50±1.07^{a}	5.86±1.32^{b}	7.00±0..94^{a}	6.40±0.91^{b}
E	6.45±0.92^{a}	6.25±1.17^{a}	4.90±1.22^{a}	7.15±0.96^{a}	6.00±0.77^{a}
F	6.00±1.26^{a}	6.00±1.09^{a}	5.10±1.20^{a}	7..00±0.77^{a}	5.50±1.00^{a}
LSD	0.74	0.71	0.66	1.82	0.57

Values with the same superscript in the same column are not significantly (P≤0.05) different. Values are means ± standard deviations of triplicate determinations
Key: LSD = least significant difference
A= (control) 100%b wheat flour. B =95% wheat flour 5% defatted peanut flour .C=90% wheat flour 5% defatted peanut flour, 5% avocado flour D =85% wheat flour 10% defatted peanut flour 5% avocado flour E= 80% wheat flour 10% defatted peanut flour 10 %avocado flour F=75 %wheat flour 15% defatted peanut flour 10 %avocado flour

3.6 Sensory Attributes of Cookies Produced from Wheat, Defatted Peanut and Avocado Flour Blends

Table 8 summarizes the results for the sensory properties and overall acceptability of the different cookie samples. The statistical analysis revealed that there were significant differences at (P≤0.05) among the cookie samples in the sensory attributes observed. All the cookies had scores above average for appearance with sample A (control) having the highest score 7.10 and sample F having the lowest score 6.00.The cookies became progressively darker with increasing substitution.

Browning in the cookie samples could have been due to Millard-type reactions [24] resulting from the presence of reducing sugars, proteins and amino acids and caramelization due to the effect of severe heating during processing. These finding were in agreement with those observed by [25]. The scores for aroma of the cookies ranged from 6.0 in sample F to 7.4 samples A (control). The score for taste showed that sample B was most liked scoring 7.5 and sample E was least liked scoring 4.9.Some panellist complained of a slightly bitter taste in samples E and F. similar results were reported by [26]. This could be attributed to the bitter taste and off flavours produced in avocado when heated. No significant difference was found in the scores for crispness among the cookies at 5% level of significance and all the samples showed scores above 7. The scores for general acceptability was all above average with sample

B scoring highest 7.7 and sample F scoring lowest 5.5. The baking conditions (temperature and time variables); the state of the cookie constituents, such as fibre, starch, protein (gluten) weather damaged or undamaged and the amounts of absorbed water during dough mixing, will all contribute to the final outcome of the overall acceptability [27].

4. CONCLUSION

The study established that it is possible to produce nutritious cookies from a combination of wheat, defatted peanuts and avocado flours. The functional properties of the flour blends increased with increasing substitution of wheat flour with defatted peanut flour and avocado flour. Pasting properties on the other hand decreased with increasing substitution when compared with wheat flour which is the conventional flour used for cookie production. Enriched cookies with defatted peanut flour and avocado flour substitutions were found to have higher protein, energy, vitamin and mineral content as compared to wheat flour cookies. Thus, the enriched cookies can conveniently be regarded as a balanced whole meal. Therefore these cookies would contribute substantially to the recommended dietary requirements for proteins, mineral and vitamins. Cookies produced from wheat defatted peanuts and avocado composite flours were shown to be generally liked as they all showed sensory attributes above average and therefore can be enjoyed by people of all ages just like cookies produced from just wheat flour. Of course the control sample with 100% wheat flour showed the best sensory attributes. However among the sample substituted with defatted peanut flour and avocado flour, Sample C cookies supplemented with 5% peanut flour and 5% avocado flour had the best sensory attributes and compared favourably with the control (100% wheat flour).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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