Production, Nutritional Evaluation and Acceptability of Cookies Made from a Blend of Wheat, African Walnut, and Carrot Flours

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Authors' contributions

This work was carried out in collaboration among all authors. Author DBKK supervised the whole investigation and designed the protocol for interpretation of the results. Author MCU performed the experiment and wrote the first draft of the manuscript assisted by authors DBKK and OMA. All authors read and approved the final manuscript.

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ABSTRACT

Cookies were developed from composite flour of wheat, African Walnut and Carrot. The wheat flour was substituted at levels of 5%, 10%, 15%, & 20% with African Walnut flour for samples, B, C, D and E, respectively, and with 5% of Carrot flour. The moisture content of the cookies reduced with increase in substitution with walnut flour and carrot flour but there was no significant difference (p>0.05) in the values obtained. The ash content and protein content of the cookies also increased with increased substitution whereas fat content of the substituted cookies samples increased and significantly differed (p< 0.05) from the control. The physical attributes are as follows:11.28 g - 13.09 g for Weight, 45.80 mm - 52.68 mm for Diameter, 6.85 mm - 9.45 mm for thickness, and 5.12 - 7.44 for spread ratio. The values of the Minerals obtained are 29.38 mg/100 g – 50.46 mg/100 g, 3.75 mg/100 g – 11.36 mg/100 g, 14.11 mg/100 g – 15.47 mg/100 g and 49.20 mg/100 g – 58.90 mg/100 g for Calcium, iron, Sodium, and Potassium, respectively. The Bioavailability was highest in sodium(57.07%-84.86%), and potassium(69.55% - 72.31%).The highest values for Vitamin C (13.85 mg/100 g), Vitamin E (0.90), and Invitro protein digestibility (59.64%) were recorded in

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sample E while the highest Carotenoids (257.40 mg/100 g) was observed in sample C. Sensory evaluation confirmed that there was no significant difference (p>0.05) between Samples A (control sample) and the substituted samples in terms of appearance, taste and aroma, and although sample A had highest overall general acceptability value, the samples produced compared favorably with the control.

1. INTRODUCTION

Cookies (soft type biscuits) are widely consumed in many developing countries [1]. They are usually affordable and consumed by all age groups. In many parts of Sub-Sahara Africa and most especially Nigeria, advancing prosperity and urbanization coupled with tremendous increase in population in recent years have led to an increase in the consumption of wheat-based products especially biscuits and bread [2]. Hence, a great need to harness our native agricultural product and diversify their uses to support this increasing population and the economy at large. African walnut flour can present an alternative means of diversifying the use of non-wheat flour by adding value to products, extend marketing, support food diversification and security and reduce wheat importation. Research has indicated that walnut has anticancer activities [3]. Compared to certain other nuts such as almonds, peanuts, and hazelnuts, walnuts, especially in their raw form, contain the highest total level of antioxidants, including both free antioxidants and antioxidants bound to fiber [4]. The antioxidant properties of walnut help lower the risk of chronic oxidative stress. Studies indicated that the risk of prostate and breast cancer are reduced by walnut intake (Pharmanews, 2016). It has been demonstrated that walnuts, when consumed as part of a low fat, low-cholesterol diet, have a beneficial effect on serum cardiovascular risk factor [5]. Treatment of prolonged and constant hiccups with leaf juice of the nut was reported by Oyenuga [6]. Carrot was incorporated into this work, to enrich the cookies because it contains high beta carotene which has lot of health benefits. Carotenoids, polyphenols and vitamins present in carrot act as antioxidants, anticarcinogens, and immune-enhancers. Carotenoids widely distributed in orange carrots are potent antioxidants which can neutralize the effect of free radicals [7]. Carrot also contains oxycarotenoids such as leutin, which has been shown to be protective against colon cancer in man and woman (Jonas, 2011). Intake of dietary carotenoids supplies the body with vitamin A which aids in vision, and maintenance of normal function of the immune system, normal skin and mucosal membrane [8]. The work of Patil et al., [9] provided the scientific evidence to the ethanomedicinal properties of carrot in wound healing activity. Therefore, the study aimed at producing cookies from a blend of wheat, Walnut and Carrot flour.

2. MATERIALS AND METHODS

2.1 Materials

Carrot and African walnut and wheat flour were purchased from Mile 1 market, Port Harcourt, Rivers State, Nigeria. Other ingredient for the work (fat, sugar, egg, salt, flavorings) was also purchased from the same market. The chemicals were obtained from the laboratory of Food Science and Technology, Rivers State University, Nigeria.

2.2 Methods

2.2.1 Production of carrot flour

The carrot was prepared into carrot flour using the method described by Marvin [10]. The carrot fruit was properly washed, scraped and sliced for easy drying. Water of about 95^0C, containing 0.1% sodium metabisulphite was used for blanching for about 3 minutes, this is to prevent browning and discoloration. The sulphited carrot was immediately cooled by exposing it to air and dried in a cabinet drier at 50^oC for 12 hours. The dried carrot was milled into fine powder and sieved, then stored for further use.

2.2.2 Production of African walnut flour

The fresh African walnut seeds were washed thoroughly to remove sand, boiled at 100°C for 50 minutes, shelled and cut into slices to facilitate drying. The slices were then be drained and oven dried at 70°C for 24 hours. The dried slices were milled into flour and sieved to obtain flour of uniform size. The flour was packaged in

well labeled polyethylene bags and stored at room temperature.

2.2.3 Recipe formulation and cookies preparation

Cookies was prepared with wheat flour (WF), African walnut flour (AWF), and carrot flour (CF) using the standard ingredients in the respective ratios of 100:0:0(control), 90:5:5, 85:10:5, 80:15:10, 75:20:5. The method of Watters et al., (2003) as described by Giami and Barber [1] was used in the cookies preparation.

2.3 Production of Cookies

The flours, sugar, baking powder and salt were hand mixed in a bowl. This was followed by addition of the fat and further mixing by hand to obtain a bread crumb-like mixture. The mixture was transferred into food processor (Homeluck). The liquid (egg and vanilla flavor) was added and the mixture mixed at medium speed for 5 minutes to obtain the dough. The dough was manually rolled out on a floured board into sheets of uniform thickness of 4 mm and cut with a circular cookie cutter with diameter of 4 cm. The cut dough was transferred to baking trays lined with grease-proof paper and baked at 180°C for 15 minutes in a domestic oven (Camara, Italy).

Thereafter the cookies were allowed to cool at room temperature and divided into 3 lots. The first was used for determination of physical characteristics immediately after cooling. The second lot was subjected to sensory evaluation after 24 hours. The third lot was milled and used for chemical analysis.

2.4 Analysis

2.4.1 Physical characteristics of developed cookies

The procedure described by AACC, [11] was used to determine the Weight. diameter, thickness and spread ratio of the developed cookies.

2.4.2 Weight

For each sample, weight of the cookies was determined using a digital loading balance (CE-410I, Camry Emperors, China), immediately after cooling. For each sample, a random choice was made and placed on a digital loading balance. This was done in triplicate and the means were recorded.

2.4.3 Diameter (D)

To determine the diameter (D), six pieces of cookies was placed horizontally (edge to edge) and rotated at 90^0 angles for reading using a venire caliper.

2.4.4 Thickness (T)

Using a venire caliper also, the thickness was measured in triplicate and the mean was recorded.

2.4.5 Spread ratio

The spread ratio of each cookies sample was calculated by diving the diameter with the thickness (D/T).

Table 1. Ingredient formulation recipe from flour blends for production of Wheat-African walnut-Carrot cookies

Ingredient (g/100 g)	Sample				
	A	**B**	**C**	**D**	**E**
Wheat flour (g)	100	90	85	80	75
Walnut Flour (g)	0	5	10	15	20
Carrot flour (g)	0	5	5	5	5
Sugar (g)	75	75	75	75	75
Margarine (g)	125	125	125	125	125
Vanilla Flavour	2.5	2.5	2.5	2.5	2.5
Baking Powder (g)	5	5	5	5	5
Egg (Whole)	1	1	1	1	1

2.5 Proximate Analysis

Proximate composition (Moisture, Ash, Fat, Protein, Crude fiber, Carbohydrate) were carried cookies samples using the method described by AOAC, [12].

2.5.1 Moisture content determination

Clean aluminum moisture cans were weighed and dried in an oven (DH6-9140A, China), transferred into a desiccator and cooled for 20 minutes. Two grams (2 g) of each sample was weighed into the cans and the weight noted. The cans and its content were heated at 105^0 C for 4 hours. At the end of the heating, the cans were cooled in the desiccator and weighed again. The moisture content was calculated using the formula:

Moisture content (%) = $\frac{W2 - W3}{W2 - W1}$ × 100

Where W_1= Initial weight of empty can
W_2=Weight of can + Sample before drying
W_3=Weight of can + Sample after drying

2.5.2 Crude protein content determination

Half (0.5) g of the sample was weighed into a 250 mL digestion flask. To this was added 2 tablets of kjedahl catalyst and 12 mL of concentrated sulphuric acid. The flask was placed on a digested furnace (Tecator digester 8, Sweden), set at 420^0C and digested for 1 hour. the digest was allowed to cool and made up to 100 mL using distilled water. Twenty (20) mL of digest was introduced into a 250 kjedahl distillation flask to which was added 20ml of 45% sodium hydroxide. The flask was placed on a kjedahl distillation unit (Foss 2100, Sweden) and ammonia liberated distilled into a 10ml boric acid mix indicator. The distillated was back titrated against 0.1 NHCL solution to a pink end point. A blank determination was carried out and subtracted from the sample reading. The% Nitrogen and% crude protein was calculated as:

% Nitrogen = $\frac{(\text{Titre} - \text{Blank}) \times \text{Normality of acid} \times 1.4}{\text{Weight of sample (g)}}$

The percentage crude protein was then calculated using 6.25 as the conversion factor
Crude protein (%) =% Nitrogen x 6.25.

2.5.3 Fat content determination

The Soxhlet extraction method of AOAC [12] was used to determine the fat content. A soxhlet extraction with a reflux condenser and a 500 mL round bottom flask was fixed. Two grams of the sample was then weighed (W_1) into a labeled thimble (W_2). Petroleum ether (300 mL) was filled into the round bottom flask and the extractor thimble was sealed with a cotton wool the Soxhlet apparatus was left to reflux for 6 hours and then the thimble removed. Petroleum ether was collected from the flask and was thereafter dried at an oven temperature of 105^0C for 1 hour, cooled in a desiccator and then weighed (W_3). This procedure was carried out for all samples.

% Fat = $\frac{W3 - W2}{W1} \times 100$

Where

W3 = Weight of flask with extracted oil
W2 = Weight of empty flask
W1 = Weight of sample

2.5.4 Ash content determination

One gram (1 g) of the sample was weighed into a previously ignited and cooled porcelain crucible. The crucible and sample were heated on a heating mantle (Gehadt,Germany) until smoking ceases (W_2). The crucible and its content were transferred into a muffle furnace and ashed for 3 hours at 550^0C. The crucible and ash were removed from the furnace, cooled in a desiccator and weighed W_3. The ash content was calculated as:

% Ash = $\frac{W3 - W2 \text{ (weight of ash)}}{W1 \text{ (weight of sample)}} \times 100$

2.5.5 Crude fiber content determination

Crude fiber was determined using the method described by AOAC [12]. Half (0.5) g of the sample was weighed and placed in a 200 mL beaker. Twenty-five (25) mL of 1.25% w/v sulphuric acid was added and covered with watch glass. The content of the beaker was heated gently on a hot plate (Gehadt, Germany) for 10 minutes (acid hydrolysis). The solution was filtered using a buchner funnel fitted with filter paper (whatman No.1) and washed with boiling water until it is no longer acidic to litmus paper. The residue was washed back into the beaker with 25 mL of 1.25% sodium hydroxide. This was treated for 10 minutes and covered with a watch glass (alkaline hydrolysis). The resulting insoluble material was transferred to a dried pre-weighed ashless filter paper (Whattman No 4)

and washed thoroughly with hot water until it is no longer acidic to litmus paper. The filter with the insoluble mater was dried at 105^0C to a constant weight (W_2). The dried filter paper and its content were incinerated to ash at 500^0C for 1 hour, cooled and weighed (W_3). The fiber was calculated as:

$$\% \text{ Crude Fiber} = \frac{W3 - W2}{W1} \times 100$$

Where:

W1= Weight of sample
W2 = Weight in gram of sample after drying
W3= Weight in gram after ashing

2.5.6 Carbohydrate content determination

The carbohydrate was estimated as the difference between 100 and the total sum of moisture, fat, protein, crude fiber and ash.

Total carbohydrate(%)
$= 100 - (\text{Moisture content} + \text{Fat} + \text{Protein} + \text{Fiber} + \text{Ash})$

2.6 Determination of Anti-nutrient

2.6.1 Phytic acid

The phytic acid content of the samples was determined according to Russel, [13]. Two (2) g of the sample was weighed into a 250 mL beaker. 100 mL of 2% conc. HCl was added and allowed to soak for 3 hours. the solution was filtered and 50 mL of the filtrate was pipetted into a 250 mL beaker. Hundred and seven (107) mL of distilled water was added to improve acidity. Ten (10) mL of 0.3% ammonium thiocyanate solution was added as an indicator. The solution was titrated against a standard iron (iii) chloride ($FeCl_3$) containing 0.00195 g iron/mL until a brownish yellow colour appeared and persisted for 5 minutes. the reading was taken and phytic acid content calculated as shown below:

Phytic acid($\text{mg}/100\text{g}$) = $\frac{0.0\ 0\ 195\ \text{volume of FeCl3 comsumed} \times DF}{\text{Weight of sample}}$

DF= Total volume of extracted solvent added / volume of aliquot taken for titration.

2.6.2 Determination of tannin

The method described by Russel [13] was used in determining the tannin content. One (1) g of sample was weighed into the flask; 10 mL of distilled water was added, agitated and left to stand for 30 minutes at room temperature. The solution was centrifuged at 2500 rpm for 15 minutes. 2 mL of the supernatant was measured into a 10 mL volumetric flask. One (1) mL of Folin-Ciocalteu reagent and 2 mL of saturated Na_2CO_3 solution was added. The solution was diluted to 10 mL with distilled water and incubated at room temperature for 30 minutes. the above solution was repeated for tannic acid standards 20,40,60,80,100 and 120 mg/L from a stock of 500 ppm. 50 mg of tannic acid standard was dissolved in 100 mL distilled water. The absorbance of tannic acid standard was read at wavelength of 725 nm and a calibration curve of absorbance against concentration was drawn for tannic acid standards. To obtain the tannic acid concentration of the sample, the absorbance was traced down to the concentration axis. The formula below was used to calculate the tannic acid content.

Tannic acid content (mg/kg)

$$= \frac{\text{Con. Obtained in mg/l} \times \text{volume of sample} \times DF}{\text{Sample Weight}}$$

2.6.3 Determination of saponin

The spectrophotometric method of Brunner [14] was used for saponin analysis. One gramme (1.0 g) of finely ground sample was weighed into a 250 mL beaker and 100ml isobutyl alcohol was added. The mixture was shaken on a UDY shaker for 5 hours to ensure uniform mixing. Thereafter, the mixture was filtered through a whatman No.1 filter paper into 100 mL beaker and 20 mL of 40% saturated solution of magnesium carbonate added. The mixture obtained with saturated $MgCO_3$ was again filtered through a whatman No.1 filter paper to obtain a clear colorless solution. One milliliter (1.0 mL) of the colorless solution was pipette into 50 mL volumetric flask and 2 mL of 5% $FeCl_3$ solution was added and made up to mark with distilled water. It was allowed to stand for 30 minutes for blood red color to develop. 0-10 ppm standard saponin solution were prepared from saponin stock solutions were treated similarly with 2 mL of 5%$FeCl_3$ solution as done for 1.0 mL sample above. The absorbance of the sample as well as the standard solutions were read after color development on a spectronic 21D spectrophotometer at a wavelength of 380 nm. Percentage Saponin was calculated using the formula:

% Saponin

$$= \frac{\text{Absorbance of sample} \times \text{average gradient} \times \text{dilution factor}}{\text{Weight of sample} \times 10,000}$$

2.7 Determination of Minerals

The determination of the mineral compositions of the samples was done according to the method described by AOAC [12]. The total mineral content (iron, calcium, sodium, and potassium) were determined. One (1) g of the sample was weighed into a crucible and sent into a muffle furnace at 550^0C for 4 hours until the color of the ash turned grey white indicating complete oxidation of all organic matter in the sample. The crucible and the ash were left to cool in a desiccator and then 10 mL of 0.1 N HCl (Larbo Chemie, Germany) was added in other to dissolve the ashes. The solution was filtered using Whattman filter paper No 1 (Sigma Aldrich, South Africa) and the filtrate was used for mineral quantification using Atomic Absorption Spectrophotometer (ThermoScientific, USA). The concentration of the minerals was read in mg/L and calculated as follows.

$$\text{Mineral} \left(^{\text{mg}}/_{100\text{g}}\right)$$
$$= \text{Concentration (ppm)} \times \frac{\text{Solution Volume}}{10 \times \text{Sample Weight}} \times 1000$$

2.8 Determination of Mineral Extractability of the Cookies

Mineral extractability was done according to the methods described by Chuahan and Mahjan [15]. One gram of the sample was extracted using 10ml of 0.03N HCL with agitation at 37^0C for 3 hours. The extract was filtered and the filtrate dried at 100^0C using hot air oven (themo Scientic 6200, Germany), and placed in a muffle furnace. (Cabolite AAF -11/18 UK) at 550^oC for 4 hours. Thereafter, the sample was cooled and to it was added a 5ml of 5N HCL. The mixture was boiled gently for 10 minutes, cooled and diluted to 100 mL with distilled water. Minerals were determined as described in section 4.0 above.

$$\text{Mineral extractibillity}(\%)$$
$$= \frac{\text{Mineral extractibilty in 0.05Hcl}}{\text{Total mineral content}} \times 100$$

2.9 Determination of Vitamins

Vitamins (B$_6$, C, and E), were determined using the method of Okwu [16]. One gram (1 g) of sample was weighed into a 250 mL conical flask fitted with a reflux condenser. 10 mL of absolute alcohol and 20 mL of 1M alcoholic sulphuric acid were added. The condenser and flask were wrapped in Aluminum foil and refluxed for 45 minutes and cooled for 15 minutes. Fifty milliliters (50 ml) of distilled water was added to the mixture and transferred to a 250ml separating funnel covered with Aluminum foil. The unsaponifiable matters in the mixture were extracted with 5 x 30 mL dimethylether. The combined extracts were washed free of acid and dry evaporated at a low temperature and the residues obtained were immediately dissolved in 10 mL absolute alcohol. Aliquots of solutions of the sample and standards (0.3-3.0 mg vitamin E) were transferred to a 20 mL volumetric flask, 5 mL absolute alcohol added, followed by a careful addition of 1.0 mL concentrated HNO_3. The flasks were placed on a water bath at 90^0C for exactly 3 minutes from the time the alcohol begins to boil. It was rapidly cooled under running water and adjusted to volume with absolute alcohol. The absorbance was determined at 470 nm against a blank containing 5ml absolute alcohol and 1 mL concentrated HNO_3 treated in a similar manner.

Vitamin E (μg/100 g) =

$$\text{Vitamin E}$$
$$= \frac{\text{Asorbance} \times \text{gradient factor} \times \text{dilution factor}}{\text{Weight of sample}}$$

2.10 Total Carotenoid Analysis

The total carotenoid was determined using the method described by Harborne, [17]. Five hundred (500) mg of sample was weighed into a centrifuge; 10 mL of 80% acetone was added, mixed properly and centrifuged at 4000 rpm for 10 minutes. the supernatant was made up to a volume 15 mL using 80% ethanol. The optical density OD (absorbance) was read at 480 nm using the UV visible spectrophotometer (Cecil CE 1000 UK) and total carotenoid calculated thus:

$$\text{Total carotenoid(mg/ml)}$$
$$= \frac{4 \times \text{Absorbance} \times \text{Total vol. of sample} \times 1000}{\text{Sample Weight}}$$

2.11 Protein Digestibility

The *In vitro* protein digestibility was carried out according to the method of Maliwal [18] in the manner described by Monjula and John [19] with

minor modification. A known weight (5 g), of the sample containing 16 mg of nitrogen was taken in triplicate and digested with 1 mg pepsin in 15 mL of 0.1 M HCL at 37^0C for 2 hours. The pepsin hydrolyzed solutions were neutralized with 0.5 M NaOH and incubated with 6.0 mg of pancreatin (Sigma Chemicals Ltd, Cat. No. P 1750) in 7.5 mL of 0.2 m phosphate buffer at pH 7.6 for 18 hours. The reaction was stopped by adding 22.5 mL of 10% trichloroacetic acid (TCA), the mixture was then filtered quantitatively through Whatman No. 1 filter paper. The TCA soluble reaction was assayed for nitrogen using the micro-kjeldahl method. Digestibility was obtained by using the following equation;

$$\% \text{ protein digestibility} = \frac{\text{N in supernatant} - \text{N in blank}}{\text{N in sample}} \times 100$$

2.12 Sensory Characteristics of Developed Cookies

Method described by Giami and Barber [1] for fluted pumpkin cookies was used. A panel of twenty consumers comprising of staff and student from Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria was used. At each session, the five samples were served on white saucers and labeled accordingly (A, B, C, D, E). Panelists are instructed to evaluate color first and then taste each sample to evaluate crispiness and aroma. The overall acceptability was then calculated from the given parameters. Sensory evaluation was carried out on the day cookies production after cooling.

2.13 Statistical Analysis

All experiments were done in three replicates and data obtained from analysis were computed in Microsoft excel spreadsheet and used to express data as Mean ±SD. The data obtained was analyzed using Minitab 16 statistical software to compare means. The significant difference between the means was analyzed using Turkey's Test. All statistical tests were performed at 5% significant level.

3. RESULTS

Results of the analysis on the cookies products are presented in the tables below.

Table 2. Physical properties of cookies

Sample	Weight(G)	Diameter(mm)	Thickness (Mm)	Spread Ratio (D/T)
A	13.09^a±0.54	45.80^a±4.81	9.45^a±0.35	5.12^c±0.33
B	12.95^a±1.15	52.68^a±0.88	9.37^{ab}±0.47	5.64^{bc}±0.37
C	11.47^a±0.45	52.00^a±0.64	8.05^{bc}±0.07	6.45^{ab}±0.16
D	11.28^a±0.21	52.15^a±1.41	9.43^a±0.42	5.53^{bc}±0.10
E	11.31^a±1.96	50.93^a±1.24	6.85^c±0.21	7.44^a±0.41
LSD	1.07	2.36	0.34	0.30

Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Table 3. Proximate composition of cookies (%)

Samples	Moisture	Ash	Fat	Protein	Crude Fibre	Carbohydrate
A	5.44^a±0.64	1.10^c±0.14	18.78^b±0.26	10.55^d±0.35	0.91^c±0.01	63.47^a±0.35
B	5.20^a±0.36	1.72^b±0.04	21.44^{ab}±0.33	11.26^{cd}±0.09	0.89^c±0.00	59.96^b±0.67
C	5.60^a±0.44	1.80^b±0.07	23.20^a±1.77	12.40^{bc}±0.14	1.28^{bc}±0.01	55.83^c±0.16
D	4.57^a±0.64	1.85^{ab}±0.07	24.06^a±0.63	13.55^{ab}±0.78	1.80^{ab}±0.42	54.28^{cd}±0.15
E	4.40^a±0.71	2.15^a±0.00	24.11^a±1.20	15.10^a±0.14	2.05^a±0.07	52.77^d±0.81
LSD	0.57	0.08	1.01	0.39	0.19	0.51

Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Table 4. Anti-nutrient composition of cookies (mg/100 g)

Samples	Phytate	Tannin	Saponin (%)
A	0.04[e]±0.00	0.23[c]±0.04	0.19[e]±0.00
B	0.05[d]±0.01	0.30[ab]±0.00	0.49[d]±0.01
C	0.15[c]±0.01	0.25[bc]±0.00	0.61[c]±0.00
D	0.20[b]±0.01	0.27[abc]±0.00	0.99[b]±0.00
E	0.23[a]±0.00	0.33[a]±0.00	1.19[a]±0.00
LSD	0.00	0.02	0.00

Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05);A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Table 5. Mineral composition of cookies (mg/100 g)

Samples	Calcium	Iron	Sodium	Potassium
A	29.38[a]±0.00	3.75[c]±1.04	14.11[a]±0.01	49.20[c]±0.29
B	27.13[a]±0.04	4.48[c]±0.00	15.26[a]±0.95	51.11[bc]±0.16
C	40.25[a]±21.69	5.27[bc]±0.28	14.57[a]±0.25	55.22[ab]±0.64
D	41.66[a]±0.63	7.10[b]±0.05	16.08[a]±0.91	56.10[a]±1.40
E	50.46[a]±0.19	11.36[a]±0.26	15.47[a]±0.21	58.90[a]±1.60
LSD	9.71	0.50	0.60	1.13

Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Table 6. Extractable mineral of cookies (mg/100 g)

Samples	Calcium	Iron	Sodium	Potassium
A	16.26[d]±0.00	0.84[e]±0.01	8.05[e]±0.00	34.22[c]±0.34
B	14.47[e]±0.01	0.92[d]±0.01	12.95[a]±0.00	36.29[bc]±1.68
C	18.86[c]±0.01	1.26[c]±0.04	9.91[b]±0.02	38.83[ab]±0.62
D	18.19[b]±0.00	1.91[b]±0.01	9.44[d]±0.01	40.11[ab]±1.29
E	23.95[a]±0.07	4.22[a]±0.00	9.71[c]±0.03	42.59[a]±0.68
LSD	0.32	0.02	0.01	1.04

Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Table 7. Carotenoid, vitamin and %IVD analysis for cookies (mg/100 g)

Samples	Carotenoid	Vitamin C	Vitamin B$_6$	Vitamin E	%IVPD
A	90.48[c]±4.41	5.32[d]±0.12	0.01[c]±0.00	0.27[d]±0.01	23.85[d]± 0.64
B	131.04[b]±13.23	5.77[d]±0.12	0.02[a]±0.00	0.30[d]±0.01	45.20[c]± 1.56
C	257.40[a]±2.21	8.59[c]±0.20	0.02[b]±0.00	0.49[c]±0.00	55.20[b]± 1.27
D	252.88[a]±4.41	12.81[b]±0.12	0.01[c]±0.00	0.83[b]±0.00	56.55[ab]±0.78
E	252.10[a]±5.29	13.85[a]±0.16	0.02[a]±0.00	0.90[a]±0.02	59.64[a]± 0.76
LSD	7.03	0.15	0.00	0.01	1.06

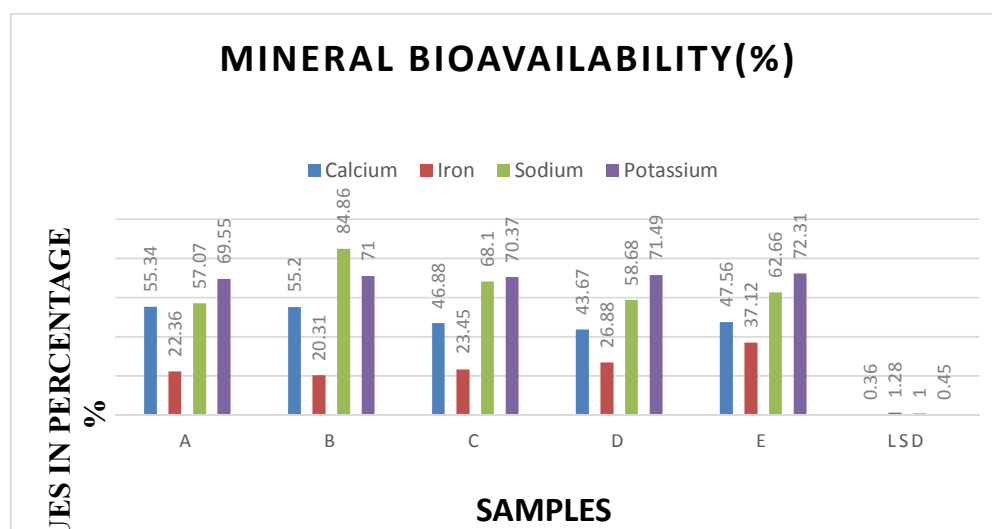*Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)*

Table 8. Sensory evaluation

Samples	Colour	Taste	Crispiness	Aroma	General Acceptability
A	7.38[a]±0.45	7.39[a]±0.19	7.50[a]±0.06	7.54[a]±0.26	7.39[a]±0.45
B	7.53[a]±0.04	6.33[b]±0.25	6.06[b]±0.06	6.19[c]±0.16	6.61[a]±0.63
C	7.27[a]±0.32	6.30[b]±0.00	6.38[b]±0.18	6.65[bc]±0.14	7.00[a]±0.00
D	6.95[a]±0.00	6.38[b]±0.32	7.39[a]±0.33	7.04[ab]±0.05	7.38[a]±0.47
E	7.12[a]±0.17	6.10[b]±0.07	7.38[a]±0.33	6. 23[c]±0.25	6.75[a]±0.00
LSD	0.26	0.20	0.23	0.19	0.29

The means ± standard deviation, number of testing panels (n) =20; Means with different superscript in the same columns differ significantly (P≤0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

Fig. 1. Mineral bioavailability of cookies (%)
Mean values are of duplicate determination. Mean values within a column with the same superscript are not significantly different (p>0.05); A=Wheat Flour (100), B=Wheat Flour+ Walnut Flour + Carrot Flour (90:5:5), C= Wheat Flour+ Walnut Flour + Carrot Flour (85:10:5), D= Wheat Flour+ Walnut Flour + Carrot Flour (80:15:5), E= Wheat Flour+ Walnut Flour + Carrot Flour (75:20:5)

4. DISCUSSION

4.1 Physical Properties of Cookies

The result of the physical properties of cookies showed that supplementation of Wheat flour with walnut flour and carrot flour in the cookies production, gave no significant difference in the weight of the samples as they all compared favorably with the control, whereas this effect increased the diameter of the supplemented cookies from 45.80 mm to 52.68 mm, although no significant difference was observed. Cookies made with 100% wheat flour had the least spread ratio; this indicated that the starch in sample A is hydrophilic [20], while supplemented cookies products had higher spread. The low spread ratio of the control sample showed that

the starch polymer molecules are highly bound with the granules when heated and when dough or batter become less viscous with the inclusion of non-wheat flour, it tends to spread more thereby increasing in diameter and consequently the spread ratio. Chinma and Gernah [21] observed a similar trend in cookies produced from cassava/soyabean/mango composite flours and attributed it to the hydrophilic nature of the flour used in producing the biscuit, which caused reduction in spread, thus leading to an increase in thickness of the cookies.

4.2 Proximate Composition of Cookies

The moisture content of the cookies as can be seen in Table 2, ranged from 4.40% to 5.60%. The moisture content of most of the substituted

cookie samples was less than that of the control, although sample C appeared to have the highest moisture content (5.60%) but does not differ significantly from the rest. Cookies with less moisture content were produced by increasing substitution of wheat flour with African walnut flour and carrot flour. This decrease in moisture content could be attributed to the low moisture and water absorption capacity (9.5 and 108% respectively) of Walnut flour [22], as compared to that of wheat flour (13.3 and 140%, respectively) [23]. Low moisture content is preferred in foods as this prevents microbial spoilage and improves shelf life. Barber et al., [24] reported similar trend of decrease in moisture content with increase in substitution level in the production of cookies with wheat-walnut flour. Ash contents of the supplemented cookies are higher than that of the control cookies product. Sample E has a value of 2.15% followed by sample D (1.85%), sample C (1.80%), sample B (1.72%) and the control with the least value of 1.10%. This may be due to the presence of carrot which is a rich source of minerals [25]. The ash content of a food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining, after the water and organic matter have been removed by heating in the presence of an oxidizing agent [26]. Increase in ash content in development of biscuit with defatted soyflour and carrot pomace powder with supplementation of biscuit with 2.5% - 10% carrot pomace powder was also reported by Gayas et al. [27]. There was a significant difference between the fat content (18.78%) of sample A and that of substituted samples. The substituted blend showed higher fat content of 21.44%, 23.20%, 24.06%, 24.11% for samples B, C, D and E respectively. Although carrot is not a rich source of fat, the values are not surprising as many researchers has reported that African walnut has high oil content [28,29,22,30] (Edema et al., 2000). The work of Ojinnaka and Agubolum (2013), in production of cashewnut-wheat based cookies, also reported an increase in fat content (16.41 -23.43%) at different levels (10 - 40%) of substitution with cashewnut flour. while this enriched product has healthy polyunsaturated fats, storage condition should be considered to prevent rancidity. Regarding protein values, cookies samples showed improvement in protein content from 10.55% to 15.10%, with substitution of wheat flour with Walnut and Carrot flour. Protein content was highest in the substituted cookies samples than in the control. This may be attributed to the high protein content of Walnut (21.6%) as observed

by Ndie et al., [22]. The values of protein obtained in the present study agrees with the work of Olanipekun et al., [31], although they appear less than the recommended daily requirement for protein (25-30 g/day) for age 15 and 19 years as recommended by WHO/FAO (1973). This indicates that walnut cookies as a frequently eaten snack may serve to alleviate the problem of protein deficiencies in children of which are the targets for production of this nutritionally improved product, and for adults who may want to snack on healthy food products. The crude fiber of the cookies produced ranged from 0.89% to 2.05%. Sample B (90% wheat flour, 5% walnut flour, 5% carrot flour), had the lowest value (0.89%) while sample E (75% wheat flour, 25% walnut flour,5% carrot flour) had the highest value (2.05%). High fiber content of carrot and walnut seed contributed to this high values. Ebere et al., [32] reported an increase in fiber content of cookies formulated from the blends of wheat/cashew apple residue up to 9.4% with 20% incorporation. Okon [33] reported that a diet low in fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of the colon like piles, appendicitis and cancer. Cookie product indicated that walnut substitution lowers carbohydrate content from 63.47% of sample A to 52.77% of sample E. presumably wheat-walnut flour products could be beneficial to adults seeking to lose weight while maintaining a healthy diet.

4.3 Anti-nutrient Composition of Cookies

The result of the anti-nutrients on cookies indicated that phytate values from 0.04 mg/100g – 0.23 mg/100g, tannin valued from 0.23 mg/100g – 0.33 mg/100g while saponin valued from 0.19% – 1.19%. Esekheigbe and Onimawo [34], reported high values of ant-nutrients in raw and cooked African Walnut, hence the anti-nutrients observed in this study can be attributed to the presence of the African walnut. The result in this present study showed that supplementation of wheat flour with African walnut flour and carrot flour slightly increased the anti-nutrients of the cookies product and agrees reasonably well with phytate and tannin levels obtained from the work of Omah and Okafor [35], in cookies production from wheat, cassava cortex and millet pigeon pea flour blends. In contrast, Ojinnaka et al., [36], reported a decrease in values of anti-nutrient in the supplementation of wheat flour with African bread fruit flour and pigeon pea flour in cookies production. Anti-

nutrients are not entirely dangerous when consumed in food since they have anti-oxidant properties when consumed at safe level Awike et al., (2005). It has been reported that tannin and phytate reduced blood glucose and insulin response to foods rich in starch [37,38]. All amples analyzed were lower than the safe limit of 4 – 9 mg\100 g as reported by Siddharuji and Becker, (2000) for the effect of processing method on anti-nutritional properties of indian tribal pulse. Heaney et al. [39] reported 301 mg/100 g as a safe level for phytate while Schiavone et al. [40] reported 150 - 200 mg/100 g as the safe level for tannin. Hence it can be agreed that the anti-nutrient contents of the products of this study are considerably low and may not pose risk to health.

4.4 Mineral Composition on Cookies

The result of mineral composition of the cookies samples showed that supplementation with Walnut flour and carrot flour improved the mineral contents of the cookies. The value of Calcium increased from 29.38 mg/100g in sample A to 50.46 mg/100g in sample E. These values are higher than that reported by of AwadElkare and Shammari [41] for production of biscuit from Wheat-lentil composite flour. The U.K. Department of Health recommended reference nutrients intake of 1000 mg/day of Calcium for adult and 550 mg/day for infants and children [42]. The highest value obtained from the present study (50.46 mg/100 g of Calcium for sample E) will supply only 5.05% of the recommended daily value to adults and 9.17% of RDA to children. Hence consumption of 500 g of the product will supply 25.25% of the recommended daily intake of Calcium to adult and 45.85% to children. Calcium helps in the formation of bones and also provide support and rigidity to skeletal bones. It is important in regulation of the tone and contractility of heart and acts as an antidote to the depressant action of potassium [42]. Calcium also aids rennin in the coagulation of milk in the stomach. There was an appreciable improvement in the Iron content of cookies products as most of the supplemented samples value higher than the control and ranged from 3.75 mg/100 g to 11.36 mg/100 g with an existing significant difference among the samples except in samples A and B. Ojinnaka et al., [43], also reported improvement in iron content (4.46 mg/100 g – 5.96 mg/100 g) of cookies produce from Wheat-Plantain-Aeriel yam composite flour. Iron is an essential trace element which plays vital roles such as

hemoglobin formation and oxidation of fats, protein and carbohydrates [44]. It is highly required for replenishment of blood in menstruating women and much more in pregnant women for proper development of the fetus. Its dietary requirement depends on age and sex of the individual. Iron requirements are also high in adolescents, particularly at their period of rapid growth. Iron content of the cookie samples ranged from 3.75 mg/100g for sample A to 11.36 mg/100 g for sample E. The WHO [45,46] daily recommended intake of iron for children (6-59 months) is 5.8 mg/100g. Hence, children can get the required Iron from consuming sample products D (7.10 mg/100 g) and E (11.36 mg/100g). Thus, the substituted products are most adequate for iron supply for children. The sodium, content ranged from 14.11 mg/100 g to 16.08 mg/100 g and there was no significant difference (p> 0.05) between the values obtained. These values do not meet the United State Department of Agriculture (USDA) recommendation for sodium (1500 mg/g). Sodium is an electrolyte compound which helps in balancing fluids in the human body system. It is also required for nerve and muscle functioning but over-consumption can lead to kidney damage and increased chances of high blood pressure (Munteanu and Iliuta, 2011). Inyang et al., (2013), reported similar values in rice, unripe banana and sprouted soyabeans flour cookies. According to USDA [47], 4700 mg/day daily intake of Potassium from food is recommended for adults. This is for reduction of blood pressure and risk of cardiovascular disease, stroke and coronary heart disease. Potassium content was higher in the supplemented cookies samples and raged from 51.11 mg/100g to 58.90 mg/100 g (only meet about 1.09 – 1.25% RDA.) and slightly low in the control sample (49.20 mg/100 g. Arshad et al., (2007), obtained higher values for Potassium (105-306 mg/100g) on cookies products supplemented with defatted wheat germ. Although the mineral values of these cookies do not meet the USDA recommendations, the high potassium and low sodium contents of the cookies make them suitable for consumption by hypertensive individuals.

4.5 Percentage Mineral Bioavailability (%MB)

Bioavailability is the ability of the body to digest and absorb the mineral in the food consumed [48]. The extractability of calcium ranged from 14.47 mg/100g to 23.95 mg/100g and its

percentage (%) extractability ranged from 43.67% to 55.34%. There was no significant difference in the calcium bioavailability of sample A and sample B. This showed that although the value of sample A is higher, sample B also falls within the same range and this can be said to mean that calcium in these cookies will be absorbed into the body at the same level. With reference to mineral contents of the cookies, the calcium content of the control sample is lower than some substituted samples but its absorption is higher than that of all others samples. This is in accordance with the finding of Weaver et al., [49], that wheat products, except for wheat bran, do not have a negative impact on calcium absorption from diet. Also, the chances of forming calcium phytate salts in the consumption of this product are minimum as the phytate levels in the cookie products are very low. Calcium salts play vital role in many metabolic processes. In helps in rigidity of the bones and its deficiency led to loss of bone mass or osteoporosis. With respect to this study, it can be observed that the absorbability of iron content of the cookies improved with the increase in the walnut and carrot flour. The extractability of iron ranged from 0.84 mg/100g to 4.22 mg/100g while its percentage (%) extractability valued from 20.31% to 37.12%. This may be attributed to the fact that walnuts and carrots are rich source of vitamin C which has been proven to aid iron absorption [50]. Hence consuming this food may help to constantly supply iron to relevant tissues and serve to reduce iron deficiency anemia. The cookies samples analyzed showed that percentage (%) sodium extractable was higher compared to other samples. The extractability of sodium ranged from 8.05 mg/100g to 9.91 mg/100g while its percentage (%) extractability ranged from 57.07% to 84.86%. Emelike et al., [51] also obtained similar value of percentage mineral extractability of sodium from defatted avocado pear seed flour. All the cookie samples showed high available Potassium, this may be as a result of high potassium mineral present in the cookies samples, hence a corresponding high extractability. Overall, the analyzed element showed potential of being present and readily available to the body.

4.6 Carotenoid, Vitamin and Percentage *In-vitro* Protein Digestibility (%IVPD) Analysis on Cookies

The carotenoid values ranged from 90.48 mg/100g – 257.40 mg/100 g, with the highest value found in the sample C (85% wheat, 10%

Walnut flour and 5% carrot flour). The values of other supplemented samples were also higher than that of the control (90.48 mg/100 g). This could be attributed to the effect of carrot flour which a major source of carotene. This value is higher than those obtained from the work of Ibidapo et al., [52] in the development of carrot powder and cowpea biscuits. There was a significant difference (p<0.05) in the carotenoid values of the supplemented samples and the control (sample A), this confirms the claim of previous workers that carrot has a good residual amount of carotenoids [53,54], and it contains a good amount of vitamins and minerals, [25]. Also, Igara et al., [55], found the African walnut seed to contain 9.64 mg/100 g of Carotenoid. Beta- carotene, a carotenoid is an important phytonutrient useful for human health [56]. The main physiological function of carotenoids is as precursor of vitamin A [57]. The Vitamin C elements evaluated in this study followed the same trend as they increased in the cookies with increase in walnut flour up to 20% (sample E) and with carrot flour supplementation. The values of each sample significantly differ from each other and the lowest value (5.32 mg/100 g) found in the control while the highest value (13.85 mg/100g) was found in sample E and these values are lower than the USRDA (2010) for Vitamin C which is 90 mg/day. This shows that sample E having the value of 13.85mg/100g supplied only 15.38% of the RDA. The Vitamin C values obtained from this work are slightly higher than the ones (3.4 mg/100g – 7.22 mg/100g) observed from the work of Anankware et al., [58] on the analysis of Cocoyam-Wheat Cake Enriched with Edible Palm Larvae. Ojobor et al., [59], observed a Vitamin C value of the dry weight of walnut seed as 5.08 mg/100g while Holland et al. (1991) reported 4 mg/100g as the Vitamin C content of carrot fruit. These findings may have contributed to the increase in the vitamin C content of the cookies. Vitamin C promotes the absorption of non-heme iron and is required for fighting infections. Vitamin C also has a unique ability as an antioxidant, to prevent or at least minimize the formation of carcinogenic substances from dietary material [60]. Inclusion of African walnut flour and carrot flour in this cookies production also improved the vitamin B_6 content of the cookie products. The highest value obtained from the cookie samples for Vitamin B6 is 0.02 mg/100g (for sample B, C and E, respectively). This value falls below the USRDA (1.3 mg/day) for Vitamin B_6 and only supplied 1.5% of the RDA. Vitamin B_6 is involved in amino acid metabolism. It has also been identified as an

anti-dermatitis factor and seemed to play a protective role against several diseases including cardiovascular diseases, diabetes, brain diseases and colon cancer [61,62]. The values of Vitamin E in the substituted cookies (0.30 mg/100 – 0.90 mg/100 g) are higher than the value obtained from the control (0.27 mg/100 g). Although there was no significant difference between the control and sample B and C, however sample and E significantly differed from the rest and appeared to be higher (0.9 mg/100 g). This value is less than the 15 mg/per day of USRDA for Vitamin E and supplied only 6% of the recommended intake. Although this contribution is small, the supplemented products will add more nutritive value than the usual whole wheat cookies. Akujiobi [63], obtained a slightly higher values of 2.77 mg/100g -3.5 mg/100 from cookies produced with cocoyam and tigernut flour. The evaluation of African walnut seed by Igara et al. [55], again indicated a value of 96.42 mg/ 100 g as the vitamin E content of the seed nut. Though these vitamins are observed in this product in trace amount, they are essential for different body metabolism. According to Enwere [64], Vitamin E which is a powerful lipid soluble antioxidant required for maintaining the integrity of cell membrane of mucus membranes and skin by protecting it from harmful oxygen-free radicals. There were significant differences in the percentage in-vitro protein digestibility (%IVPD) among cookies samples. The in-vitro protein digestibility of cookies sample ranged from 23.85 mg/100g – 59.64 mg/100g with the substituted samples having higher values. The increase in the values of the substituted samples may be attributed to the highly digestible protein fractions found in African walnut (Sze-Tao and Sather 2000). It can also be observed that the anti-nutrients in the cookies were too low to have an adverse effect the digestibility of the cookies. These values are in line with those observed in the work of Wabali et al. [65], on the biscuit sample containing 20% walnut flour and 80% wheat flour (39.46% IVPD) and also 56.15%IVPD for sample containing 20% walnut flour, 5% moringa seed flour and 75% wheat flour, but they are slightly lower than the values obtained (62.33% – 64.81%) obtained from Okpala and Chinyelu [66] on cookies from pigeon pea and cocoyam flour blend. A protein with higher digestibility provides more amino acids on proteolysis and is of higher nutritional value [67].

4.7 Sensory Analysis

Sensory attributes of all cookie samples were evaluated in fresh condition at ambient temperature. Hedonic scale rating was used for evaluation of cookies samples. Different attributes selected were appearance, taste, crispiness, aroma, and overall acceptability. There was no significant difference (P>0.05) in the appearance of the cookies, though high values were obtained in the supplemented samples with sample B having the highest mean score (7.53%), while sample D has the least score (6.95%). It can be seen that the supplemented samples have good acceptability in terms of colour, obviously contributed by the rich carotene colour of the carrot powder. Gayas et al., [27] reported improvement in colour and other sensory characteristics of carrot pomace powder incorporated with defatted soy flour fortified biscuits. There was no significant difference (P>0.05) in the taste of the substituted cookies samples. However, Sample A has the highest value (7.39%) and differ from the rest of the samples, followed by sample D (6.38%), sample B (6.33%) sample C (6.30%), with the least value in sample E (6.10%). Flavor is the main criteria that makes the product to be liked or disliked (Abu-Salem and Abou-Arab, 2011). The sensations of taste and smell are functions of flavor which is a complex of sensations (Iwe, 2007). The substituted cookies samples significantly differ from themselves and from the control (sample A) in terms of crispiness and Aroma. For crispiness, Sample A has the highest value (7.50%), closely followed by sample D (7.39%) and E (7.38%). While for Aroma, the result indicated that cookies sample A (100%) with the value of 7.54% was most preferred followed by value 7.04% of sample D (80% wheat, 15% walnut, 5% carrot). Overall, the control cookies sample (100% wheat) was rated to be most preferred but did not significantly differ (P>0.05) from the substituted cookies samples. Among the substituted samples, sample D (80% wheat, 15% walnut, 5% carrot), was most preferred (7.38%), followed closely by sample C (85% wheat,10% walnut,5%carrot) with value of 7.00%.

5. CONCLUSION

African walnut and carrot flours has been extensively researched and fund to be of laden with nutritious values. This work buttresses their potential for use as raw material in commercial confectionary industries. The study has shown

that healthy nutritious cookies can be produced from the composite flour of wheat, walnut and carrot flours. This research study indicates that cookies produced from this composite blend contain sufficient percentage of protein, good fat, minimal carbohydrate, and sufficient fiber, hence can serve as relief for malnutrition. The carrot flour was found to significantly improve the carotenoids content, a potent antioxidant which helps in neutralizing the effects of free radicals. Use of walnut and carrot flour in this work improved the Protein content of the products samples and showed more than 50% invitro protein digestibility from samples produced with 10% walnut flour and more. Also, minerals analyzed on the products of this work are not only present but can be absorbed by the body owing the bioavailability of more than 50% obtained in most of the samples. Judicious incorporation of walnut and carrot flours in suitable proportions into bakery products to enhance dietary quality with respect to fat and protein should therefore be encouraged. This could serve as a means of tackling and combating vitamin A deficiency and improve the health status of the vulnerable groups.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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