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Effect of Incorporating Orange Flesh Sweet Potato Flour, Starch and Non-starch Residue Flour to Wheat on the Quality Characteristics of Cookies

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Abstract

Cookies was produced from wheat (*Trititum spp*) orange flesh sweet potato (Ipomoea batatas L.) flour, starch and non-starch residue blends. The orange-fleshed sweet potatoes were washed, peeled, sliced, dried and milled to flour. The starch and non-starch residue were also produced from the orange-fleshed sweet potatoes. Different proportions of wheat and flour, wheat and starch and wheat and non-starch residue of orange-fleshed sweet potato with increasing level of orange-fleshed sweet potato at 10, 20, 30 and 40 % addition in wheat were prepared. Control samples were 100 % wheat flour (A_0), 100 % orange-fleshed sweet potato flour (A_1), 100 % orange-fleshed sweet potato starch (B_1) and 100 % orange-fleshed sweet potato non-starch residue (C_1). Cookies from these different proportions were formulated. The proximate, mineral, vitamin, physical properties and sensory attributes of the cookies samples and their composites were determined. The GENSTAT Statistical Software (version 17.0) was used for data analyses. The Proximate compositions of the cookies ranged as follows; moisture 9.96-12.00 %, protein 3.48-10.27 %, fat 19.21-23.11 % fibre 4.01-6.42 % ash 1.10-1.90 % and carbohydrates 50.58-58.79 %. Data for mineral composition and vitamin contents of the cookies samples ranged as follows; calcium 22.56-39.16, zinc 1.22-10.65, magnesium 2.64-33.64, phosphorus 43.00-310.00 and potassium 76.70-398.80 mg/100g), vitamin B1 0.13-0.90, vitamin B2 0.13-1.25, vitamin B6 0.12-3.37, vitamin B12 0.19-2.35, vitamin C 0.16-12.05 mg/100g and vitamin A 0.00-12496µg/100g. The physical properties of the cookies ranged from 6.22-10.18 g, 9.00-14.00 mm, 33.00-43.33 mm and 2.61-4.13 for weight, thickness, diameter and spread ratio, respectively.

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The sensory evaluation results indicated that, up to 40 % substitution of starch and non-starch residue flour was acceptable in cookies formulation, while 20 % substitution was acceptable for orange-fleshed sweet potato flour.

Keywords: proximate composition; phosphorus; zinc; potassium; sensory attributes.

1. Introduction

Cookies (also called biscuits or sweet biscuits in some countries) are baked flour confectionery dried down to low moisture content of generally less than 5 % (except for soft-type cookies). Its recipe is more variable than those of other types of bakery products [1]. According to [2], cookies are the most widely consumed bakery product due to its ready to eat nature, good nutritional quality, low cost and longer shelf life that has also been enriched with dietary fibre. Cookies are consumed extensively all over the world as a snack food and on a large scale in developing countries where protein and caloric malnutrition are prevalent [3]. Composite flour can be defined as a mixture of several flours obtained from roots and tubers, cereal, legumes, etc., with or without the addition of wheat flour [4]. Usually, the aim of producing composite flour is to get a product that is better than the individual components. Thus [5] reported that the composite flour mixture could provide a balanced nutrient. Thus, composite flour became the subject of numerous studies. There has been increasing interest in replacing conventional gluten-free formulations made from refined gluten-free flour, starch, and hydrocolloids with those enriched with functional gluten-free ingredients [6]. In developing countries such as Africa and other parts in the world, the use of composite flours had many benefits in saving of hard currency and as a promotion of high yielding of native plant species. Besides that, [7] also stated that the use of composite flour would promote better overall use of domestic agriculture production. It is considered economically advantageous to reduce or even eliminate imports of wheat and the demand for bakery products met by use of locally grown raw material [8]. Efforts have been made in many countries to produce baked products by conventional methods from wheat flour to which other flours are added. Sweet potato (*Ipomea batatas)* is a tuber of the herbaceous climbing plant known in Britain much earlier than the Irish potato. The flesh may be white, yellow or pink (if carotene is present) and its leaves are also edible [9]. Sweet potato is another of the world's most important food crops and an important staple in Nigeria and other developing countries [10]. It is a low input crop and is used as vegetable, a desert, a source of starch and animal feed [10]. The orange-fleshed sweet potato (OFSP) varieties are rich in β-carotene, the major precursor of vitamin A. This bio fortified variety was developed using conventional breeding practices drawing on sweet potato rich genetic diversity. The orange colour of OFSP is indicative of the level of β-carotene present; the more intense the colour, the more vitamin A present [11]. According to Author [12], the OFSP (along with the yellow root cassava) are examples of how research can be transferred to development on a continent-wide scale. Furthermore, they added that new employment and income generation opportunities were created through improved value chains and development of novel products contributing to a more stable food system and predictable source of income. The objectives of this research work were to evaluate the physico-chemical and sensory attributes of cookies substituted with orange fleshed sweet potato flour, starch and non-starch residue flour blends and reduce post-harvest lost of orange flesh sweet potato.

2. Materials and Methods

2.1 Source of Raw Materials

Orange-fleshed sweet potato (*Ipomea batatas L. Lam*), (Mother's delight) was purchased from the Raw Material Research and Development Centre (RMRDC) commercial outlet in Kaduna. Baking materials: wheat flour (Dangote), sugar (Dangote), baking powder (STK Royal), margarine (Simas), salt (Mr. Chef), filled milk (Cowbell), were purchased from a Supermarket in Kaura Namoda, Zamfara State. Packaging material: Johnson's polyethylene ziplock double zipper storage bags (26.8 x 27.3 cm; 17.7 x 19.5 cm) were purchased from the Abubakar Gumi Central Market, Kaduna. All laboratory materials and reagents used were of analytical grade. The raw materials were properly cleaned by removing extraneous matter prior to their subjection to different processing treatments.

2.2 Preparation of Raw Materials

2.2.1 Production of orange-fleshed sweet potato (OFSP) flour

Native Orange fleshed sweet potato (OFSP) flour was produced according to the method of [13], with modification. OFSP tubers were washed and peeled manually with knives, keeping them in water to prevent enzymatic browning. The tubers were trimmed and sliced thinly (manually) and oven dried at 60^0C, milled, sieved (0.5 mm), packaged in polyethylene bag and labeled accordingly (Figure 1).

2.2.2 Production of OFSP Starch and non-starch residue

Starch was prepared from sweet potato roots according to the method of [14], with modification as presented in figure 2. Roots were cleaned under running tap water, then manually peeled and milled in a food processor (MK-5080, National, Malaysia) by adding 1:1 (w/w) of clean water ratio for 2 min at medium speed. After filtering through sieve, the residue was subjected to repeated extraction with water (1:0.5, w/w). The filtrate was mixed and filtered through muslin cloth. Starch slurry was allowed to settle for 3 h at room temperature (30±2 ^{0}C). The supernatant was poured off. The starch in the bottom of container was re-suspended in water, filtered through cloth bag and kept in the refrigerator (8±1 ^{0}C) to settle. The settling process was repeated three times. The sediment starch was dried in a convection oven at 50 ^{0}C for 6 h, cooled to room temperature, packed and sealed in polyethylene bags. Non starch residue pulled together from the filtering processes was oven dried at 60 ^{0}C for 7 h, cooled to room temperature, packaged, and labeled accordingly. Dried starch and non-starch residue were milled, sieved, packaged and refrigerated prior to use.

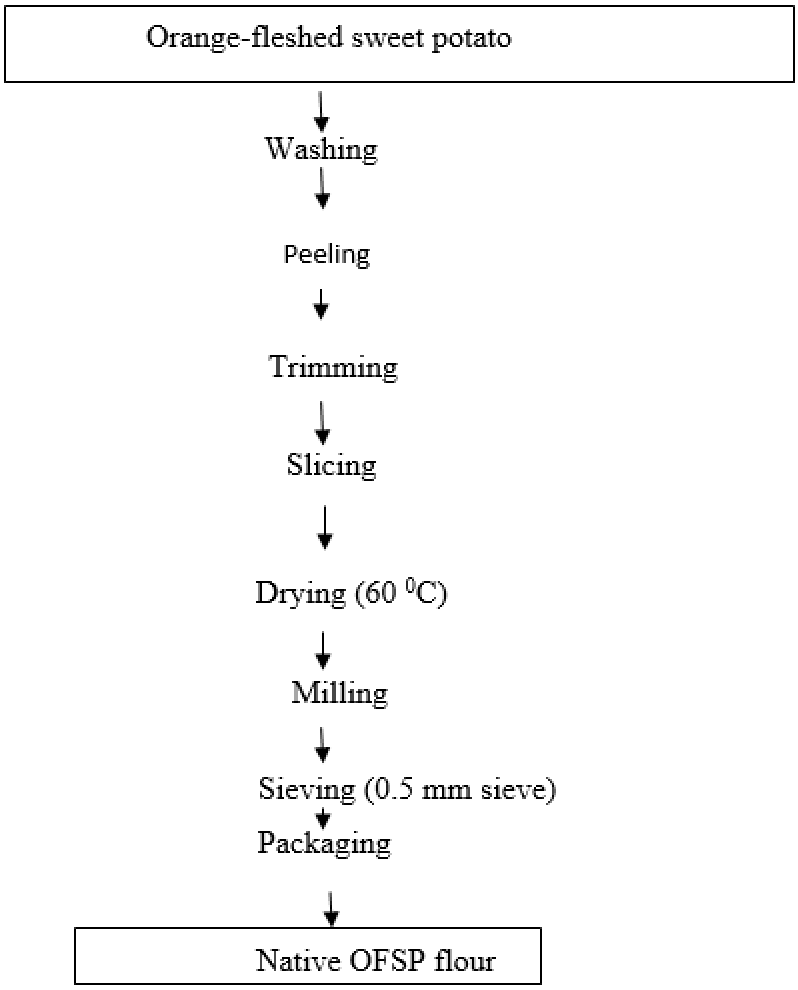

Figure 1: Flow chart for the production of native orange-fleshed sweet potato (OFSP) flour

Source: Procedure of [13] with modification.

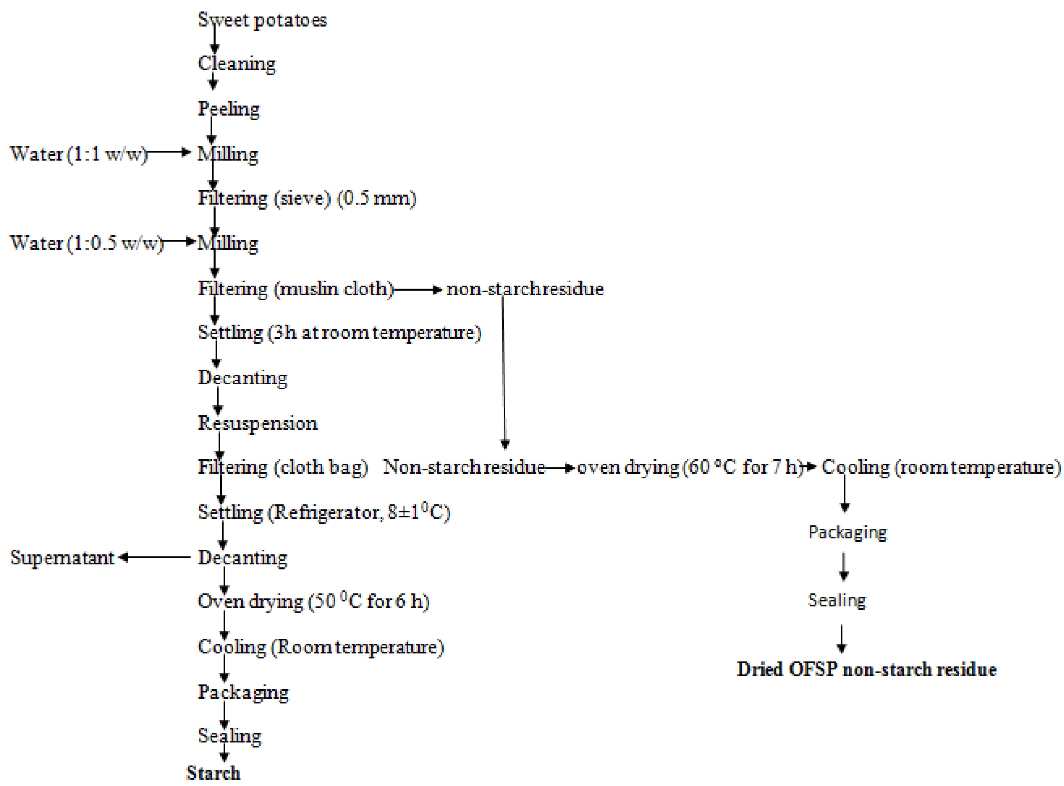

Figure 2: Flow chart for the production of orange fleshed sweet potato starch and non-starch residue

Source: Procedure of [14] with modification

2.2.3 Blend formulation

Various flour blends of wheat flour (WF) and either OFSP flour, starch or non-starch residue were produced with 10, 20, 30, and 40 percent OFSP component into wheat flour, respectively. (Table 1).

Table 1: Blend Formulation

Sample Code	**Description**
A0	100% Wheat Flour
A1	100% OFSP Flour
A2	90:10 Wheat Flour: OFSP Flour
A3	80:20 Wheat Flour: OFSP Flour
A4	70:30 Wheat Flour: OFSP Flour
A5	60:40 Wheat Flour: OFSP Flour
B1	100% OFSP Starch flour
B2	90:10% Wheat Flour: OFSP Starch flour
B3	80:20% Wheat Flour: OFSP Starch flour
B4	70:30% Wheat Flour: OFSP Starch flour
B5	60:40% Wheat Flour: OFSP Starch flour
C1	100% Non-starch Residue flour
C2	90:10% Wheat Flour: Non-starch Residue flour
C3	80:20% Wheat Flour: Non-starch Residue flour
C4	70:30% Wheat Flour: Non-starch Residue flour
C5	60:40% Wheat Flour: Non-starch Residue flour

OFSP: Orange fleshed sweet potato

2.2.4 Production of cookies and composite cookies

The method described by [15] with modification was used to produce cookies and composite cookies (Figure 5). Sugar and margarine were weighed into a Master Chef mixer (MC HM 5577) and mixed at medium speed until fluffy. Milk powder was added while mixing and then mixing continued for about 30 min. Sifted wheat flour or composite flours, baking powder and salt were slowly added to the mixture, water was added with continual mixing and kneading to form dough. It was then rolled on a flat rolling board (sprinkled with flour) to a uniform thickness, cut using cookies cutter, placed in greased baking trays and baked in the oven at 180 ^{0}C for 25 min. Other samples with different blends ratio and the control with 100 % wheat flour were baked in the same manner. Table 2 provides the Ingredients for production of bread and cookies.

Table 2: Ingredients for Production of Cookies

Component	Cookie composition
Flour (g)*	100
Sugar (g)	7
Salt (g)	1
Fat (g)	8
Baking powder (g)	1
Egg (whole)	1
Skimmed milk (g)	7.5
Water (ml)	70

***** Wheat or composite flour

Source: Procedure of [16] with modification

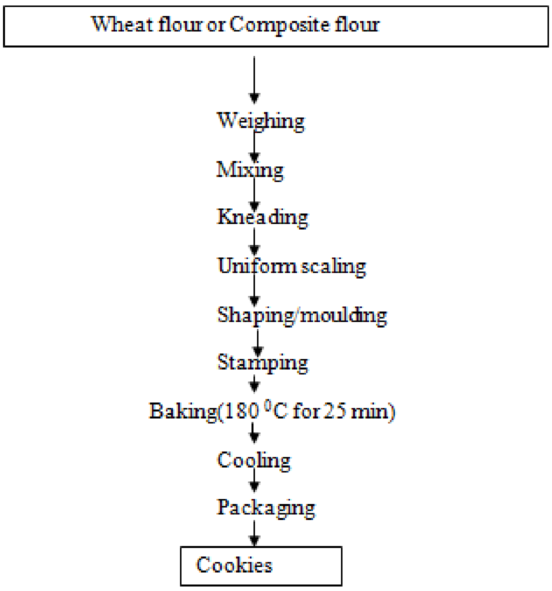

Figure 5: Flow Chart for the Production of Cookies and Composite Cookies

Source: Procedure of [15] with modification.

2.3 Determination of Proximate Composition of the Breads

The proximate composition of the cookies samples were determined by the standard methods described by [18]. Carbohydrate content was determined by difference [17].

2.3.1 Moisture

Moisture content was determined using the air oven drying method. A clean dish with a lid was dried in an oven (GENLAB, England B6S, serial no: 85K054) at 100^0C for 30min. It was cooled in desiccator and weighed. 2 g of sample was then weighed into the dish. The dish with its content was then put in the oven at 105°C and dried to a fairly constant weight. The loss in weight from the original sample (before heating) was reported as percentage moisture.

$$\% \, Moisture = \frac{weight\ loss\ (W2-W3)}{WeightofSample\ (W2-W1)} x\ 100 \qquad (1)$$

$Where$

$W1 = weight\ of\ dish,$

$W2 = weight\ of\ dish + sample\ before\ drying,$

$W3 = weight\ of\ dish + sample\ after\ drying.$

2.3.2 Crude protein

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

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

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

% Crude Protein = % Nitrogenx 6.25 (correction factor).

2.3.3 Crude fat

Crude fat was determined using Solvent extraction method. 5 g sample was weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the bottom extractor of the Soxhlet apparatus. Flat bottom flask (250ml) of known weight containing 150 – 200ml of 40 – 60^{0}C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferredinto a hot air oven (GENLAB, England B6S, serial no: 85K054) at 105^{0}C for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 min before weighing.Percentagefat content was calculated as

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

2.3.4 Crude fibre

Two gram (2 g) of the sample was extracted using diethyl ether. This was digested and filtered through the California Buchner system. The resulting residue was dried at 130 ± 2^{0}C for 2 h, cooled in a desiccator and weighed. The residue was then transferred in to a muffle furnace (Shanghai box type resistance furnace, No.: SX2-4-10N) and ignited at 550^{0}C for 30 min, cooled and weighed. The percentagecrudefibre content was calculated as:

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

2.3.5 Ash

Two gram (2 g) of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace (Shanghai box type resistance furnace, No.: SX2-4-10N) at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

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

$Where$:

$W1\ =\ Weight\ of\ empty\ crucible,$

$W2\ =\ Weight\ of\ crucible\ +\ sample\ before\ ashing,$

$W3\ =\ Weight\ of\ crucible\ +\ content\ after\ ashing.$

2.3.6 Carbohydrate

Carbohydrate content was determined by difference, viz:

$$\% \, Carbohydrate = 100 - (\% \, Moisture + \%Protein + \%Fat + \%Ash \, + \, \%Fibre) \quad (6)$$

2.4 Determination of the Mineral Content

The mineral content (Ca, Zn, P and K) of the cookies samples were determined using the standard methods described by the [18]. The cookies samples produced from wheat, orange fleshed sweet potato flour, starch and non-starch residue flour blends were subjected to mineral content determination, the Ca was determined by precipitation method, Zn and Mg by Absorption spectrophotometer, P by calorific method and K determined by Flame Photometry.

2.5 Determination of the Vitamin Content

The cookies samples produced were subjected to vitamin content determination, the B1, B2, B6 and B 12 were determined by High Performance Liquid Chromatography (HPLC) and Vitamin A by AAS as described by (AOAC, 2012)

2.6 Determination of the Physical Properties

The physical properties (weight, diameter, thickness and spread ratio) of the cookies samples were determined using standard methods described by [19].

2.6.1 Cookies weight

The bread samples were weighed using a weighing balance (Model KD- BN (CN), V5 0-2010).

2.6.2 Diameter

The diameter of the cookies were determined using a vernier calliper with 0.01mm precision.

2.6.3 Thickness

The thickness of the cookies was measured with the aid of a vernier calliper with 0.01mm precision.

2.6.4 Spread ratio

The spread ratio of the respective cookies and composite cookies was calculated as diameter divided by thickness

2.7 Determination of the Sensory Attributes of Breads

Test for acceptability: A semi-trained panel of 20 judges made up of male and female staff and students of the Department of Food Technology, Federal Polytechnic, Kaura Namoda, Zamfara State was used. The panelists were educated on the respective descriptive terms of the sensory scales and requested to evaluate the various cookies samples for taste, appearance, texture, aroma and overall acceptability using a 9-point Hedonic scale, where 9 was equivalent to like extremely and 1 meant dislike extremely. Presentation of coded samples were done randomly and portable water was provided for rinsing of mouth in between the respective evaluations [17].

2.8 Statistical Analyses

Data generated from the respective analyses were compiled appropriately and subjected to Analysis of Variance. Mean separation for sensory results was done using the Fischer's least significance difference test. All other data had the means separated using the Duncan Multiple Range test (GENSTAT Statistical package, version 17.0).

3. Results and Discussion

Table 3: Proximate Composition of Cookies and Composite Cookies

Sample	Moisture	Protein	Fat	Fibre	Ash	Carbohydrates
A0	$10.18^{bc}\pm0.06$	$10.27^{f}\pm0.06$	$19.21^{a}\pm0.01$	$5.22^{ab}\pm0.14$	$1.29^{c}\pm0.00$	$53.83^{b}\pm0.14$
A1	$9.96^{a}\pm0.04$	$3.79^{b}\pm0.14$	$23.11^{i}\pm0.12$	$4.15^{a}\pm0.03$	$1.89^{g}\pm0.01$	$57.11^{c}\pm0.09$
A2	$10.16^{bc}\pm0.07$	$9.79^{e}\pm0.02$	$19.33^{a}\pm0.13$	$5.39^{ab}\pm0.00$	$1.29^{c}\pm0.00$	$54.05^{b}\pm0.08$
A3	$10.06^{ab}\pm0.08$	$9.76^{e}\pm0.01$	$19.62^{ab}\pm0.43$	$5.39^{ab}\pm0.00$	$1.28^{c}\pm0.00$	$53.89^{b}\pm0.34$
A4	$10.12^{abc}\pm0.11$	$9.72^{e}\pm0.03$	$19.69^{abc}\pm0.04$	$5.38^{ab}\pm0.00$	$1.28^{c}\pm0.00$	$53.81^{b}\pm0.04$
A5	$10.02^{ab}\pm0.01$	$9.71^{e}\pm0.01$	$20.01^{bc}\pm0.01$	$5.38^{ab}\pm0.00$	$1.28^{c}\pm0.00$	$53.61^{b}\pm0.02$
B1	$11.08^{g}\pm0.21$	$3.48^{a}\pm0.26$	$19.26^{a}\pm0.04$	$6.42^{b}\pm3.55$	$1.14^{b}\pm0.03$	$58.62^{c}\pm3.67$
B2	$10.28^{cd}\pm0.07$	$9.51^{d}\pm0.01$	$22.62^{hi}\pm0.54$	$5.16^{ab}\pm0.04$	$1.68^{d}\pm0.02$	$50.77^{a}\pm0.60$
B3	$10.91^{fg}\pm0.03$	$9.51^{d}\pm0.00$	$22.10^{gh}\pm0.01$	$5.18^{ab}\pm0.02$	$1.69^{de}\pm0.00$	$50.62^{a}\pm0.04$
B4	$10.89^{f}\pm0.01$	$9.52^{d}\pm0.01$	$22.11^{gh}\pm0.00$	$5.20^{ab}\pm0.00$	$1.71^{e}\pm0.00$	$50.58^{a}\pm0.01$
B5	$10.15^{bc}\pm0.06$	$9.51^{d}\pm0.01$	$22.02^{g}\pm0.00$	$5.20^{ab}\pm0.00$	$1.71^{e}\pm0.00$	$51.41^{a}\pm0.07$
C1	$12.00^{h}\pm0.02$	$3.89^{b}\pm0.01$	$20.22^{cd}\pm0.01$	$4.01^{a}\pm0.01$	$1.10^{a}\pm0.00$	$58.79^{c}\pm0.00$
C2	$10.43^{de}\pm0.13$	$9.23^{c}\pm0.00$	$20.61^{de}\pm0.56$	$5.06^{ab}\pm0.06$	$1.90^{g}\pm0.01$	$52.78^{ab}\pm0.65$
C3	$10.92^{fg}\pm0.01$	$9.26^{c}\pm0.01$	$21.10^{ef}\pm0.01$	$5.09^{ab}\pm0.00$	$1.83^{f}\pm0.04$	$51.81^{ab}\pm0.04$
C4	$10.57^{e}\pm0.06$	$9.24^{c}\pm0.04$	$22.06^{gh}\pm0.07$	$5.09^{ab}\pm0.00$	$1.84^{f}\pm0.02$	$51.21^{a}\pm0.14$
C5	$11.09^{g}\pm0.02$	$9.21^{c}\pm0.01$	$21.62^{fg}\pm0.43$	$5.09^{ab}\pm0.00$	$1.82^{f}\pm0.00$	$51.17^{a}\pm0.46$

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts differ significantly ($p<0.05$).

Key: A0= 100% wheat flour. A1= 100% OFSP, A2= 90:10 Wheat flour: OFSP flour. A3= 80:20 Wheat flour: OFSP flour. A4= 70:30 Wheat flour: OFSP flour. A5= 60:40 Wheat flour: OFSP flour. B1= 100% OFSP Starch. B2= 90:10 Wheat flour: OFSP Starch. B3= 80:20 Wheat flour: OFSP Starch. B4= 70:30 Wheat flour: OFSP Starch. B5= 60:40 Wheat flour: OFSP Starch. C1= 100% Non-starch Residue. C2= 90:10 Wheat flour: Non-starch Residue. C3= Wheat flour: Non-starch Residue. C3= 80:20 Wheat flour: Non-starch Residue. C4= 70:30 Wheat flour: Non-starch Residue. C5= 60:40 Wheat flour: Non-starch Residue.

3.1 Proximate composition of Cookies and composite Cookies

The highest moisture content was recorded in the cookies produced from the control flour of orange-fleshed sweet potato non-starch residue (C_1) and the least was in the cookies produced from the control flour of orange-fleshed sweet potato (A_1). Significant ($p<0.05$) differences existed between the cookies produced from the control of orange-fleshed sweet potato flour (A_1), orange-fleshed sweet potato starch (B_1) and orange-fleshed sweet potato non-starch residue (C_1) and their respective composites cookies. The result is similar to the finding of [20] who reported a higher moisture content in non-starch residue of yam, Taro and sweet potato more than in their flour and starch counterparts. There was a reduced moisture content of cookies with the incorporation of orange-fleshed sweet potato flour to wheat which agreed with the assertion of [21] that incorporation of orange-fleshed sweet potato in wheat products reduce the moisture content due to the difference in the flour structure and water holding capacities.The protein contents of the control cookies of orange-fleshed sweet potato flour (A_1), orange-fleshed sweet potato starch (B_1) and orange-fleshed sweet potato non-starch residue (C_1) were significantly ($p<0.05$) low compared to the protein contents of wheat flour cookies and composite cookies owning to the fact that wheat is higher in protein than orange-fleshed sweet potato. Between the composite cookies of wheat and orange-fleshed sweet potato flour (A_2-A_5), wheat and orange-fleshed sweet potato starch (B_2-B_5) and wheat and orange-fleshed sweet potato non-starch residue (C_2-C_5), there were no significant ($p>0.05$) differences. There was an observed decreased protein contents in the composite cookies from orange-fleshed sweet potato flour to orange-fleshed sweet potato starch and finally to orange-fleshed sweet potato non-starch residue. The lower protein in the composite cookies of its starch and non-starch residue is attributed to the fact that orange-fleshed sweet potato starch is low in protein as reported by [22, 14]. The protein content of wheat flour cookies (A_0) is higher than all the cookies produced from the blends formulation which agreed with the reports of [23]. The relatively high protein content in the composite cookies of wheat with orange-fleshed sweet potato flour (A_2-A_5), orange-fleshed sweet potato starch (B_2-B_5) and orange-fleshed sweet potato non-starch residue (C_2-C_5) would be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high proteinous foods because of their high cost [24]. Lowest fat content was recorded in the wheat four control cookies (A_0) and the highest was in composite cookies of orange-fleshed sweet potato starch (B_2). Higher fat content was observed in the cookies products than the flour blends and bread products. This could be attributed to the fact that cookies recipe contained higher fat content than the flour blends and bread recipe. Similar report was observed by [25] from flour blends and cookies produced from orange-fleshed sweet potato and mango. The high fibre contents of the cookies produced from both wheat flour, orange-fleshed sweet potato flour, orange-fleshed sweet potato starch and orange-fleshed sweet potato non-starch residue are good enough for the body because their presence in food products are essential owing to their ability to facilitate bowel movement (peristalsis), bulk addition to food and prevention of many gastrointestinal diseases in man [26]. The ash contents of both controls and composite cookies suggest that the product would provide more minerals to consumers. Thus [27] observed similar ash contents from biscuits and instant noodles produced from composites of wheat and orange-fleshed sweet potato respectively. There was a significant reduction in the carbohydrate content of the cookies in comparison to the carbohydrate contents of flour blends and bread samples. This could be attributed to the high protein and fat contents of cookies as the result of the cookies recipes used.

Table 4: Mineral Composition (mg/100g) of Cookies and Composite Cookiess

Sample	Calcium	Zinc	Magnesium	Phosphorus	Potassium
A0	27.66^{d}±0.49	2.95^{b}±0.09	3.02^{b}±0.01	262.70^{d}±5.01	308.70^{d}±0.64
A1	36.41^{g}±0.02	10.65^{e}±0.02	33.64^{h}±0.40	151.20^{b}±1.47	398.80^{e}±0.69
A2	27.30^{cd}±0.01	2.91^{b}±0.03	3.91^{c}±0.07	258.70^{d}±0.78	300.20^{d}±0.13
A3	27.00^{c}±0.00	2.91^{b}±0.00	3.96^{c}±0.00	259.30^{d}±0.01	300.10^{d}±0.01
A4	26.95^{c}±0.02	2.91^{b}±0.00	4.32^{d}±0.01	260.00^{d}±0.01	300.00^{d}±0.00
A5	26.94^{c}±0.00	2.90^{b}±0.00	4.74^{e}±0.25	261.20^{d}±0.07	300.00^{d}±0.00
B1	22.56^{a}±0.50	2.95^{b}±0.02	22.29^{g}±0.04	43.00^{a}±0.05	200.20^{b}±0.00
B2	26.12^{b}±0.02	1.22a±0.01	2.64^{a}±0.40	200.70^{c}±0.78	305.20^{d}±7.13
B3	26.40^{b}±0.01	1.22^{a}±0.00	3.30^{b}±0.01	200.20^{c}±0.01	300.20^{d}±0.03
B4	26.96^{c}±0.04	1.23^{a}±0.00	3.34^{b}±0.02	203.30^{c}±0.01	257.10^{c}±70.91
B5	26.98^{c}±0.01	1.23a±0.00	3.37^{b}±0.04	209.90^{c}±0.01	308.10^{d}±1.49
C1	39.16^{h}±0.06	6.67^{d}±0.08	4.20^{cd}±0.01	134.70^{b}±2.10	76.70^{a}±0.76
C2	28.76^{e}±0.52	3.31^{c}±0.01	13.25^{f}±0.06	266.80^{d}±0.77	321.70^{d}±0.66
C3	30.06^{f}±0.18	3.31^{c}±0.00	13.29^{f}±0.00	297.70^{de}±0.77	316.70^{d}±6.35
C4	29.99^{f}±0.00	3.32^{c}±0.00	13.40^{f}±0.01	260.30^{d}±72.08	317.20^{d}±7.12
C5	30.05^{f}±0.06	3.33^{c}±0.00	13.31^{f}±0.01	310.00^{e}±0.00	323.90^{d}±0.04

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts differ significantly ($p<0.05$).

Key: A0= 100% wheat flour. A1= 100% OFSP, A2= 90:10 Wheat flour: OFSP flour. A3= 80:20 Wheat flour: OFSP flour. A4= 70:30 Wheat flour: OFSP flour. A5= 60:40 Wheat flour: OFSP flour. B1= 100% OFSP Starch. B2= 90:10 Wheat flour: OFSP Starch. B3= 80:20 Wheat flour: OFSP Starch. B4= 70:30 Wheat flour: OFSP Starch. B5= 60:40 Wheat flour: OFSP Starch. C1= 100% Non-starch Residue. C2= 90:10 Wheat flour: Non-starch Residue. C3= Wheat flour: Non-starch Residue. C3= 80:20 Wheat flour: Non-starch Residue. C4= 70:30 Wheat flour: Non-starch Residue. C5= 60:40 Wheat flour: Non-starch Residue.

3.2 Mineral composition of Cookies and composite Cookies

Potassium, and phosphorus were the predominant minerals in the cookies recorded in both the cookies and composite cookies of wheat, orange-fleshed sweet potato flour, starch and non-starch residue samples. While calcium is low, magnesium and zinc were lower. Author [28] described sweet potato as a moderate source of magnesium. Calcium is more prominent in the cookies produced from orange-fleshed sweet potato flour (A_1) and in the cookies and composite cookies of non-starch residue more than the wheat control cookies (A_0). This demonstrates that processing of orange-fleshed sweet potato to non-starch residue can greatly improve mineral constituents such as calcium and magnesium. The zinc content of the 100 % orange-fleshed sweet potato flour cookies was significantly ($p<0.05$) higher than other cookies' samples. The composite cookies of non-starch residue (C_2-C_5) gave higher contents of zinc and was followed by composite cookies of orange-fleshed sweet potato flour (A_2-A_5) but showed no significant ($p>0.05$) differences between each composite cookies. The most abundant mineral in the cookies and composite cookies is potassium followed by phosphorus which agreed and correspond with the finding of [29]. The high potassium contents of the cookies and composite cookies will make them suitable for use by hypertensive individuals [29].

Table 5: Vitamin Content of Cookiess and Composite Cookiess

Sample	**Vitamins (mg/100g)**					
	B1	B2	B6	B12	C	A(µg/100g)
A0	$0.33^{e}\pm0.01$	$0.26^{d}\pm0.04$	$0.64^{bc}\pm0.04$	$0.19^{a}\pm0.22$	$0.16^{a}\pm0.05$	$0.00^{a}\pm0.00$
A1	$0.19^{b}\pm0.01$	$0.13^{a}\pm0.01$	$3.37^{h}\pm0.07$	$2.12^{f}\pm0.01$	$11.26^{h}\pm0.14$	$12496.00^{f}\pm233.42$
A2	$0.21^{d}\pm0.00$	$0.19^{bc}\pm0.00$	$0.62^{c}\pm0.01$	$0.30^{a}\pm0.00$	$1.06^{b}\pm0.08$	$131.00^{abc}\pm1.41$
A3	$0.20^{c}\pm0.00$	$0.19^{bc}\pm0.00$	$0.62^{bc}\pm0.00$	$0.29^{a}\pm0.00$	$1.02^{b}\pm0.01$	$169.00^{bcd}\pm0.84$
A4	$0.20^{c}\pm0.00$	$0.19^{bc}\pm0.00$	$0.62^{bc}\pm0.00$	$0.30^{a}\pm0.00$	$1.02^{b}\pm0.00$	$210.00^{cd}\pm0.00$
A5	$0.20^{c}\pm0.00$	$0.18^{b}\pm0.00$	$0.62^{bc}\pm0.00$	$0.30^{a}\pm0.00$	$1.03^{b}\pm0.00$	$289.00^{d}\pm0.71$
B1	$0.13^{a}\pm0.01$	$0.21^{c}\pm0.00$	$0.12^{a}\pm0.00$	$1.93^{e}\pm0.00$	$12.05^{i}\pm0.06$	$0.00^{a}\pm0.00$
B2	$0.33^{ef}\pm0.00$	$0.38^{e}\pm0.02$	$0.93^{df}\pm0.00$	$0.95^{b}\pm0.02$	$2.08^{f}\pm0.02$	$0.00^{a}\pm0.00$
B3	$0.33^{f}\pm0.00$	$0.39^{ef}\pm0.00$	$0.98^{fg}\pm0.00$	$0.99^{b}\pm0.01$	$2.09^{f}\pm0.00$	$0.00^{a}\pm0.00$
B4	$0.42^{g}\pm0.00$	$0.42^{g}\pm0.00$	$0.99^{fg}\pm0.00$	$0.99^{b}\pm0.00$	$2.06^{f}\pm0.00$	$0.00^{a}\pm0.00$
B5	$0.41^{g}\pm0.00$	$0.42^{fg}\pm0.01$	$0.99^{fg}\pm0.00$	$0.99^{b}\pm0.00$	$2.07^{f}\pm0.01$	$0.00^{a}\pm0.00$
C1	$0.90^{h}\pm0.00$	$1.25^{j}\pm0.02$	$1.21^{g}\pm0.01$	$2.35^{g}\pm0.20$	$9.25^{g}\pm0.02$	$6269.00^{e}\pm60.86$
C2	$0.33^{ef}\pm0.00$	$0.93^{h}\pm0.00$	$0.39^{b}\pm0.42$	$1.03^{b}\pm0.01$	$1.26^{c}\pm0.01$	$43.00^{ab}\pm0.83$
C3	$0.33^{ef}\pm0.00$	$0.96^{i}\pm0.00$	$0.69^{cd}\pm0.00$	$1.11^{bc}\pm0.02$	$1.36^{d}\pm0.04$	$67.00^{ab}\pm0.92$
C4	$0.33^{ef}\pm0.00$	$0.96^{i}\pm0.00$	$0.69^{cde}\pm0.00$	$1.24^{cd}\pm0.01$	$1.43^{d}\pm0.01$	$110.00^{abc}\pm0.23$
C5	$0.33^{ef}\pm0.00$	$0.97^{i}\pm0.00$	$0.69^{cde}\pm0.00$	$1.30^{d}\pm0.01$	$1.86^{e}\pm0.04$	$130.00^{abc}\pm1.27$

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts differ significantly ($p<0.05$).

Key: A0= 100% wheat flour. A1= 100% OFSP, A2= 90:10 Wheat flour: OFSP flour. A3= 80:20 Wheat flour: OFSP flour. A4= 70:30 Wheat flour: OFSP flour. A5= 60:40 Wheat flour: OFSP flour. B1= 100% OFSP Starch. B2= 90:10 Wheat flour: OFSP Starch. B3= 80:20 Wheat flour: OFSP Starch. B4= 70:30 Wheat flour: OFSP Starch. B5= 60:40 Wheat flour: OFSP Starch. C1= 100% Non-starch Residue. C2= 90:10 Wheat flour: Non-starch Residue. C3= Wheat flour: Non-starch Residue. C3= 80:20 Wheat flour: Non-starch Residue. C4= 70:30 Wheat flour: Non-starch Residue. C5= 60:40 Wheat flour: Non-starch Residue.

3.3 Vitamin content of Cookie and composite Cookies

Processing of orange-fleshed sweet potato to starch and non-starch residue resulted to an increased thiamine and riboflavin contents of the cookies and composite cookies more than the cookies and composite cookies of orange-fleshed sweet potato flour. The cookies of orange-fleshed sweet potato flour (A_1) and non-starch residue (C_1) were significantly ($p<0.05$) higher than other cookies samples in their pyridoxine and cobalamin contents.

This shows that processing orange-fleshed sweet potato reduces its pyridoxine and cobalamin vitamins content. The vitamin C content of the cookies is higher in that of orange-fleshed sweet potato flour (A_1), orange-fleshed sweet potato starch (B_1) and orange-fleshed sweet potato non-starch residue (C_1) but low in wheat flour cookies and the composite cookies. The reduction in the composite cookies is attributed to the low vitamin C wheat flour content. While [30] reported low level of vitamin C in 100 % wheat flour cookies, [31] revealed significant presence of vitamin C in orange-fleshed sweet potato and [32] reported a higher content of vitamin C in cookies produced from 100 % orange-fleshed sweet potato flour than 100 % wheat flour. This report is similar to that reported by [33] for cooked orange-fleshed sweet potato. Similar to flour and bread samples, the wheat flour cookies A0 recorded no vitamin A content due to non-presence of vitamin A in wheat, a trend also reported by [19]. Orange-fleshed sweet potato flour which is a good source of vitamin A as reported by [33, 34, 35], gave the highest vitamin A content of cookies and was significantly ($p<0.05$) different from other cookies samples. Orange- fleshed sweet potato (OFSP) is an excellent source of vitamin A and a cheaper source of this vitamin for poor rural and urban families in sub- Saharan Africa [36]. Thus [33] reported a value as high as 788 mg/100g RAE of vitamin A in orange-fleshed sweet potato. Contrary to the assertion of [27] that orange-fleshed sweet potato flour can retain beta-carotene which determines the quantity of vitamin A available in the flour despite being subjected to different processing methods, the vitamin A content of cookies and composite cookies of orange-fleshed sweet potato starch (B_1-B_5) were greatly affected and gave zero contents due to processing. The present study (cookies and composite cookies of orange-fleshed sweet potato flour and non-starch residue) showed potential of cookies enriched with orange-fleshed sweet potato for combating vitamin A deficiency (VAD) and could be promoted as the new developed product to the (VAD) consumers to alleviating nutritional insecurity.

Table 6: Physical Properties of Cookies and Composite Cookies

Sample	Weight (g)	Thickness (mm)	Diameter (mm)	Spread ratio
A0	7.58^{abc}±0.17	12.67^{efg}±0.58	33.67^{ab}±0.58	2.66^{ab}±0008
A1	8.37^{bcd}±1.22	9.67^{ab}±0.58	35.00^{abc}±0.00	3.63^{def}±0.23
A2	8.24^{bc}±0.86	14.00^{g}±1.00	37.33^{cde}±2.08	2.67^{ab}±0.22
A3	8.84^{bcd}±1.51	14.00^{g}±1.00	36.33^{bcd}±1.53	2.61^{ab}±0.28
A4	9.38^{cd}±0.66	12.67^{defg}±0.58	39.00^{def}±1.00	3.08^{bcd}±0.17
A5	7.98^{abc}±1.09	10.33^{abc}±1.15	39.67^{ef}±1.16	3.89^{ef}±0.58
B1	7.39^{ab}±0.28	10.50^{abcd}±0.50	43.33^{g}±0.58	4.13^{f}±0.15
B2	10.18^{d}±1.56	16.67^{h}±0.58	39.00^{def}±1.00	2.36^{a}±0.08
B3	6.22^{a}±0.51	12.67^{defg}±1.15	36.33^{bcd}±1.16	2.89^{abc}±0.33
B4	8.76^{bcd}±2.10	14.00^{g}±3.00	41.00^{fg}±2.65	3.00^{abc}±0.47
B5	6.28^{a}±0.35	13.67^{fg}±0.58	38.67^{def}±2.08	2.83^{abc}±0.28
C1	7.41^{ab}±0.58	9.00^{a}±1.00	33.00^{a}±1.00	3.69^{def}±0.30
C2	7.24^{ab}±0.38	13.33^{fg}±0.58	36.33^{bcd}±0.58	2.73^{ab}±0.14
C3	8.70^{bcd}±0.32	10.67^{abcde}±0.58	36.00^{abcd}±2.65	3.39^{cde}±0.44
C4	8.80^{bcd}±1.31	12.33^{cdefg}±1.53	34.67^{abc}±2.52	2.89^{abc}±0.34
C5	8.11^{abc}±0.23	11.67^{bcdef}±1.53	36.33^{bcd}±2.52	3.17^{bcd}±0.66

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts differ significantly (p<0.05).

Key: A0= 100% wheat flour. A1= 100% OFSP, A2= 90:10 Wheat flour: OFSP flour. A3= 80:20 Wheat flour: OFSP flour. A4= 70:30 Wheat flour: OFSP flour. A5= 60:40 Wheat flour: OFSP flour. B1= 100% OFSP Starch. B2= 90:10 Wheat flour: OFSP Starch. B3= 80:20 Wheat flour: OFSP Starch. B4= 70:30 Wheat flour: OFSP Starch. B5= 60:40 Wheat flour: OFSP Starch. C1= 100% Non-starch Residue. C2= 90:10 Wheat flour: Non-starch Residue. C3= Wheat flour: Non-starch Residue. C3= 80:20 Wheat flour: Non-starch Residue. C4= 70:30 Wheat flour: Non-starch Residue. C5= 60:40 Wheat flour: Non-starch Residue.

3.4 Physical properties of Cookies and composite Cookies

The weight and thickness of the cookies samples showed that sample B_2 was significantly (p<0.05) heavier and thicker than all other cookies and composite cookies samples. The variation in weight and thickness of sample B_2 cookies compared with the other control cookies and composite cookies may have some implications for sales. Sample B_1 had the largest diameter and was significantly different from the diameters of other cookies samples. The result of the present study is in line with the findings of [37] for diameter and thickness of cookies produced from wheat supplemented with orange-fleshed sweet potato. Sample B_2 spread lesser than other cookies samples which suggests that the starches in it are very hydrophilic [38], while sample B_1 spread more than other cookies samples. Low spread ratio suggests that the starches in the cookies are very hydrophilic [38].

Table 7: Sensory Evaluation of Cookies and Composite Cookies

Sample	Taste	Appearance	Texture	Aroma	Overall acceptability
A0	$6.93^c±0.80$	$6.93^c±0.80$	$7.40^c±0.99$	$7.20^c±0.86$	$7.47^a±1.13$
A1	$4.80^a±0.77$	$4.27^a±0.80$	$4.67^a±0.82$	$5.60^a±0.63$	$6.67^a±1.35$
A2	$6.07^b±0.59$	$5.93^b±0.96$	$6.73^{bc}±0.96$	$6.67^{bc}±0.98$	$7.13^a±1.25$
A3	$6.20^b±0.77$	$6.60^c±0.63$	$6.67^{bc}±1.18$	$6.60^{bc}±0.74$	$7.00^a±1.36$
A4	$6.40^{bc}±0.74$	$7.00^c±0.65$	$6.47^b±1.25$	$6.53^b±1.06$	$7.00^a±1.36$
A5	$6.27^b±0.80$	$6.93^c±0.59$	$6.60^b±1.24$	$6.27^b±0.96$	$6.93^a±1.39$
LSD	0.54	0.55	0.79	0.64	0.95
B1	$4.47^a±1.06$	$5.40^a±0.83$	$5.27^a±0.70$	$5.13^a±0.74$	$4.67^a±0.90$
B2	$6.27^{bc}±0.88$	$6.20^b±0.86$	$5.87^b±0.74$	$5.60^a±0.83$	$5.07^{ab}±0.70$
B3	$5.93^b±0.80$	$6.20^b±0.94$	$5.67^{ab}±1.05$	$5.13^a±0.83$	$5.20^{ab}±0.68$
B4	$6.60^c±0.83$	$5.53^a±0.74$	$5.47^{ab}±0.74$	$5.60^a±0.99$	$5.53^b±0.64$
B5	$6.47^{bc}±0.74$	$5.60^{ab}±0.74$	$5.73^{ab}±0.70$	$5.13^a±0.92$	$5.53^b±0.83$
LSD	0.63	0.60	0.58	0.63	0.55
C1	$5.47^a±0.99$	$4.00^a±0.76$	$3.33^a±0.82$	$5.00^a±0.65$	$5.73^a±0.70$
C2	$6.13^b±0.92$	$5.00^b±1.07$	$4.07^b±0.70$	$5.33^a±0.62$	$6.87^c±0.74$
C3	$6.07^{ab}±0.70$	$6.40^c±0.74$	$4.67^c±0.98$	$5.47^a±0.64$	$6.67^{bc}±0.72$
C4	$6.07^{ab}±0.96$	$6.20^c±0.86$	$6.07^d±0.70$	$5.47^a±0.92$	$6.20^{ab}±0.68$
C5	$6.13^b±0.83$	$6.07^c±0.59$	$5.87^d±0.64$	$5.47^a±0.92$	$7.07^c±0.70$
LSD	0.65	0.60	0.57	0.55	0.52

Means in the same column with different superscripts differ significantly (p<0.05)..

Key: A0= 100% wheat flour. A1= 100% OFSP, A2= 90:10 Wheat flour: OFSP flour. A3= 80:20 Wheat flour: OFSP flour. A4= 70:30 Wheat flour: OFSP flour. A5= 60:40 Wheat flour: OFSP flour. B1= 100% OFSP Starch. B2= 90:10 Wheat flour: OFSP Starch. B3= 80:20 Wheat flour: OFSP Starch. B4= 70:30 Wheat flour: OFSP Starch. B5= 60:40 Wheat flour: OFSP Starch. C1= 100% Non-starch Residue. C2= 90:10 Wheat flour: Non-starch Residue. C3= Wheat flour: Non-starch Residue. C3= 80:20 Wheat flour: Non-starch Residue. C4= 70:30 Wheat flour: Non-starch Residue. C5= 60:40 Wheat flour: Non-starch Residue.

3.5 Sensory attributes of Cookies and composite Cookies

Cookies produced from 100 % wheat flour (A_0) tasted better than all other cookies sample but not significantly ($p>0.05$) different from samples A_4, B_2, B_3 and B_4while sample B_1had the least score for taste. An attractive golden brown colour was observed on all of the cookies and composite cookies. Sample A_4 appeared more appealing than other cookies samples but not significantly ($p>0.05$) different from 100 % wheat flour cooking sample (A_0) and other composite cookies (A_3-A_5), and (C_3-C_5). The beautiful appearance imparted by the peculiar colour of the orange-fleshed sweet potato could be responsible for the higher appearance rating of some of the composite cookies than the cookies produced from 100 % wheat flour. This is similar to the finding of [39] who discovered a higher appearance of biscuits and breads of composite wheat- orange-fleshed sweet potato more than the biscuits and bread from the control of wheat flour respectively. The cookies produced from control flour of wheat gave the highest texture which differed significantly ($p<0.05$) from other cookies samples. The textural values of the cookies reported here correspond with the cookies produced from wheat-defatted rice bran composite flours by [40] for wheat-breadfruit composite flour. Similar to the findings of [41], the cookies produced from the control flour of wheat was significantly ($p<0.05$) different from other cookies samples. There was no significant ($p>0.05$) difference between the cookies and composite cookies of both the orange-fleshed sweet potato starch (B_1-B_5) and non-starch residues (C_1-C_5). The result of the overall acceptability shows no significant ($p>0.05$) difference between wheat control cookies (A_0), orange-fleshed sweet potato control cookies (A_1) and its composite cookies (A_2-A_5). Also, it is not significantly ($p>0.05$) different from cookies of orange-fleshed sweet potato starch (B_1) and non-starch residue cookies (C_1). The present study findings are similar with the findings of [37] for wheat-orange fleshed composite cookies.

4. Conclusion

The composite cookies (B1 and C5) recorded higher moisture contents than the cookies from 100 % wheat flours. Generally, the protein, fat, fibre and ash contents of the composites cookies from orange-fleshed sweet potato flour (A_1), starch (B_1) and non-starch residue (C_1) were low, but higher contents were observed in the other samples of the cookies. The phosphorus and potassium contents of the cookies were high as compared to calcium, zinc and magnesium. The vitamin C contents of the cookies of orange-fleshed sweet potato flour (A_1), starch (B_1) and non-starch residue (C_1) were high but decreased in their composites cookies. The cookies of wheat (A_0), orange-fleshed sweet potato starch and its composites (B_1-B_5) lacked vitamin A, but grandeur was observed in the cookies of orange-fleshed sweet potato flour and its composites (A_1-A_5). The study showed that the composite cookies produced from orange-fleshed sweet potato flour, starch and non-starch residue were of higher weights than the cookies produced from wheat flour. except samples B_1, B_3 C_1 and C_2 with lower weights than wheat flour cookies. The diameters of the cookies compared favourably with each other. It also showed that both the wheat (A_0) cookies tasted better than other cookies samples formulated from orange-fleshed sweet potato flour, starch and non-starch residue. The results of the overall acceptability of the cookies revealed that wheat flour can be substituted with orange-fleshed sweet potato flour without greatly affecting the overall acceptability of the and cookies. The study revealed that up to 40 % inclusion of starch and non-starch residue flour was acceptable in cookies formulation.

5. Recommendation

Based on the findings of this study, the composite flours and cookies of orange-fleshed sweet potato, starch and non-starch residue be used in the supplementation of wheat flour in confectioneries production due to their high nutritional contents. Cookies of acceptable quality was produced from composites with up to 20 % substitution of wheat flour with either orange-fleshed sweet potato flour, starch or residue flours and thus recommended. further study be carried out to ascertain the cookies storage stability.

6. Conflict of Interest

Authors declare no conflict of interest.

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References

[1]. Onwuka, G.I (2014). Food Science and Techology. Somolu: Naphtali prints. Pp 349-360

[2]. Adeleke, R. O. and Odedeji, J. O. (2010). Acceptability Studies of Bread Fortified with Tilapia Fish Flour. Pakistan Journal of Nutrition, 9(6): 531-534.

[3]. Chinma, C. E. and D.I. Gernah (2007). Physicochemical and sensory properties of cookies produced from cassava/soya bean/mango composite flours. J. Raw Mat. Res., 4: 32-43.

[4]. Adeyemi, S.A. O. and Ogazi, P.O., 1985. The Place of Plantain in Composite Flour. Commerce Industry, Lagos state, Nigeria, WHO Rep Seri 1973 No 522 WHO Geneva.

[5]. Shantthi P, John Kennedy Z, Parvathi K, Malathi D, Thangavel K and Raghavan GSV. (2005). Studies on wheat based composite flour for pasta products. Indian Journal Nutritional Diet, 42: 503-506.

[6]. Alvarez-Jubete, L., Arendt, E.K. and Gallagher, E. (2010). Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients. Trends in Food Science and Technology, 21(2), 106–113.

[7]. Bugusu, B.A., Campanella, O. and Hamaker, B.R. (2001). Improvement of sorghum-wheat composite dough rheological properties and breadmaking quality through zein addition. Cereal Chemistry, 78(1), 31-35.

[8]. Mepba, H., Eboh, L. and Nwaojigwa, S. U. (2007). Chemical Composition Functional and Baking Properties of Wheat-Plantain Composite Flours. African Journal of Food, Agriculture, Nutrition and

Development, 7: 1-22.

[9]. Bender, A.E. and Bender, D.A. (1995). A Dictionary of food and Nutrition. Oxford: oxford University Press. Pp 293, 298-299, 342.

[10]. Odebode, S. O., Egeonu N and Akoroda M.O (2008). Promotion of sweet potato for the food industry in Nigeria. bulg. j. agric. sci., 14: 300-308.

[11]. RMRDC (2017). Sweet Potato for Health and Wealth in Nigeria: The Rainbow Project Bulletin. Raw Material Research and Development Council (RMRDC) Bulletin.

[12]. Nteranya, S and Adiel, M (2015) Root and Tuber Crops (Cassava, Yam, Potato and Sweet potato). Paper presented at an international conference in Senegal, Pp 1-26.

[13]. Avula, R.Y. (2005). Rheological and Functional Properties of Potato and Sweet Potato Flour and Evaluation of its Application in Some Selected Food Products. Ph.D Thesis. Department of Fruit and Vegetable Technology. University of Mysore, Mysore, India. 131pp.

[14]. Soison, B., Jangchud, K., Jangchud, A., Harnsilawat, T. and Piyachomkwan, K. (2015). Characterization of Starch in Relation to Flesh Colours ofSweet Potato Varieties. International Food Research Journal 22(6): 2302-2308.

[15]. 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.

[16]. Olapade, A. A. and Adeyemo, A. M. (2014). Evaluation of Cookies Produced from Blends of Wheat, Cassava and Cowpea Flours. International Journal of Food Studies, 3: 175-185.

[17]. Onwuka, G.I. (2018). Food Analysis and Instrumentation theory and Practice: Analytical Techniques. 2nd Ed. Surulere., Naphthali prints, pp 229-230, 342-352, 413-453.

[18]. A.O.A.C. (2012). Official methods of Analysis. 19th edition. Association of official Analytical Chemists. Washington, D.C., U.S.A.

[19]. Dabel, N., Igbabul, B.D, Amove, J., Iorliam, B. (2016). Nutritional Composition , physical and sensory properties of cookies from wheat, acha and mung bean composite flours. International Journal of Nutrition and Food Science. 5(6):401-406.

[20]. Aprianita, A., Purwandari, U., Watson, B. and Vasiljevic, T. (2009). Physico-Chemical Properties of Flours and Starches from Selected Commercial Tubers Available in Australia. International Food Research Journal**,** 16**:** 507-520**.**

[21]. Richelle, M. A, Wilma AH, Erlinda, I. D. (2013). The Nutritional Value and Phyto-chemical Components of Taro [Colocasia esculenta (L.) Schott] Powder and its Selected Processed Foods. Journal of Nutrition and Food Science. 3: 207.

[22]. Eke-Ejiofor, J. (2015). Physico-chemical and Pasting Properties of Starches from Cassava, Sweet Potato and three Leaf Yam and their Application in Salad Cream Production. International Journal of Biotechnology and Food Science, 3(2): 23-30.

[23]. Mais, A. (2008). Utilization of Sweet Potato Starch, Flour and Fibre in Bread and Biscuits: Physico-Chemical and Nutritional Characteristics. M.Tech. Thesis. Department of Food Technology, Massey University.

[24]. Atobatele, O. B. and Afolabi, M. O. (2016). Chemical Composition and Sensory Evaluation of Cookies Baked from the Blends from the Blends of Soya Bean and Maize Flours. Applied Tropical

Agriculture,21(2):8-13.

[25]. Sengev, I. A, Gernah, D. I and Bunde-Tsegba, M. C. (2015). Physical, Chemical and Sensory Properties of Cookies Produced from Sweet Potato and Mango Mesocarp Flours. African Journal of Food, Agriculture, Nutrition and Development, 5(5): 10428-10442.

[26]. Satinder, K., Sativa, S., and Nagi, H. P. S. (2011). Functional Properties and Anti-Nutritritional Factors in Cereal Bran. Asian Journal of Food and Agro- Industry, 4: 122-131.

[27]. Effiong, B. N., Maduka, N. and Essien, A. G. (2018). Evaluation of Wheat and Orange-fleshed Sweet Potato Composite Flour Fortified with African Yam Bean Flour for Instant Noodle Production. Archives of Current Research International, 13(4): 1-15.

[28]. Sneha, S., Genitha, T., and Vrijesh, Y., (2012). Preparation and Quality Evaluation of Flour and Biscuit from Sweet Potato. Journal of Food Processing and Technology, 3(12): 1-5.

[29]. Ufot, E. I., Comfort, F. E. and Anne, P. E. (2018). Physical Properties, Nutritional Composition and Sensory Evaluation of Cookies Prepared from Rice, Unripe Banana and Sprouted Soybean Flour Blends. International Journal of Food Science and Biotechnology, 3(2): 70-76.

[30]. Onyekwelu, C. N. and Ogbu, O. A. C (2017). Quality Assessment of Cookies Produced from Composite Flour of Wheat, unripe Plantain and Moringa Leaf. Science Arena Publications Specialty Journal of Agricultural Sciences, 3(2): 1-7.

[31]. Grace, M. H., Yousef, G. G., Gustafson, S. J., Truong, V. D., Yencho, G.C., and Lila, M. A. (2014). Phytochemical Changes in Phenolics, Anthocyanins,Ascorbic Acid, and Carotenoids Associated with SweetPotatoStorage and Impacts on Bioactive Properties. Food Chemistry, 145: 717-724.

[32]. Fausat, L. K., Bolanle, A. A. and Beatrice, I. O. A.(2018). Physicochemical Properties of Novel Cookies Produced from Orangefleshed Sweet Potato Cookies Enriched with Sclerotium of Edible Mushroom (Pleurotustuberregium). Journal of the Saudi Society of Agricultural Sciences, 19(2020): 174-178.

[33]. USDA. (2003). USDA National Nutrient Database for Standard Reference, Release 16.

[34]. Christina, S. L. (2007). Nutrient and Sensory Quality of Orange-fleshed Sweet Potato. M. Sc. Thesis. Department Consumer Science School of Agricultural and Food Sciences. University of Pretoria, South Africa.

[35]. Buzo, H. (2016). Development of Orange Fleshed Sweet Potato and Bambara groundnut-based snacks for School Children in Tanzania. M.Sc. Thesis. Department of Food Technology and Nutrition. Sokoine University of Agriculture, Makerere, Tanzania. 82pp.

[36]. Gebremedhin, K., Kebede, A., Afework, M. and Pragya, S.(2013). Nutritional Analysis of Vitamin A Enriched Bread fromOrange Flesh Sweet Potato and Locally Available Wheat Flours at Samre Woreda, Northern Ethiopia. Current Research in Nutrition and Food Science, 1(1): 49-57.

[37]. Jessica, A., Herman, L.,Reginald, A. A.Anthony, E. and Su, P. L. (2019). Nutritional Composition and Acceptability of Biscuits Fortified with Palm Weevil Larvae (Rhynchophorus phoenicis fabricius) and Orange- Fleshed Sweet Potato Among Pregnant Women. Food Science and Nutrition,7:1807-1815.

[38]. Temesgen, L., Abebe, H. and Tigist, F. (2015). Production and Quality Evaluation of Cookies Enriched with β-Carotene by Blending Orange-Fleshed Sweet Potato and Wheat flours for Alleviation of Nutritional Insecurity. International Journal of Food Science and Nutrition Engineering, 5(5): 209-217.

[39]. Okpala, L. C. and Egwu, P. N. (2015). Utilization of Broken Rice and Cocoyam Flour Blends in the Production of Biscuit. Nigerian Food Journal, 33(1): 8-11.

[40]. Andualem, A., Kebede, A. and Abadi, G. M. (2016). Development of Pro-Vitamin A and Energy Rich Biscuits: Blending of Orange-fleshed Sweet Potato (Ipomea batatas L.) with Wheat (Triticum vulgare) Flour and Altering Baking Temperature and Time. African Journal of Food Science, 10(6): 79-86.

[41]. Taiwo, A. A. and Olajide, J. A. (2015). Quality Evaluation of Cookies from Wheat and Breadfruit Composite Flour. Annals of Food Science and Technology, 16(2): 354-358.

[42]. Endrias, D., Negussie, R., and Gulelat, D. (2016). Comparison of three Sweet Potato (Ipomoea Batatas (L.) Lam) Varieties on Nutritional and Anti-Nutritional Factors. Global Journal of Science Frontier Research: D Agriculture and Veterinary, 16(4): 1-11.