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Research Article

Chemical Composition, Functional Properties and Consumer Acceptability of Cookies Produced from Blends of Wheat, Orange Fleshed Sweet Potato and Pawpaw Flours

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ABSTRACT

The chemical composition, functional properties and consumer acceptability of cookies produced from blends of wheat, orange-fleshed sweet potato and pawpaw flours was studied. Wheat grain, orange fleshed sweet potato tubers and semi-ripe pawpaw fruit were processed into flours, and the flours were blended in different proportions to produce five samples, where pawpaw flour was constant (5%). The processed flours were designated as: A (100:0), B (95:5), C (90:10), D (85:15) and E (80:20) of wheat and orange fleshed sweet potato, respectively and sample A served as the control. The flour blends were subjected to functional properties analysis and then used in the production of cookies. The cookies were analyzed for proximate, vitamin A, and physical properties using standard analytical methods. Sensory analysis of the cookies was carried out using the 9-point hedonic scale. The functional properties results showed significant differences ($p<0.05$). The proximate results ranged for moisture (5.83 - 7.49 %), dry matter (92.51 - 94.17 %), ash (1.47 - 1.64 %), protein (7.41 - 9.47 %), fibre (1.19 - 1.34 %), fat (14.61 - 18.61 %) and carbohydrate (62.52 - 69.50 %). Significant differences ($p<0.05$) existed in the physical properties and vitamin A composition of the cookies. Sensory scores ranged (7.25 - 8.20) for taste, appearance (7.40 - 8.50), texture (7.20 - 8.05), aroma (7.35 - 7.85) and general acceptability (7.80 - 8.40). The study concludes that nutritive and acceptable cookies can be produced from blends of wheat, orange-fleshed sweet potato and pawpaw flours.

Keywords: Acceptability; Blends; Cookie; Orange-fleshed sweet potato; Semi ripe pawpaw; Wheat

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INTRODUCTION

Cookies are popular confectionery products with unique texture and taste, long shelf life and relatively cheap price (Petrovic *et al*., 2016). They are popular snacks widely consumed all over the world by people of all ages. High consumption of cookies by growing children necessitates the need to make it of high nutritional quality that could be useful in nutritional programs to combat malnutrition and nutritional deficiencies. Wheat flour has been the main cereal crop used for baking different products primarily because of its high gluten content and bland flavour (Mayhew and Penny, 2008). With the soaring of wheat prices at the global market (Dewettinck *et al*., 2008) and local concern about huge import of cereal grains, the need arises to promote the utilization of local sources of flour for substitution of wheat flour (Akingbala *et al*., 2011). Orange fleshed sweet potato (OFSP) flour has been identified as a local alternative to substitute wheat flour in composite flours (Idolo, 2011). Orange fleshed sweet potato has also been identified to be a rich source of vitamin A due to its high level of beta-carotene (Idolo, 2011) and hence its usage in cookies production would yield a cookie product with increased nutritional value.

In Nigeria, orange fleshed sweet potato is mostly consumed as a snack, roasted, boiled, used with fresh yams in pounded yam and as a sweetener in beverage production. Processing sweet potato into flour for cookies production or other food products would increase its utilization, serve as a source of nutrients such as carbohydrates, beta-carotene (pro vitamin A), vitamin C, vitamin B6, and minerals such as calcium, phosphorus, iron, potassium, magnesium and zinc (Adenuga, 2010).

Fruits are mostly known and accepted as an excellent source of nutrients such as minerals and vitamins and also contain carbohydrates in form of soluble sugar, cellulose and starch (Schweiggert *et al*., 2011). Economically, pawpaw (*Carica papaya*) is the most important fruit in the *caricaceae* family. The pulp of ripe pawpaw is usually consumed fresh in slices, in chunks as dessert and it can be processed and used in a variety of products such as jams and fruit juice. Pawpaw is a fruit which has high amount of vitamin C and minerals such as potassium, magnesium, iron and sodium (Yusufu and Akhigbe, 2014). Pawpaw fruit is also a source of essential amino acids such as histidine, isoleucine, arginine, lysine, tryptophan, threonine and leucine (Nam *et al*., 2018) and contains significant amounts of riboflavin, niacin, phosphorus and zinc. The amounts of these nutrients are greater than or the same as those found in bananas, apples or oranges (Yusufu and Akhigbe, 2014). Presently, there is little or no reported information on the use of processed pawpaw flour in conventional baked products.

In the recent past, the prices of cookies baked from 100 % wheat have continued to soar considering the fact that Nigeria does not grow enough wheat grain to meet up local demand and that has increased the rate of wheat importation (Edema *et al*., 2004). Over dependency on wheat based products (especially cookies) has increased the nation's fund outflow due to wheat importation hence, there is need to look for local crops that can substitute wheat in cookie production. The use of pawpaw fruit in food production has been limited solely to minimal processing in the form of packaged cut fruits or cut fruit blends which are sold by some food vendors. Ripe pawpaw also has a short shelf life which increases post-harvest losses hence, there is need to convert pawpaw fruit into a more shelf stable product.

Although orange fleshed sweet potato is being promoted in Nigeria, there are limited diversified products from the crop, which will encourage its consumption. Orange fleshed sweet potato has much potential which is still being underutilized and one of which is the utilization of its products (flour) in the production of cookies. If the use of composite flours can be successfully adopted, then it will reduce over-dependence on wheat and ultimately enhance food security. Composite flours have better advantages like; promotion of natural plant species, better supply of nutrient such as vitamin A and encourage the agricultural sector to improve on the cultivation of these crops. The main objective of this study is to determine the chemical composition, functional properties and consumer acceptability of cookies produced from blends of wheat, orange fleshed sweet potato and pawpaw flours.

MATERIALS AND METHODS

Raw materials procurement

The raw materials used in this research work including wheat grains, sweet potatoes, pawpaw fruit and other baking ingredients were purchased from Ubani main market, Umuahia, Abia State.

Sample preparation

The orange fleshed sweet potato tubers and pawpaw fruit were properly sorted and washed to remove extraneous materials prior to flour production.

Production of orange-fleshed sweet potato flour

The orange fleshed sweet potato flour was produced using the method described by Olapade and Ogunade (2014). The tubers were peeled and washed with clean water. The clean tubers were sliced into 5mm thickness and blanched at 95˚C for 10 min, then dried at 60 ˚C for 8 h in a cabinet drier and dry milled in a hammer mill (Full screen hammer mill, Model: FSHM QGA) and screened through a sieve of 0.8 mm aperture to get the flour. The flour obtained was packaged in a low-density polyethylene bag and stored in a cool place until needed.

Wheat flour production

The method of Bibiana *et al*. (2014) was adopted in the production of wheat flour. The whole wheat grain was cleaned, sorted to remove contaminants such as sands, stones and dirty, then washed with clean water and soaked for 8 h. The soaked grains were washed, drained and oven (Continental, India) dried (at 60˚ C for 6 h), after which it was milled using a prime attrition mill (ModelSK-30-SS) and sieved to get a fine whole wheat flour using a 0.2 mm mesh size.

Pawpaw flour production

Pawpaw flour was produced using the method of Yusufu and Akhigbe (2014). The pawpaw fruit was properly washed, peeled and sliced using a stainless-steel knife. The sliced pawpaw fruit was grated to reduce the particle size of the pawpaw to 5mm. The grated pulp was blanched in hot water at a temperature of 95 ^oC for 5 minutes. It was then cooled rapidly, spread thinly on a tray and oven dried for 3 h to give a dried brittle texture and milled into flour using a hammer mill machine. The flour obtained was sieved with an 80mm mesh sieve size to obtain a very fine particle size pawpaw flour.

Formulation of composite flour

The various ratio combinations for the formulation of composite flour for cookies production are presented in Table 1. Wheat flour (100%) was measured out and this served as the control. Wheat flour was then substituted with orange fleshed sweet potato and pawpaw flours in the ratios of 90:5:5, 80:15:5, 70:25:5, 60:35:5 and 50:45:5, respectively.

Table 1: Formulation of composite flour

Wheat flour (%)	Sweet potato flour (%)	Pawpaw flour (%)
100	-	-
90	5	5
80	15	5
70	25	5
60	35	5

Recipe for the production of cookies

The recipe for the production of cookies from blends of wheat, orange fleshed sweet potato and pawpaw flours are given as follows: The various ingredients used for the cookies production and their measurement include; 0.5 g salt, 25 g sugar, 10 g baking powder, 200 g flour, 50 g fat, 2 g vanilla flavour and 20 g egg. The above ingredients and their measurements were maintained without variation in all the samples.

Production of cookies

The method described by Yadav *et al*. (2012) was adopted for the cookies production. Each flour blend was used separately to mix with the ingredients for the cookie production. The fat and sugar were mixed to get a creamed product. The dry materials and cream were mixed and the mixture was kneaded until desirable dough was obtained. The dough was rolled and flattened into a uniform thickness of about 3.5 mm before cutting into shapes using a hand circle-cutter, and baked at 200 ^oC for 30 min. The flow chart for the production of cookies is shown in Figure 1.

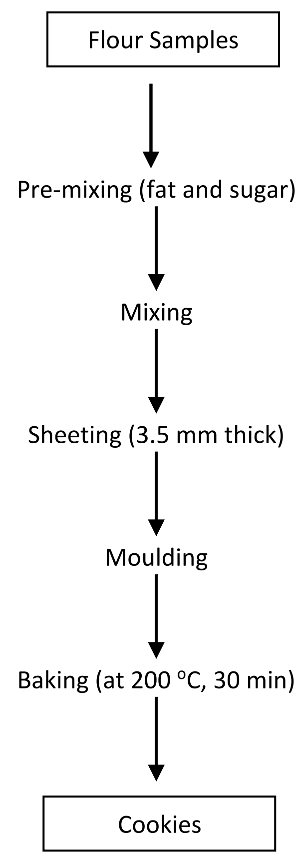

Figure 1: Flow chart for the production of cookies

Source: Yadav *et al*. (2012)

Proximate Analysis

Determination of moisture content

Moisture content of the samples was determined according to the method of AOAC (2010). Two grams of each of the samples were weighed into different moisture cans. They were then placed in an oven at 150 ˚C for 3 h, drying was stopped after obtaining two consecutive values differing by 0.001. The samples were cooled in a desiccator and weighed. Moisture content of the samples was then calculated as follows:

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

where: W_1 = initial weight of empty can,
W_2 = weight of empty can + sample before drying,
W_3 = final weight of empty can + sample after drying.

Determination of ash content

The method described by AOAC (2010) was used to determine the ash content of the samples. Porcelain crucible were dried and cooled in desiccators before weighing. Two grams of the each of the samples were weighed into the crucible and the weight taken. The crucible containing the samples were placed into the muffle furnace and ignited at 550 ˚C. This temperature was maintained for 3 h. The muffle furnace was then allowed to cool; the crucibles were then brought out, cooled and weighed. The ash content was calculated as follows:

$$\% \text{ Ash} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where: W_2 = weight of crucible + ash,
W_1 = weight of empty crucible.

Determination of fat content

The fat content of the samples was determined using solvent extraction in a soxhlet apparatus as described by AOAC (2010). Two grams of each of the samples were wrapped in a filter paper and placed in a soxhlet reflux flask which is connected to a condenser on the upper side and to a weighed oil extraction flask full with two hundred milliliters of petroleum ether. The ether was brought to its boiling point, the vapour condensed into the reflux flask immersing the samples completely for extraction to take place on filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go on for four hours before the deffated samples were removed. The oil extract in the flux was dried in the oven at 60 ˚C for thirty minutes and then weighed.

$$\% \text{ Fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Determination of crude fibre

The crude fibre of the samples was determined according to the AOAC (2010) method. Two grams of each of the samples were boiled under reflux for 30 min with 200 ml of solution containing 1.25 g of tetraoxosulphate (vi) acid (H_2SO_4) per 100 ml of solution. The solution was filtered through linen on a flaunted funnel and washed with water until the washing is no longer acidic. The residue was then transferred to a beaker and boiled for thirty minutes with 100 ml of solution. The final residue was filtered through a thin but closer pad of washed and ignited asbestos in a Gosh crucible. The residue was then dried in an electric oven and weighed. The residue was incinerated, cooled and weighed. Crude fibre content of the sample was then calculated as follows:

$$\% \text{ Crude fibre} = \frac{W_2 - W_3}{W_1}$$

Where: W_1 = weight of sample used, W_2 = weight of crucible plus sample,
W_3 = weight of sample crucible

Determination of crude protein

Crude protein of the samples was determined using the Kjedahl method as described by AOAC (2010). One gram of the sample was introduced into the digestion flask. Kjedahl catalyst (Selenium tablets) was added to the sample. Twenty milliliters of concentrated sulphuric acid was added to the sample and fixed to the digester for eight hours until a clear solution was obtained. The cooled digest was transferred into 100 ml volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for ten minutes after boiling. Twenty milliliters of 4 % boric acid were pipetted into conical flask. Five drops of methyl red were added to the flask as indicator and the sample was diluted with 75 ml distilled water. Ten milliliters of the digest were made alkaline with 20 ml of sodium hydroxide (NaOH) (20 %) and distilled. The steam exit of the distillatory was closed and the change of color of boric acid solution to green was timed. The mixture was distilled for 15 min. The filtrate was then titrated against 0.1 N Hydrochloric acid (HCl).

The total percentage of protein was calculated:
% protein = % nitrogen x conversion factor (6.25).

Determination of carbohydrate

Carbohydrate content of the samples was determined using the formula described by AOAC (2010).
% carbohydrate =100 − % (protein + fat + fibre + ash +moisture) content.

Pro-vitamin A **determination**

The spectrophotometric method described by Onwuka (2018) was employed in the determination of pro-vitamin A. Five grams (5 g) of the samples was dissolved in 30 mL of absolute alcohol (ethanol) and 3 mL of 5 % potassium hydroxide was added to it. The mixture was boiled under reflux for 30 min and was cooled rapidly with running water and filtered. Thirty milliliters (30mL) of distilled water was added and the mixture was transferred into a separating funnel. Three (3) portions of 50 mL of the ether were used to wash the mixture, the lower layer was discarded and the upper layer was washed with 50 mL of distilled water. The extract was evaporated to dryness and dissolved in 10 mL of Isoprophyl alcohol and its absorbance was measured at 325 nm. Pro-vitamin A content of the samples was then calculated as follows:

Pro-vitamin A (µg/100g) $= \frac{100 \times}{W} \frac{au}{as} \times c$

Where: au = absorbance of test sample, as = absorbance of standard, solution s = concentration of the test, sample w= weight of sample.

Functional properties

The methods described by Onwuka (2018) were employed to determine wettability, bulk density, water absorption capacity, oil absorption capacity, foam capacity, gelatinization temperature and swelling index.

Bulk Density: A 10ml capacity graduated measuring cylinder was weighed and sample was gently filled into the cylinder. The bottom of the cylinder was gently tapped on the laboratory bench severally until there was no diminution of the sample level after filling to the 10ml mark. Bulk density (g/ml) was then calculated as weight of the sample (g) / volume (ml) according to Onwuka (2018).

Water Absorption Capacity (WAC): Water absorption capacity was determined as described by Onwuka (2018). One (1g) of sample was weighed and placed into a conical graduated centrifuge tube. A waring whirl mixer was used to mix the sample thoroughly, 10ml was added and sample was allowed to stay for 30min at room temperature and then centrifuged at 5000 × g for 30min. The volume of the free water (supernatant) was read using 10ml measuring cylinder. Water absorption was calculated as the amount of water absorbed (total minus free water) x 1 g/ml.

Oil Absorption Capacity (OAC): The method as described by Onwuka (2018) was adopted for the determination of OAC. Refined groundnut oil with density of 0.92g/ml was used. One gram (1g) of the sample was mixed with 10ml of the oil (V_1), for 30s. The sample was allowed to stand for 30min at room temperature and then centrifuged (Centurion scientific, Model k241) at 10,000rpm for 30min. The amount of oil separated as supernatant (V_2) was measured using 10ml cylinder. The difference in volume was taken as the oil absorbed by the samples. The result obtained was calculated using the following equation:

Oil absorption capacity = $\frac{(V_1 - V_2)P}{\text{Weight of sample}}$

Where, V_1 = the initial volume of oil used, V_2 = the volume not absorbed

P = the density of oil (0.92g/ml)

Foam Capacity: The foam capacity and stability were determined by the method described by Onwuka (2018). A known weight of the flour sample was dispersed in 100ml distilled water. The resulting solution was homogenized for 5min at high speed. The volume remaining at interval of 0.00, 0.30, 1, 2, 3, 4 up to 24h was noted for the study of foaming stability. Foam capacity and stability was calculated using the formula:

$$\text{Foaming capacity (\%)}: \frac{\text{Volume after homogenizaton} - \text{Volume before homogenization}}{\text{Volume before homogenization}} \text{ x} \frac{100}{1}$$

Swelling Index: This is the ratio of the swollen volume to the original volume of a unit weight of the flour. The method reported by Onwuka (2018) was used. One (1) gram of the flour sample was weighed into a clean dry measuring cylinder. The height occupied by the sample was recorded (H_1) and then 5ml of distilled water added to the sample. This was left to stand undisturbed for 1h, after which the height was observed and recorded again (H_2). The swelling index was then calculated using the following equation: $\mathrm{SI} = \frac{H_2}{H_1}$

Where: H_1 = initial height, H_2 = final height

Gelatinization temperature: One gram (1 g) of each sample was placed in a beaker and 10 mL of distilled water was added and stirred to obtain a homogenized mixture. The beaker containing the sample was heated in a boiling water bath with continuous stirring until it gelled. The temperature was read 30sec after gelation using a thermometer, while gelatinization time was recorded as time it required the same to gel (Onwuka, 2018).

Determination of wettability

Wettability of the flour samples was determined according the method described by Onwuka (2018). One (1) gram of each of the flour samples was weighed using an analytical balance and were each added into a 25 ml graduated measuring cylinder with a diameter of 1 cm. The finger was then placed over the open end of the cylinder in each case, inverted and was clamped at a height of 10 cm from the surface of a 600 ml beaker containing 500 ml of distilled water. The finger was then removed and the test sample was allowed to dump. The wettability was recorded as the time required for the sample to become completely wet.

Physical analysis of cookies

Thickness: The thickness of the biscuit was measured with the aid of a digital vernier caliper with 0.01mm precision.

Breaking strength: The break strength of the cookies was determined using Bala *et al*. (2015) method. Cookies of known thickness was placed between two parallel wooden bars (3 cm apart). Weight was added on the cookies until the cookie snapped. The least weight that caused the breaking of the cookies was regarded as the break strength of the cookies.

Diameter: The diameter was measured by arranging ten pieces of biscuit edge to edge. The measurement was conducted in triplicates for each sample and the average value was recorded in mm.

Weight: A weighing balance was used to determine the weight of the cookies. Mean values for weight was reported in g.

Spread ratio: The spread ratio was determined by the method of Bala *et al*. (2015). Three rows of five well-formed cookies were made and the height measured. Also the same cookies were arranged horizontally edge to edge and sum diameter measured. The spread ratio was calculated thus:

$$\text{Spread ratio} = \frac{\text{Diameter}}{\text{Height}}$$

Sensory evaluation

The samples were subjected to sensory evaluation using 20 semi-trained panellists selected from Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, on the basis of their familiarity with cookies as described by Iwe (2007). The semi-trained panelists were instructed prior to the exercise. All samples were put on different plates and served to the panelists with portable water to rinse their mouth after each testing so as not to interfere with the taste of the preceding samples. Quality attribute such as appearance, aroma, taste, texture and general acceptability of the products were scored on a 9-point hedonic scale. The degree of likeness was expressed as follows: Like extremely 9, like very much 8, like moderately 7, like slightly 6, neither like nor dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike extremely 1. Like extremely to like slightly constitute good while dislike slightly to dislike extremely constitutes poor. Neither like nor dislike indicates that the product was neither good nor bad.

Experimental design

The experimental Design used for this study was a Complete Randomized Design (CRD).

Data Analysis

Experimental data was analyzed by one-way analyses of variance (ANOVA) using SPSS version 22 and means were separated using Duncan Multiple Range (DMRT) and Least Significant Difference (LSD) Test at a significant level p<0.05. Results were expressed as the means ± standard deviation of two separate determinations.

RESULTS AND DISCUSSION

Functional Properties of the Composite flour samples

The result of the functional properties of the composite flour samples is presented in Table 2. The bulk density values ranged from 0.56 to 0.63 g/ml. The 100 % wheat flour (sample A) was observed to have the highest bulk density (0.63 g/ml) while sample D (70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend) and E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend) had the lowest bulk densities of 0.56 g/ml. The bulk density result revealed that addition of orange fleshed sweet potato (OFSP) flour and pawpaw flour to wheat flour decreased the bulk density of the composite flour, implying that the composite flour samples may occupy greater space and, therefore, would require more packaging material per unit weight which may result to high packaging cost. However, the low bulk densities of the composite flours would be advantageous in the formulation of complementary foods (Ugwu and Ukpabi, 2002). Bulk density is an indication of the porosity of a product which influences package design (Oladunmoye *et al*., 2010). The bulk densities of the flour samples would be useful in determining suitable packaging requirements of the samples as it relates to the load the product could carry if allowed to rest directly on one another (Etudaiye *et al.,* 2008). The observed bulk density range recorded in the present study was found to be in consonant with (0.42 to 0.93 g/ml) earlier reported by Apotiola and Fashakin (2013) on wheat, yam and soybean flours.

Table 2: Functional Properties of the composite flour samples

Samples	BD (g/ml)	WAC (g/g)	SI (g/ml)	OAC (g/g)	Wettability (Sec)	FC (%)	G.T (°C)
A	0.63^{a}±0.00	1.85^{e}±0.03	2.61^{d}±0.01	1.69^{c}±0.01	15.29^{d}±0.30	19.48^{a}±0.02	62.45^{d}±0.07
B	0.58^{b}±0.00	1.95^{d}±0.01	2.61^{d}±0.01	1.75^{b}±0.01	22.34^{c}±0.08	19.47^{a}±0.01	68.00^{c}±0.07
C	0.57^{c}±0.00	2.25^{c}±0.01	2.89^{c}±0.02	1.77^{b}±0.01	22.89^{c}±0.00	18.61^{b}±0.01	69.00^{b}±0.35
D	0.56^{d}±0.00	2.38^{b}±0.01	2.97^{b}±0.01	1.79^{b}±0.01	31.66^{b}±0.01	18.50^{b}±0.04	69.05^{b}±0.00
E	0.56^{d}±0.00	2.70^{a}±0.01	3.25^{a}±0.01	1.85^{a}±0.02	33.05^{a}±0.07	17.41^{c}±0.14	70.25^{a}±0.00

Means with different superscripts within the same column are significantly different (p<0.05)

A= 100 % wheat flour, B= 90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, C= 80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, D= 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, E= 60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies

Water absorption capacity (WAC) values ranged from 1.85 to 2.70 g/g. Sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend) had the highest water absorption capacity value (2.70 g/g) while sample A (100 % wheat flour) had the least value. The increase in OFSP flour inclusion was observed to progressively increase the water absorption capacity of the composite flour samples. The lower water absorption capacity observed in sample A suggests lower moisture retention rate and hence implies an increased shelf life for the product. The water absorption capacity range observed in the present study was found to be in conformity with the range (0.57 to 2.21 %) reported by Bello *et al*. (2020) on flour blends from wheat, unripe plantain and germinated fluted pumpkin seeds.

The swelling index (SI) of the composite flour samples and the control ranged from 2.61 to 3.25 g/ml. Addition of OFSP flour and pawpaw flour to wheat flour was observed to increase the swelling index of the composite flour samples. Sample E had the highest SI (3.25 g/ml) while samples A and B had the lowest SI (2.61 g/ml). The swelling index values recorded in the present study were found to be higher than 1.24 to 1.65 g/ml reported by Ezeocha *et al*. (2022) for flours from wheat, bambara groundnut and velvet tamarind flour blends. High swelling index would play a very crucial role in preparation of food formula where swelling property is essential to cause increase in volume of the product which results to a leathery and swollen food. High swelling power has been reported as part of the criteria for good quality products (Apotiola and Fashakin, 2013).

The oil absorption capacity (OAC) of the composite flour samples ranged from 1.69 to 1.85 g/g. The addition of OFSP flour and pawpaw flour to wheat flour was observed to increase the oil absorption capacities of the composite flour samples. Samples E and A recorded the highest and lowest OAC values respectively. Oil absorption capacity is an important functional property that enhances mouth feel while retaining the flavor of food products (Adebowale and Lawal, 2004). The oil absorption capacity values recorded in this study were found to be lower than 106.32 to 121.19 g/g reported by Abdel-Gawad *et al*. (2016) for wheat/legume composite flour.

The wettability of the flour samples ranged from 15.29 to 33.05 sec. Addition of orange fleshed sweet potato and pawpaw flour to wheat flour also increased the wettability of the composite flour samples. Sample A had the least value of 15.29 sec while sample E had the highest value (33.05 sec). The wettability index is defined as the time (in seconds) required to wet all the particles of a solid material (flour) (Nguyen *et al*., 2013). The increase in the wettability index obtained in the composite flours could be explained by the variability of their chemical composition. According to Okafor *et al.* (2015), the increase in wettability is due to the decrease in foaming capacity. This implies that the composite flour samples which had higher wettability values will require longer time to wet and to also initiate reconstitution than the 100% wheat flour. Lower values of wettability recorded in the 100% wheat flour suggests that they would reconstitute faster.

The foam capacity of the flour samples ranged from 17.41 to 19.47 %. Sample A (100% wheat flour) was observed to have the highest foam capacity value (19.48 %) though it was not significantly different ($p>0.05$) from sample B (70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend) with value of 19.47 %. Sample E had the lowest foam capacity value of 17.41 %. The range of foam capacity values observed in this study was found to be lower than 6.16 to 9.04 earlier reported by Ubbor and Akobundu (2009) for composite flours from watermelon seed, cassava and wheat. Foaming capacity (FC) which is the percentage increase in volume after 30 seconds is used to determine the ability of the flour to foam which is dependent on the presence of the flexible protein molecules which decrease the surface tension of water (Asif-Ul-Alam *et al*., 2014).

Gelation temperature (GT) was observed to increase (62.45 to 70.25^{o}C) with increase in inclusion of orange fleshed sweet potato and pawpaw flour to wheat flour with sample E having the highest gelation temperature (70.25^{o}C) while the 100% wheat flour had the lowest gelation temperature (62.45^{o}C). The increased gelation temperature observed on the composite flour samples suggests that the composite flour samples will require more energy for processing which will invariably increase production cost.

Proximate Composition of the Cookie samples

The proximate composition of the cookie samples is presented in Table 3. Moisture content of the cookie samples was observed to increase with increase in orange fleshed sweet potato and pawpaw flour inclusion. The moisture content values ranged from 5.83 to 7.49%. The 100% wheat flour had the lowest moisture (5.83%) while sample D (70% wheat: 25% orange fleshed sweet potato: 5% pawpaw flour cookies) had the highest moisture content (7.49%). Moisture content is very essential for life maintenance and analysis of it is one of the most widely used instruments which determine the way the food was processed and its shelf life (Akinsanmi *et al*., 2015). It has also been used as a measure of stability and susceptibility to microbial contamination. The moisture values observed in the present study were found to be in agreement with 6.44 to 7.46 % reported by Okpala and Okorie (2011) for cookies produced from pigeon pea, cocoyam and sorghum flour blends.

The dry matter of the cookie samples ranged from 92.51 to 94.17 %. Addition of orange fleshed sweet potato flour and pawpaw flour to wheat was observed to decrease the dry matter of the cookie samples. The 100 % wheat cookies had the highest dry matter (94.17 %) while composite cookies from 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour had the lowest dry matter content of 92.51 %. The high dry matter observed on the control sample suggests low moisture retention rate and hence implies longer shelf life for the product.

Table 3: Proximate composition of the cookie samples

Samples	Moisture (%)	Dry matter (%)	Ash (%)	Protein (%)	Fiber (%)	Fat (%)	Carbohydrate (%)
A	5.83^{e}±0.01	94.17^{a}±0.01	1.47^{d}±0.02	7.41^{e}±0.01	1.19^{d}±0.01	14.61^{e}±0.01	69.50^{a}±0.08
B	6.77^{b}±0.02	93.24^{d}±0.02	1.53^{c}±0.01	9.20^{b}±0.00	1.31^{ab}±0.01	17.55^{b}±0.01	63.65^{d}±0.02
C	6.50^{d}±0.00	93.50^{b}±0.00	1.57^{b}±0.01	9.47^{a}±0.02	1.34^{a}±0.02	18.61^{a}±0.01	62.52^{e}±0.03
D	7.49^{a}±0.01	92.51^{e}±0.01	1.48^{d}±0.00	8.74^{d}±0.02	1.24^{c}±0.01	15.38^{d}±0.04	65.68^{c}±0.08
E	6.61^{c}±0.01	93.39^{c}±0.01	1.64^{a}±0.01	8.84^{c}±0.02	1.28^{bc}±0.02	15.61^{c}±0.01	66.03^{b}±0.04

Means with different superscripts within the same column are significantly different ($p<0.05$).
A= 100 % wheat flour, B= 90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, C= 80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, D= 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, E= 60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies.

Ash content of the cookie samples ranged from 1.47 to 1.64 %. The ash content of the cookie samples was observed to increase with increase in orange fleshed sweet potato and pawpaw flour inclusion. The 100% wheat flour had the lowest ash content (1.47%) while sample E (60% wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest ash content of 1.64 %. According to Iheanacho and Udebuani (2009) ash content is an indication of the level of mineral or inorganic component of the sample, and these minerals act as inorganic co-factors in metabolic processes, which means in the absence of these inorganic co-factors there could be impaired metabolism. Eke-Ejiofor (2013) reported ash content of 1.05 to 1.15% for African breadfruits/sweet potato/wheat composite cookies samples, which is lower than the result of the present study, while Arukwe *et al*. (2021) reported higher ash values (1.83 -3.95%) for cookies produced from blends of African yam bean, sorghum and wheat flours. The ash result therefore, suggest that substitution of wheat flour with OFSP and pawpaw flours increased the ash content of the cookies which could in turn increase the mineral intake of the consumer.

Protein content of cookie samples increased (7.41 to 9.47%) with an increase in OFSP and pawpaw flour inclusion. The 100% wheat cookies had the lowest protein content (7.41%) while sample C (80% wheat: 15% orange fleshed sweet potato: 5% pawpaw flour blend cookies) had the highest protein content of 9.47%. The increased protein content of the composite cookies suggests that consumption of their product could help alleviate the problem of protein-energy malnutrition among the malnourished group (Temba *et al*., 2016). The protein values recorded in the present study were found to be lower than (11.02 to 13.15 %) reported by Arukwe (2020) for biscuits produced from wheat, cocoyam and pigeon pea flour blends.

Fibre content of the cookie samples ranged from 1.19 to 1.34 %. Fibre was also found higher on the composite cookie samples with sample C (80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) having the highest fibre content (1.34 %) while the 100 % wheat cookie had the lowest fibre content of 1.19 %. The fibre content recorded in the present study was found to be lower than (1.05 to 3.20 %) reported by Arukwe (2020) for biscuits produced from wheat, cocoyam and pigeon pea flour blends. Diet low in crude fibre is undesirable and may cause constipation and low fibre diets have been associated with disease of colon like piles, appendicitis and cancer (Ayoola and Adeyeye, 2010).

Fat content ranged from 14.61 to 18.61 %. The fat content of the samples was observed to be higher on the composite cookie samples with sample C (80% wheat: 15% orange fleshed sweet potato: 5% pawpaw flour blend cookies) having the highest fat content (18.61%) while 100% wheat cookies had the lowest fat content (14.61%). Fats improve flavor and increase the mouth feel of food products, it is therefore, is a significant factor in food formulations. The fat values observed in the present study were found to be higher than 5.10 to 6.36 % reported by Okpala and Okorie (2010) for cookies produced from pigeon pea, cocoyam and sorghum flour blends. The high fat content observed on sample C (80% wheat: 15% orange fleshed sweet potato: 5% pawpaw flour blend cookies) suggest that consumption of the product could boost the energy of the consumer since fat supplies twice the energy of carbohydrate.

Carbohydrate content of the different cookie samples ranged from 62.52 to 69.50 %. Sample C (80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the lowest carbohydrate content (62.52 %) while 100 % wheat cookies had the highest carbohydrate content of 69.50 %. The carbohydrate content of the cookies was found to decrease with the addition orange fleshed sweet potato and pawpaw flour. Similar observation was also made by Eke-Ejiofor and Deedam (2015) who reported a decrease in carbohydrate with an increase in wheat flour substitution with sweet potato and tiger nuts flour. The carbohydrate values observed in this study were found to be lower than 66.90 to 78.73 % reported by Offia-Olua and Akubuo (2021) for cookies produced from flour blends of sprouted mungbean and malted sorghum.

Physical Properties of the Cookie samples

The result of the physical properties of the cookie samples is presented in Table 4. Addition of OFSP and pawpaw flours to wheat flour was observed to increase the weight of the cookie samples. The cookies weight ranged from 12.77 to 16.71 g. The control sample (100% wheat cookies) had the lowest weight (12.77 g) although it was not significantly different (p>0.05) from sample E (60 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) with a weight of 12.82 g, while sample C (80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest weight (16.71 g). The cookies' weight range obtained in this study was found to be lower than 29.44 to 30.62g reported for cookies made from flour blends of wheat, yam and soybean (Apotiola and Fashakin, 2013).

Table 4: Physical Properties of the Cookie samples

Samples	Weight (g)	Breaking strength (g)	Spread ratio	Diameter (mm)	Thickness (mm)
A	12.77^{d}±0.04	178.50^{cd}±0.00	5.65^{e}±0.03	35.51^{e}±0.01	6.23^{c}±0.04
B	15.41^{b}±0.01	182.41^{ab}±0.01	5.70^{d} ±0.01	36.23^{d}±0.04	6.41^{b}±0.01
C	16.71^{a}±0.01	184.85^{a}±0.71	6.43^{b}±0.02	37.45^{c}±0.07	5.83^{d}±0.04
D	13.68^{c}±0.00	177.05^{d}±2.05	6.87^{a}±0.01	38.65^{b}±0.21	5.63^{e}±0.04
E	12.82^{d}±0.03	180.45^{bc}±0.07	5.89^{c}±0.00	39.55^{a}±0.07	6.71^{a}±0.01

Means with different superscripts within the same column are significantly different (p<0.05).

A= 100 % wheat flour, B= 90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, C= 80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, D= 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, E= 60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies

Breaking strength was found to be higher on the composite cookie samples. The breaking strength of the samples ranged from 177.05 to 184.85 g. Sample C (80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest breaking strength (184.85 g), although it was not significantly different (p>0.05) from sample B (90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) with a breaking strength of 182.41 g, while sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the lowest breaking strength of 180.45 g but was found to be statistically similar (p>0.05) to samples A (100 % wheat flour) and B (90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) with breaking strength values of 178.50 g and 182.41 g respectively. The higher breaking strength obtained in cookies made from composite flours indicates greater hardness of cookies structure (Banusha and Vasantharuba, 2014). The breaking strength values obtained in this study was found to be lower than 411 to 504 g reported by Offia-Olua and Akubuo (2021) for cookies produced from flour blends of sprouted mungbean and malted sorghum.

The spread ratio of the cookie samples ranged from 5.65 to 6.87. Spread ratio was higher on the composite cookie samples, with sample D (70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) having the highest spread ratio (6.87) while 100 % wheat cookies had the lowest spread factor of 5.65. The low spread ratio value of the 100 % wheat cookie showed that the starch polymer molecules are highly bound with the granules and swelling is limited when heated. On cooling, the starch rapidly forms a rigid gel with capacity characteristics of large molecular aggregates (Ade *et al.,* 2012). When a dough or batter becomes less viscous, it tends to spread more thereby increasing in diameter and consequently the spread ratio (Ade *et al.,* 2012). The spread ratio was observed to increase with an increase in wheat flour substitution. This observation was however, contrary to the report of Offia-Olua and Akubuo (2021) who reported a decrease in spread ratio with increasing sprouted mungbean and malted sorghum flours inclusion.

The cookies diameter ranged from 35.51 to 39.55 mm. The diameter of the cookie samples was observed to progressively increase with an increase in OFSP and pawpaw flours inclusion. The 100% wheat cookie had the lowest diameter (35.51 mm) while sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest diameter (39.55 mm). The observed range of diameter in this study was found to be lower than 45.50 to 58.50 mm reported for cookies made from flour blends of acha, wheat and mungbean (Nanyen *et al*., 2016).

The cookie thickness ranged from 5.63 to 6.71 mm. Sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest cookie thickness (6.71 mm) while sample D (70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the lowest cookie thickness of 5.63 mm. The cookies thickness result suggests that addition of OFSP and pawpaw flours to wheat increased the thickness of cookies product.

Vitamin A composition of the cookie samples

The result of the vitamin A composition of the cookie samples is presented in Table 5. The vitamin A values ranged from 2.74 to 3.47 ug/g. The vitamin A content of the cookie samples was observed to progressively increase with the increase in OFSP flour inclusion suggesting that OFSP could be a good source of vitamin A. Korese *et al*. (2021) and Ubbor *et al*. (2022) also made similar observations for cookies from orange-fleshed sweet potato and wheat four blends and cookies from wheat, Bambara nut and orange fleshed sweet potato flour blends respectively. The vitamin A range (2.74 to 3.47 ug/g) obtained in this study was found to be lower than the range of 0.78 to 7.35 ug/g reported by Mbaeyi-Nwaoha *et al*. (2015) for biscuit from acha, pigeon pea and sweet potato blends.

Table 5: Pro-vitamin A composition of the cookies samples

Parameters (µg/g)	Samples A	B	C	D	E
Vitamin A	2.74^{e}±0.01	2.88^{d}±0.02	3.14^{c}±0.03	3.27^{b}±0.02	3.47^{a}±0.02

Values are Means ± standard deviation of duplicate determinations $^{a-e}$ Means with the same superscripts within the same rows are not significantly different (P>0.05).

A= 100 % wheat flour, B= 90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, C= 80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, D= 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, E= 60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies.

Sensory Properties of the Cookie samples

The sensory properties of the cookie samples is presented in Table 6. Significant differences (p<0.05) existed among the cookie samples in terms of taste, appearance, texture, aroma and general acceptability. The taste, appearance, texture, aroma and general acceptability scores ranged from 7.25 to 8.20, 7.40 to 8.50, 7.20 to 8.05, 7.35 to 7.85 and 7.80 to 8.40 respectively. The cookies taste however, increased with an increase in OFSP and pawpaw flours inclusion. The 100 % wheat cookie had the lowest taste score (7.25) while sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest taste score (8.20). The scores for the taste of the cookies (7.25 to 8.20) obtained in this study was found to be in consonant with 6.3 to 8.3 reported for cookies produced from flour blends of wheat, acha and mungbean (Nanyen *et al*., 2016).

Addition of OFSP and pawpaw flour to wheat flour was also observed to enhance the appearance of the cookie samples. The appearance scores ranged from 7.40 to 8.50. Sample C (80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies) had the highest appearance score (8.50) while sample B had the lowest appearance score although it was not significantly different (p>0.05) from sample D. Sample A (100 % wheat flour cookie) had the same score (7.70) with sample D. The appearance scores obtained in the present study was found to be in agreement with 5.65 to 7.85 reported by Offia-Olua and Akubuo (2021) for cookies produced from flour blends of sprouted mungbean and malted sorghum. The sensory results showed that sample E (60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookie) was more acceptable judging from the general acceptability scores (8.40) followed by sample A (100 % wheat flour cookie) with a score of 8.25.

Table 6: Sensory Composition of the cookie samples

Samples	Taste	Appearance	Texture	Aroma	General acceptability
A	7.25^{e}±1.09	7.70^{b}±0.80	7.60^{b}±1.39	7.75^{a}±1.33	8.25^{b}±0.91
B	7.85^{b}±1.25	7.40^{c}±0.94	7.55^{b}±1.28	7.40^{b}±1.19	7.95^{c}±0.94
C	7.70^{c}±1.26	8.50^{a}±1.15	7.55^{b}±1.39	7.85^{a}±1.09	7.80^{d}±1.24
D	7.50^{d}±0.89	7.45^{c}±0.94	7.20^{c}±1.36	7.35^{b}±1.23	7.90^{c}±0.91
E	8.20^{a}±0.95	7.70^{b}±1.08	8.05^{a}±1.05	7.70^{a}±1.08	8.40^{a}±0.68

Means with different superscripts within the same column are significantly different (p<0.05).

A= 100 % wheat flour, B= 90 % wheat: 5 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, C= 80 % wheat: 15 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, D= 70 % wheat: 25 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies, E= 60 % wheat: 35 % orange fleshed sweet potato: 5 % pawpaw flour blend cookies

CONCLUSION

The result of this study revealed the applicability of orange-fleshed sweet potato and pawpaw flour in the production of nutritious and acceptable cookies. The proximate composition result revealed an increased ash, protein, fibre and fat, as well as vitamin A content in the composite cookie samples, this implying that the consumption of these cookies may increase the nutrient intake of the consumers. The sensory result also demonstrated that wheat flour can be substituted with orange fleshed sweet potato and pawpaw flours up to 40 % without affecting the texture, aroma and general acceptability but with enhanced taste and appearance which are key sensory properties in determining consumer preference.

The use of orange fleshed sweet potato and pawpaw flours in cookies production will go a long way in reducing wheat importation, enhancing nutrition, health and wellbeing of the consumers as well as reduce food insecurity and diversify the use of these local crops. Therefore, the use of orange fleshed sweet potato and pawpaw flours in cookies production should be encouraged in the food industry as it has shown to increase the nutritive value and sensory properties of the product. Furthermore, more research should be carried out to determine the shelf stability of cookies produced from wheat, orange fleshed sweet potato and pawpaw flour blends.

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