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Chemical composition, physical properties and organoleptic acceptability of bread produced from Acha-Orange fleshed sweet potato flour blends

Ayo, J.A[1]., Ibrahim, A. N[1*]., Sarial, P[1].

[1]Department of Food Science and Technology, Federal University Wukari, Wukari, Taraba State, Nigeria.

Correspondence author: : ajibola@fuwukari.edu.ng

Abstract

Orange fleshed sweet potatoes puree - acha flour can be an alternative means of diversifying the use of non-wheat composite flour. Therefore, this research studied the impact of substituting acha flour with orange fleshed sweet potato on the chemical composition, nutritional quality and sensory attributes of bread. A bread made from 100 % wheat flour served as the control in the study. The orange fleshed sweet potato puree was substituted into acha flour at 5, 10, 15 and 20 % to produce acha- orange fleshed sweet potato bread. The phytochemical, mineral, vitamin, physical and sensory properties of the developed breads were determined. The phytochemical composition; carotenoid, flavonoid and saponins increased from 29.84 to 38.61, 683.00 to 913.00 and 5.40 to 10.53 g/100g respectively, with increase added orange fleshed sweet potato puree. The mineral composition iron and phosphorus increased from 112.03 to 180.22, and 18.60 to 20.83 g/100g respectively with where added orange fleshed sweet potato puree. While potassium decreases from 203.38 to 444.9 g/100g. Generally, there was slight improvement in sensory quality with increase orange fleshed sweet potato puree into wheat-acha flour. Conclusively, the orange fleshed sweet potato incorporation had significant effects p = 0.05 and contributed to the improvement of the blend bread nutrition composition quality.

Keywords: Acha flour; Orange fleshed sweet potato; high-fibre breads.

1. Introduction

Bread is a major staple wheat-based food product which has gained wide acceptance among consumers in the world especially Nigeria for many years (Seleem and Omran, 2014). It is predominantly rich in carbohydrates and is an appropriate vehicle for food fortification of essential macronutrients such as protein and micronutrients like vitamins and minerals. This bread is basically made from hard wheat flour, yeast, fat, sugar, salt and water.

Wheat is the choice cereal for manufacture of bread because it contains a large amount of gluten, which produces raised loaves (Sanni *et al.,* 2019). However, there is a growing concern to its usage, as cereal flours generally are limiting in lysine, an essential amino acid. There are also economic, social and health issues associated with its usage. This has resulted in the supplementation of cereal based foods with other protein sources such as legumes in the recent time among researchers (Oluwole and Olapade, 2011, Olapade *et al.,* 2011, Bolarinwa and Oyesiji, 2021). This is because legume proteins are good sources of lysine. The critical criteria for use of any food material in processing are its availability and cost. The main problem facing the bakery industry in Nigeria is overdependence on importation of wheat to sustain it, since Nigeria's climate does not favour cultivation of wheat.

However, the partial substitution of wheat flour by other flour types presents considerable technological difficulties because their proteins lack the ability to form the necessary gluten network for holding the gas produced during the fermentation (Bitrus *et al*., 2020).

Therefore, any effort geared towards substituting whole or part of wheat flour with readily available cereal flours in bread making will be a welcome idea. Sweet potato, *Ipomoea batatas* L. (Lam.), is an important economic crop in many countries. In terms of annual production, sweet potato ranks as the fifth most important food crop in the tropics and the seventh in the world food production after wheat, rice, maize, potato, barley, and cassava (FAO 2016).

Sweet potato fulfills a number of basic roles in the global food system, all of which have fundamental implications for meeting food requirements, reducing poverty, and increasing food security (El-Sheikha *et al*., 2017). Semi processed products from orange fleshed sweet potatoes have been extensively studied in some countries such as Kenya. Complementary food in form of porridge by orange fleshed sweet potatoes flour was highly accepted by the assessors (Stathers *et al.,* 2013). Presently, several researches are being carried out concentrating on the methods to develop retention of the carotenes by the processing and are trying to develop the traditional foods from orange fleshed sweet potatoes such as bread (Nzamwita, *et al.,*2017), cookies (Kolawole, *et al.,*2018), juices (Muhammad, *et al.,*2012), and porridge (Pillay *et al.,*2018)

The gelatinization characteristics of orange fleshed sweet potatoes, its swelling power, solubility properties, and low-amylose content offer some unique advantages that suggest its suitability, not only for pastry and pasta production but also in other food applications. Variations in the functional properties of the blends studied could be of significance in choosing wheat replacement level for different products.

Notably, the use of other crops as a supplement for wheat in bread making has widely been done. Example is seen in cases of enriching wheat flour for bread making with fluted pumpkin flour (Giami, 2003, Giami *et al*., 2003), yellow pea, lentil and fabia bean flours (Hsu *et al.,* 1982), mung pea flour (Finney *et al*., 1982), chick pea flour (Fernandez and Berry, 1989), soy flour (Misra *et al*., 1991), sunflower flour (Yue *et al.,* 1991) and winged bean flour (Kailasaptty *et al.,* 1985). A research conducted by Babalola and Alabi (2015) on the substitution of wheat flour with acha flour, concluded that substitution at 25% (w/w) produced acceptable bread that compared favorably with all wheat bread. However, substitution of acha flour for wheat flour in excess of 30% (w/w) was reported to produce significant reduction in the evaluated qualities of bread (Das *et al.,* 2020). This Acha, (*Digitaria exilis*), commonly referred to as fonio or fundi is an old and underutilized cereal in Africa (Isong *et al.,* 2022). The cereal is uniquely rich in methionine and cystine, and evokes low sugar on consumption (Agu *et al.,* 2020). Acha is noted for its high pentose's content, which gives it the property of absorbing water to produce very viscous solution, an attribute recognized for good baking operation (Lasekan, 1994). However, to the best of our knowledge, there is no study that has used orange fleshed sweet potatoes-acha flour blend in the production of the staple food, bread.

Orange fleshed sweet potatoes puree - acha flour can be an alternative means of diversifying the use of non-wheat composite flour. Several researches have proven that the blending of orange fleshed sweet potatoes with wheat in composite flour can be used as a medium for vitamin A fortification (Owade *et al.*, 2018; Omodamiro *et al.,*2012) and fibre enhancement (Atuna *et al*., 2018). Incorporation of orange fleshed sweet potatoes in wheat products also has economic advantages as it was the case of cassava that helped reduce reliance on imported expensive wheat flour. The incorporation of either orange fleshed sweet potatoes flour or orange fleshed sweet potatoes puree in bread aims at improving the β-carotene content of bread (kamal *et al* 2013; Bonsi *et al* 2014).

Therefore, this research studied the influence of using orange fleshed sweet potatoes puree and acha flour blends as base flour on the chemical composition, physical attributes and sensory qualities of acha based bread in comparison with conventionally made bread (Wheat based bread).

2. Methodology and methods

2.1. Materials

The raw material used in this work include; acha (*Digitaria exilis),* baking powder (Monita, Nigeria), baking fats (stk royal active, Nigeria), salts, orange flesh sweet potato (*Ipomoea batatas*). These materials were purchased from Jos main market, Jos, Plateu state.

2.2. Preparation of acha flour

The method described by Ayo et al., (2010) was adopted for the preparation of acha flour. The acha grain was oven dried (APV Cabinet Drier, 45˚C), milled (Attrition Mill Yamaha Japan), and sieved (350 nm aperture) to produce acha flour.

2.3. Preparation of Orange fleshed sweet potato puree

The method described by Tedesco and Stathers (2015) was adopted for the production of orange fleshed sweet potato puree. The orange flesh sweet potato was peeled, steamed in a boiler, cooled and pureed using a pureeing machine.

2.4. Composite Flour Formulation

The orange fleshed sweet potato flour was substitute at 5, 10, 15, 20,25 and 30% into the acha flour. The two flour were mixed using food processer (120 rpm) (Mariam@, 6 in 1 stainless steel juicer, Model No: M2, Germany) for 10 minutes. The flour blends were packaged in HDPE bags at room temperature in a dry place away prior to use. The moisture level was 14 % prior to use.

2.5. Determination of Mineral Composition

2.5.1. Iron Content

Phenanthroline method as described in AOAC (2016) was used. Phenanthroline solution was prepared by dissolving 100mg I,10-phenanthroline molybdate in 100ml distilled water by stirring and heating to 80 ^{o}C. Hydroxylamine solution was prepared by dissolving 10g in 100ml of distilled water, while ammonium acetate buffer solution was prepared by dissolving 250g in 150ml distilled water. 5ml of the digested sample was added in a test-tube. Then, 3ml of phenanthroline solution and 2ml of HCl was added. Hydroxylamine solution (1ml) was added to the mixture and boiled in a steam bath at 600oC for 2 minutes. Then, 9ml of ammonium acetate buffer solution was added and 35 diluted to 50ml with water. The absorbance was taken at 510nm. Calibration curve was prepared by pipetting 2, 4, 6, 8, and 10ml standard iron solution into 100ml volumetric flasks to prepare a solution of known concentrations. The curve obtained was used to read off the value of iron in an Atomic Absorption Spectrophotometer.

2.5.2. Potassium (K)

Potassium stock solution and standard dilute potassium solution was prepared with the method for sodium solution as outlined by Eke-Ejiofor and Nnodim (2019). A calibration graph was prepared from the reading obtained. About 2 mL of sample was mixed with 2 mL of sodium cobaltinitrite and allowed to stand for 45 minutes. About 2 mL of water was added to the mixture and centrifuged for 15minutes. The supernatant was obtained and mixed with 2 mL of 70 % ethanol. The mixture was centrifuged for 5 minutes and the supernatant boiled in a water bath for 10 minutes. About 1 ml of 1 % choline hydrochloride, 1 ml potassium ferricyanide and 2 mL of distilled water was added to the extract. Absorbance was determined at 620 nm using a colorimeter. The sample solution will then be read and potassium content was calculated using equation 1 below;

$$Potassium = \frac{A_s \times C_{ss} \times D_f}{A_{ss} \times S_v} \times 100 \quad \ldots \quad (1)$$

Where A_s is absorbance of sample, C_{ss} is concentration of standard solution, D_f is Dilution factor, A_{ss} is aborbance of standard solution and S_v is sample volume.

2.5.3. Phosphorus (P)

The Vanado Molybdate method was used from phosphorus determination. About four (4) drops of ammonia, 2.5 ml vanadyl molybdate and 2.5 ml of distilled water was added to 5 ml of mineral ash sample solution. Absorbance was taken at 470
Using a colourimeter (Pearson, 1976). Phosphorus was calculated as follows:
Absorbance of sample x Concentration of standard solution x Dilution factor
Absorbance of standard solution x Sample volume

2.6. Determination of Vitamins

2.6.1. Pro - vitamin A analysis

Estimation of Pro Vitamin – A was done as described by Bayfield and Cole (1980).

Extraction procedure: Each sample (5 g) was measured into a test-tube and 1.0 mL of saponification mixture (2 N KOH in 90 % alcohol) was added. The tubes were refluxed gently for 20 min at 60 °C and then the tubes were cooled to room temperature (30 ºC $\pm$ 0.01). 20 ml of distilled water was added to the mixture and shaken until mix. Vitamin A, from the sample, was extracted with 10 mL of petroleum ether in a separating funnel, the extraction was repeated twice. From the mixture, the organic layer alone was taken to which sodium sulfate (anhydrous) was added to remove the moisture. 5 ml aliquot of the ether extract was dried at 60 °C. Lastly, the dried residue obtained was dissolved in 1 mL of chloroform.

Assay procedure: Aliquots of standard, which was obtained by dissolving of 1.5 mg vitamin A palmitate in 10 mL chloroform were collected in a series of tubes in a concentration ranging from 1.5 - 7.5 µg, volumes in the tubes were made up to 1 ml by adding chloroform. 2 ml of TCA (Tri Chloroacetic acid – 15 g TCA crystals dissolved in 25 ml of chloroform) was added to all the tubes and the tubes were vortexed gently. The sample tubes were also prepared similarly as the standard. Change in color was read at 620 nm in the UV-Vis spectrophotometer. The amount of pro - vitamin A was calculated from the curve of absorbance against the concentration of Vitamin.

2.6.2. Ascorbic Acid (Vitamin C)

One gram (1g) of sample was homogenized with 10 % trichloroacetic acid and 0.5 ml chloroform. The mixture was centrifuged and allowed to settle. The clear supernatant liquid was taken out and mixed with 0.4 ml freshly prepared colour reagent (5 ml 2, 4, dinitrophenyl hydrazine, 0.1 ml 5 % cupric sulphate and 0.1 ml 10 % thiourea) and incubated for 56 ○C in a water bath for 1 hour. This was cooled in ice bath for 3 minutes. Ice cold 85% sulphuric acid was added slowly to each tube with mixing and left at room temperature for 30 minutes. The absorbance was taken at 490 nm (Ball, 1994) in a UV-Vis spectrophotometer. Calculations were made using:

$$\frac{\text{Absorbance of sample x Concentration of standard solution x Dilution factor}}{\text{Absorbance of standard solution x Sample volume}}$$

2.6.3. Vitamin E

One gram (1 g) of sample was mixed with petroleum ether to extract the oil fraction containing the vitamin by withdrawing the supernatant. This was allowed to evaporate by adding 5 ml of 1.5 M alcoholic potash and boiling for 1 hour in a water bath. About 5 ml of petroleum ether and 5 ml of distilled water was added and the mixture centrifuged for10 minutes. The supernatant was again withdrawn and allowed to evaporate. About 3 ml of ethanol, 1 ml of 0.2 % ferric chloride and 1 ml of 0.5 % alcoholic were added. Absorbance was taken at 520 nm in a UV-Vis spectrophotometer. Calculation was made using:

$$\frac{\text{Absorbance of sample x Concentration of standard solution x Dilution factor}}{\text{Absorbance of standard solution x Sample volume}}$$

2.7. Determination of Phytochemical Composition

2.7.1. Determination of flavonoids

Flavonoid was determined by the method described by Okwu (2005). Samples (10 g) was extracted repeatedly with 80 % aqueous methanol 100ml at room temperature. The entire solution was filtered through Whatman No. 1 filter paper. The filtrate is then transferred into a crucible, evaporated to dryness over a water bath and weighed. The percentage was calculated using equation (2).

% flavonoid content = $\frac{weight\ of\ residues}{weight\ of\ sample\ taken} \times 100$ … eqn (2)

2.7.2. Determination of chlorophylls and total carotenoids

The carotenoids was determined by the method described by Branisa et al. (2014). Acetone-water mixture (4:1, v/v) was used as a solvent. The absorbance maxima were read for carotenoids Contents. Total carotenoids were calculated using Equations 3, 4 and 5 respectively;

$$\text{chlorophyll a } (\mu g/ml) = 12.25A_{663.6} - 2.25A_{646.6} \ldots\ldots 1$$

$$\text{chlorophyll b } (\mu g/ml) = 20.31A_{646.6} - 4.91A_{663.6} \ldots\ldots 2$$

$$\text{total carotenoids } (\mu g/ml) = \frac{1000A_{470} - 2.27\,(\text{chl a}) - 81.4\,(\text{chl b})}{227} \ldots\ldots 3$$

2.7.3. Determination of Saponins

The method described by Onwuka (2018) was adopted; exactly 1.0 g of the ground sample was macerated with 20 ml of petroleum ether (pet ether) twice, the mixture filtered, and the filtrate evaporated to dryness. 5 ml of alcoholic potassium hydroxide was added to the residue and then boiled for 1 hour. Another 10 ml of pet ether and 2 ml of distilled water were added. The mixture was shaken and allowed to stand for 2 minutes. The upper layer (pet ether layer) was collect into another test tube and evaporated to dryness. 6mls of ethanol was added to the residue, followed by 2 dml of saponin chromogen (cholesterol colour reagent). The absorbance was taken at 550nm after 30 minutes in an AAS.

2.8. Physical Properties

2.8.1. Determination of loaf volume

Loaf volume was measured by seed displacement method as described by Raman et al. (2004). The loaf was put in a metallic container with known volume (VC). The container was topped up with sorghum grains. The loaf was removed and the volume of the sorghum noted (VR). Loaf volume (VL) was then as:
VL (cm^3) = VC - VR

2.8.2. Loaf weight

Loaf weight was measured 30 minutes after the loaves were removed from the oven using a laboratory electronic weighing scale (CE- 410I, Camry Emperors, China) and the readings recorded in grams.

2.8.3. Loaf volume index

Loaf weight was determined by dividing the volume of loaf sample volume by bread weight of loaf sample by the bread as follows:

Volume index (cm^3/g) = $\frac{\text{Volume of loaf sample}}{\text{Weight of loaf sample}}$

2.9. Evaluation of Sensory Properties

The bread samples were evaluated for color, taste, odor and texture by twenty (20) trained panelists who were randomly selected from staff and students of the Department of Food Science and Technology, Faculty of Agriculture and Life sciences, Federal University Wukari, Taraba state, Nigeria based on their familiarity with breads. The bread samples were presented on 3 digits coded white plastic plates at 29 ± 3 °C. The samples were evaluated on 9-point Hedonic scale where 1 = disliked extremely and 9= like extremely. The order of presentation of the sample to the panelist was randomized. The panelists were provided with bottle water to wash their mouths in between evaluation. The sensory evaluation was carried out at mid-morning (10 am) in the sensory evaluation laboratory under adequate lighting and ventilation.

2.10. Statistical analysis

The analytical results were presented as the mean values ± standard deviation of three independent readings per analysis on every sample. The results were analyzed statistically using IBM SPSS version 23.0, one-way analysis of variance was performed (1-way ANOVA). Difference assessment was done for sensory analysis evaluation by the new Duncan Multiple Range Test (DMRT), where $p < .05$ signifies significant difference, otherwise the data is significantly the same.

3. Results and discussion

3.1. Mineral composition of bread

The mineral composition of the samples including wheat flour bread (control) and acha - orange fleshed sweet potato flour blend bread is shown in Table 1 below. The iron, potassium and phosphorus content of the blend bread increased from 112.03 to 180.22, 203.38 to 444.90 and 18.60 to 20.83 mg/100g with increase in added orange fleshed sweet potato puree. The effect is significant, p= 0.05. The increase in the respective minerals could be due to the high level of the same in the orange fleshed sweet potato root / puree. The acha-orange sweet potato blend bread could be a rich source of iron, potassium and phosphorus. Iron, potassium and phosphorus have been noted to improve the development of bone and blood composition in man (Mason, 2016). Important of iron in human body, to uses iron to make hemoglobin, a protein in red blood cells that carries oxygen from lungs to all parts of the body, and myoglobin, a protein that provide oxygen to muscles (Mason et al., 2016). Phosphorus also helps the body make ATP, a molecule the body uses to store energy. Phosphorus works with the B vitamins.it also help the following: kidney function, muscle contractions, normal heartbeat, nerve signaling. While potassium (K) helps in muscle contractions, improvement in nerve transmission and regulation of blood pressure. (Elsevier saunders 2016).

Table 1: Mineral composition of acha- orange fleshed sweet potato flour blend bread

Acha : OFSP	Iron	Potassium	Phosporus
100 : 0	112.03^{e}±0.14	203.38^{d}±0.14	18.60^{b}±0.14
95 : 5	134.11^{d}±0.14	244.98^{c}±0.67	18.68^{b}±0.14
90 : 10	156.08^{c}±0.21	286.36^{b}±3.18	18.76^{b}±7.21
85 : 15	168. 21^{b}±0.14	368.15^{b}±0.14	19.83^{b}±7.14
80 :20	180.22^{a}±0.21	444.9^{f}±0.14	20.83^{b}±0.14
Control	10.90 ^{b}±70	42.94 ^{f}±0.27	161.21 ^{a}±0.01

Orange fleshed sweet potato. Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=s0.05).

3.2. Vitamin composition (mg/100g) of bread

The vitamin A, vitamin C, vitamin B_6 and vitamin E content of the acha-orange fleshed sweet potato from blend bread increased (table 2) from 1.38 to 4.16, 0.40 to 1.70 and 0.00 to 0.56 and 24.99 to 76.4 mg/100g, respectively, with increase in the added orange fleshed sweet potato puree. The effect is significant, p=0.05. The increase in the vitamin A, vitamin C, vitamin $B_{6\ \text{and}}$ vitamin E could be due the relative high content of the same in the orange fleshed sweet potato root / puree. (Ball, 1994).

Meister (1994) and Palacios (2006) reported the. Reported in increase in vitamin C continent with addition of orange fleshed sweet potato, which contributed to the relative high content of the same in the root. Vitamin C was reported by Liu et al. (2016) to be involved in the immune system by stimulating white blood cell function, *which* could result in risk of pre-eclampsia during pregnancy. Vitamin C has been shown to lessen the severity and duration of cold symptoms (Liu et al., 2016). Furthermore, there is supporting evidence that more than 200 mg/day of vitamin C may be optimal for maximum health benefits (Frei et al., 2012).

Table 2: Vitamin composition of acha- orange fleshed sweet potatoe flour blend bread

Acha : OFSP	Vitamin A	Vitamin C	Vitamin B_6	Vitamin E
100: 0	1.38^{e}±0.14	0.40^{d}±0.00	0.00^{e}±0.00	24.99^{d}± 0.14
95: 5	2.06^{d}±0.01	0.56^{e}±0.01	0.01^{e}±0.00	63.01^{b}±0.21
90: 10	2.73^{c}±0.14	0.98^{d}±1.09	0.25^{d}±0.14	67.04^{c}±0.21
85: 15	3.43^{b}±0.21	1.70^{b}±0.33	0.36^{c}±0.01	70.03^{e}±0.14
80: 20	4.16^{a}±0.14	1.49^{c}±0.01	0.47^{b}±0.01	76.4^{a}±0.14
Control	3.81^{b}±1.4	0.77^{a}±1.6	0.56^{a}±0.21	20.1^{e}±0.21

Orange fleshed sweet potato; Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05).

The vitamin B_6 content of the samples showed that there was significant difference p= 0.05, between the wheat flour bread and the blend's vitamin B_6 content. This could be a result of fortification of the wheat flour. The additions of the oranges fleshed sweet potato puree have improved the vitamins content of the blend breath significant.

3.3. Phytochemical composition of bread.

The phytochemical composition of wheat flour bread and wheat flour supplemented with orange fleshed sweet potato flour bread is shown in Table 3 below. The phytochemical content of the flour blend bread; carotenoid, flavonoid and saponin increased from 29.84 to 38.61, 683.00 to 913.00 and 5.40 to 10.53 mg/100g, respectively, with increase in added orange fleshed sweet potato puree. The Wheat flour bread had 72.53 mg/100gn of flavoured while the bread containing 10% orange fleshed sweet potato puree 776.5 mg/100g flavonoids content. The result agreed with Okpala and Akpu (2014) who prepared bread using wheat flour supplemented with orange peel flour.

Table 3: Phytochemical composition of acha- orange fleshed sweet potatoe flour blend bread

Acha:OFSP	Carotenoids	Flavonoids	Saponins
100: 0	29.84^{c}±0.14	683.00^{e}±1.14	5.40^{e}±0.14
95: 5	30.68^{c}±2.96	729.00^{d}±1.41	6.52^{d}±0.07
90: 10	32.73^{b}±0.14	776.50^{c}±7.07	7.64^{c}±0.14
85: 15	33. 42^{b}±0.14	844.50^{b}±2.12	4.05^{c}±4.94
80: 20	38. 61^{a}±0.34	913^{a}.00±1.41	10.53^{b}±0.21
Control	23. 28^{d}±0.35	72.53^{c}±0.22	15.61^{a}±0.31

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05).

The carotenoids contents of wheat flour bread and the bread containing 0 %, 5 %, 10 %, 15 % and 20 % wheat-acha orange fleshed sweet potato flour were 23.28 and 29.84, 30.68, 32.73, 33.42 and 38.61 mg/100g respectively. The wheat flour bread had lower carotenoids content than the bread containing orange fleshed sweet potato puree. Carotenoids have been proven to improve the recovery of night blindness and loss of appetite. Flavonoids are anti-oxidants, and could lower cholesterol, inhibit tumor formation, and decrease tumor formation and protect against cancer and heart disease (Abegunde et al., 2019).

3.4. Physical properties of breads

The physical property of the acha-orange fleshed sweet potato (OFSP) bread (Plate 1 and 2) is presented in Table 4 below. The loaf weight decreased from 178.67 to 152.33g, while the loaf volume and loaf index decreased from 440 to 303.33 cm^3, and 2.91 and 1.49 respectively with increase in the added orange fleshed sweet potato (0 to 20%). The effect is significant, p=0.005. The loaf index of the blended bread is significantly different from that of 100% wheat bread (3.16).

The significant reduction in the loaf volume and loaf index resulting in to production of heavy bread could be due to absence of gluten in the orange fleshed sweet potato. The findings agreed with former work of Akubur (2016). Gluten is also responsible for dough volume increase as a result of its extensibility, during bread production, gluten form networks which increases the volume of dough along with the action of yeast Raman et al. (2019). Heavy bread, a resultant effect of closed none reflection of the carbon (iv) oxide during fermentation could reduce digestion of the product, with consequence of pour release of nutrient and citification.

Plate 1: Various appearance of breads (A to G; Left to right)
A= 100% wheat, B=100 % acha, C= 100% acha/wheat, D= 95% acha and wheat, E= 90% acha and wheat, F= 85% acha and wheat G=80% acha wheat.

Appearance of breads (A to G; Left to right)
A= 100% wheat, B=100 % acha, C= 100% acha/wheat, D= 95% acha and wheat, E= 90% acha and wheat, F= 85% acha and wheat G=80% acha wheat.

Plates 2: Longitudinal section of bread

Table 4: Physical properties acha- orange fleshed sweet potatoe puree blend bread

Material Acha: OFSP	Loaf weight (g)	Loaf volume (cm^3)	loaf Index
100: 0	$178.67^{b}\pm3.51$	$440.00^{b}\pm10.00$	$2.91^{b}\pm0.78$
95: 5	$176.33^{b}\pm16.50$	$386.67^{cd}\pm32.15$	$2.19^{ac}\pm0.00$
90: 10	$173.00^{b}\pm20.07$	$423.33^{bc}\pm30.55$	$2.39^{b}\pm0.08$
85: 15	$159.33^{c}\pm3.51$	$366.67^{d}\pm30.55$	$2.20^{bc}\pm0.06$
80: 20	$152.33^{d}\pm3.21$	$303.33^{e}\pm15.28$	$1.49^{d}\pm0.70$
Wheat flour	$200.67^{a}\pm1.52$	$581.00^{a}\pm27.62$	$3.16^{a}\pm0.00$

OFSP is Orange fleshed sweet potato

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05)

3.5. Sensory properties of breads

The sensory quality of the acha-orange fleshed sweet potato puree is shown in figure 1 below. The average mean scores of the taste, flavor, colour, odour, texture, appearance and general acceptability of the blend breads ranged from with increase in added orange fleshed sweet potato puree 6.66-7.17, 6.63-6.68, 7.27-7.79, 6.53-7.03, 6.83 –7.03 and 7.07- 7.47 respectively. The blended bread products were generally accepted, but most preferred at 20% added orange fleshed sweet potato purees. The relatively high average means scores for the colour could be due to attractive (orange colour) of the added sweet potato.

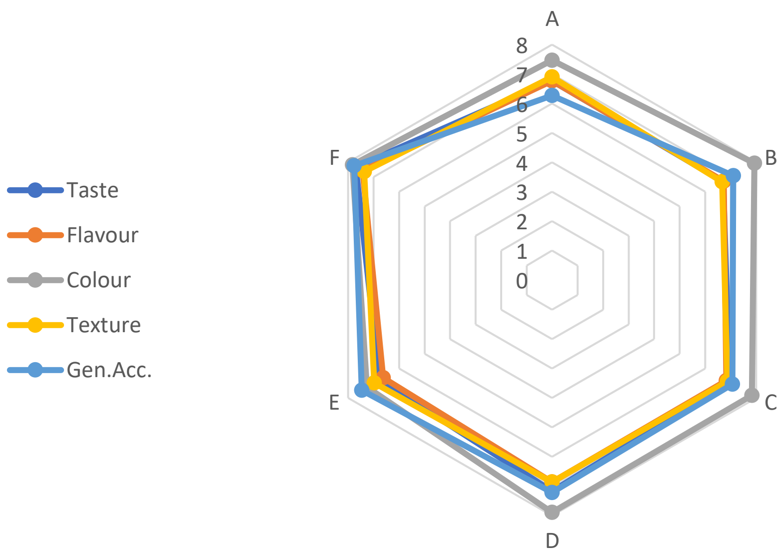

Figure 3: Sensory result chart

A = 100:0 acha : OFSP, B = 95:5 acha : OFSP, C = 90:10 acha : OFSP, D = 85:15 acha : OFSP, E = 80:20 acha : OFSP and F = wheat flour bread

Flavour of the breads ranged from 6.83-6.63, the incorporation of rich orange fleshed sweet potato puree into wheat-acha flour the improved texture of the blended bread could be due to the relatively high fibre content of the orange fleshed sweet potato.

General acceptability of the breads ranged from 7.76-6.83, the incorporation of orange fleshed sweet potato puree into wheat-acha flour. Generally, there was slight improvement in sensory quality with increase orange fleshed sweet potato puree into wheat-acha flour. The finding agreed with Okpala and Akpu (2014) who reported decrease in sensory quality with increased orange peel flour.

4. Conclusion

The findings of the present study suggest that supplementing acha flour with orange fleshed sweet potato flesh is a good and effective way of enhancing the nutritional and sensory properties of the flour.The nutritional composition results (proximate, vitamins, minerals) were within established standard and thus concluded that orange fleshed sweet potato is an adequate alternative to wheat flour. Sensory results obtained showed that slight improvement in sensory quality with increase orange fleshed sweet potato puree into wheat-acha flour. While Physical properties findings showed that bread made from acha-orange fleshed sweet potato blend could compete favourably with those made from 100 % wheat and 100 % acha flour. Conclusively, the addition of orange fleshed sweet potato puree to the acha flour blends have successfully improved the phytochemical, mineral (iron, potassium and phosphorus) and vitamin (A, B_6, C and E) content of the blended bread product. The sensory quality, particularly the colour and the texture were relatively improved with added orange-fleshed sweet potato. Although, all the samples were rated above average (5.0) on the 9-point hedonic scale, the sample with 20 % orange fleshed sweet potato puree was most preferred and accepted by the panelist.

Conflict of Interest

Authors have declared no conflict of interest.

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