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Impact of Orange-Flesh Sweet Potato Flour Incorporation on Micronutrient, Physical Characteristics, and Consumer's Acceptability of Bread

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ABSTRACT: Micronutrient contents of composite flour, physical characteristics, and sensory properties of bread from wheat and orange-flesh sweet potato flour blend were carried out. Orange-flesh sweet potato flour was used as a means of biofortification of wheat that produced composite flour at varied ratios. The composite flour samples were used for bread baking, and a control was produced with 100% wheat flour. Composite and control flour were subjected to provitamin A and mineral analyses, and physical characteristics of the dough and sensory properties of the bread samples were also evaluated using standard analytical methods. The values obtained from all analyses evaluated in this work were significantly different ($p<0.05$). The concentration of β-carotene (Provitamin A) and mineral content of the flour increased with increased addition (10% to 40%) of orange flesh sweet potato flour. Provitamin A content of the flour increased from 5.62 mg/100g to 50.31 mg/100g, calcium 10.99 mg/100 g to 14.88 mg/100g, potassium 310.47 mg/100g to 367.43 mg/100g, and phosphorus increased from 7.24 mg/100 g to 11.57 mg/100 g. On the other hand, magnesium, iron, and zinc decreased gradually from 50.10 to 31.08 mg/100g of magnesium, 3.38 mg/10g to 2.01 mg/100g and 8.01 to 6.87 mg/100 g in the flour samples. The values of physical characteristics of the dough were not the same; loaf volume decreased from 271.08 to 160.43 cm^3 while loaf specific volume decreased from 1.39 to 0.71, however, the loaf weight increased from 180.62 to 234.10g as the level of orange flesh sweet potato flour incorporation of increased. In addition, the mean preference scores for sensory properties such as crust colour, taste, and overall acceptability of bread loaves samples were not the same ($p>0.05$). In all the samples, the composite bread incorporated with 10% orange flesh sweet potato flour having 6.90 mean score was closely related to the control sample in terms of overall acceptability. Indications from quality characteristics and organoleptic properties assessed showed the potential of orange flesh sweet potato flour for improving the nutritional and consumers' acceptability of bread.

Keywords: composite flour, orange-fleshed sweet potato, flour, micronutrients, dough properties, bread sensory properties

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is widely grown to a greater extent in Nigeria and other African countries, where it serves a lot of purposes, which include battling hidden hunger, food security, and raw material for the food industry (FAO, 2015; Shonga *et al.,* 2013). The bulk of sweet potato production in developing countries in Africa is still accounted for by domestic consumption, with little industrial application. The known varieties of *Ipomoea batatas* with white, cream, or yellow flesh in Africa are low in provitamin A, while the orange-flesh variety contains provitamin A compound mainly ß-carotene, thereby making it a promising crop in food and nutrition (*Hernández Suárez et al., 2016*). The presence and concentration of the colour pigment have been attributed to or used as an indicator of ß-carotene in the orange-flesh variety of the sweet potato (Satheesh and Solomon, 2019).

The ß-carotene (provitamin A) component of the coloured sweet potato variety has been exploited in food formulation and production as a means of prevention of hidden hunger known as vitamin A deficiency in many developing countries across the globe (Satheesh & Solomon, 2019; *Kaguongo, 2012)*. Despite the nutritional value and high production yield potentials in areas where orange-flesh sweet potato is grown in Nigeria and other West African countries, the crop is still underutilized. Inadequate scientific information on the application of orange-flesh sweet potato in food formulation has been identified as a major factor limiting the utilization of the potato to its full potential in the food industry (Satheesh and Solomon, 2019).

Prevalence of micronutrient deficiency in human nutrition is increasing and becoming a public health concern, this deficiency affects more than two billion individuals (FAO *et al*., 2015) or one in three people affected globally. Lack of adequate dietary supply and intake of vitamins and minerals has been implicated as a major problem of micronutrient deficiency. Most people in developing countries live below the per capita income, couple with high inflation, thereby difficult to afford non-staple foods that are rich in fortified and processed foods (Bouis *et al*., 2011a). Most of the high quality food that are known to be adequate diet that capable of prevention or eradication of micronutrient deficiency are processed through fortification, nutrient complementary and biofortification techniques that are expensive thereby make the food beyond the reach of many poor households then depend on local or indigenous food in form of composite flour mostly in developing countries (Saltzman *et al.* (2013; 2015; Bouis *et al*., 2011b). Biofortification and food complementary techniques have been employed to improve the vitamin and mineral density in food products (Bouis *et al*., 2011b). Saltzman *et al.* (2013; 2015) stated that biofortified foods, when consumed regularly, can lead to measurable improvements in human health and nutrition. Many nutritional techniques and interventions are combined to alleviate micronutrient deficiencies in addition to biofortification, supplementation, and industrial food fortification (Saltzman *et al.,* 2015).

The reliance on imported wheat flour in many Sub-Saharan African countries poses a great challenge to the nutritional, economic, and social life of a vast population. In developing countries, there have been growing concerns on the nutritional value of wheat-based bakery and confectionery products (West & Darnton-Hill, 2008). This is simply because wheat is not known as a dietary source of micronutrients such as vitamin A, iron, B-complex, etc. Most effort used to address this challenge has been through fortification with food-grade sources to prevent and eradicate its nutritional deficiencies in vulnerable populations (Huo *et al*., 2011, 2012). Researchers have been tasked to seek alternative means of micronutrient biofortification of foods using indigenous food materials such as orange-fleshed sweet potato to produce composite flour. This practice will not only reduce the effect of foreign exchange due to importation but also improve the nutritional content of composite flour for bakery and confectionery productions.

Composite flour has been strongly advocated for in bakery production and also gained popularity in West African countries with the goal of partially substituting wheat with non-wheat flour. The techniques for composite flour reduce foreign exchange due to importation of wheat flour and also to improve the nutritional value (Shittu *et al.* 2007; Hasmadi *et al*., 2014; Abdelghafor *et al*., 2011). Shittu *et al.* (2007) stated that binary or ternary mixtures of flours from some other crops with or without wheat flour can produce composite flour (Hasmadi *et al*., 2014). Globally, several developing countries have launched programmes to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al*., 2011).

The FAO reported that the application of composite flour in various food products would be economically advantageous if the imports of wheat could be reduced or even eliminated, and that demand for bread and pastry products could be met by the use of domestically grown crops instead of wheat (Jisha *et al*., 2008). The bakery products produced using composite flour were of good quality, with some characteristics similar to wheat flour bread, though the texture and the properties of the composite flour bakery products were different from those made from wheat flour, with an increased nutritional value and appearance. Apart from being a good source of calories and other nutrients, wheat is considered nutritionally poor, as cereal proteins are deficient in essential amino acids such as lysine and threonine (Dhingra and Jood, 2001).

The complementary synergy of flour from local or indigenous crops that are rich in nutrient content and, more importantly, micronutrients will help to improve the nutritional quality of composite flour and food products. This research work evaluates the potential of partial substitution of orange-fleshed sweet potato flour on the quality of composite flour and bread.

MATERIALS AND METHODS

Materials

The orange-fresh sweet potato tubers (Plate 1), wheat flour, baking powder, sugar, butter, eggs, and water were purchased from Eke Umuagwo Market and transported to the food processing workshop of the Department of Food Science and Technology, University of Agriculture and Environmental Sciences, Umuagwo, Imo State, for processing.

Production of orange-flesh sweet potato flour

The procedure described by Adeleke and Odedeji (2010) was modified for the production of orange-flesh sweet potato flour. Five (5 kg) of freshly harvested orange-flesh sweet potato were transferred to the food processing workshop within 24 hr of harvest for processing. The tubers were cleaned under running portable water to remove adhering materials and soils. The cleaned tubers were peeled underwater to prevent enzymatic browning, sliced at 5-7 mm thickness using a manual stainless slicer, and blanched in hot water (65 °C for 15 min), and immediately cooled in cold water. The cooled slices of the sweet potato were then drained on a perforated stainless tray. The sliced potatoes were dried in a hot air oven at 70 °C until the chips were brittle and easy to be milled. The dried chips were milled into fine powder using an electric grinder (High-Speed sampling machine model-FW100, China). The milled potato chips were sieved through a 0.425 mm sieve. The fine flour particles were packaged in an air-tight polyethylene bag for further use.

Plate 1: Freshly harvested orange-fleshed-sweet potato tubers (Adeleke & Odedeji, 2010)

Formulation of Composite Flour

Blending orange-flesh sweet potato flour with wheat flour in the proportion of 10:90, 20:80, 30:70, and 40:60, and 100% soft wheat flour as a control, was made for bread baking.

Production of bread

Recipe for bread baking

The recipe stated by Al-Saleh and Brenna (2012) was used. Flour 1500 g, yeast 30 g, salt 7 g, Dough improver 30 g, Shortening/fat 75 g, milk flavour 30 g, and water 900 mL.

Bread baking

The bread was produced using the straight dough method as reported by Ayoade *et al*., (2020). The ingredients (flour, salt, sugar, yeast, and water) were mixed, the mixture was kneaded properly until soft to obtain the dough. The dough was cut and placed in greased baking pans, then covered with muslin cloth for 2 h to ferment and rise. It was baked at 230 °C in an oven (model: HENZ300, China) for 30 min. The bread was removed from the pans and allowed to cool before being packaged in polyethylene bags.

Determination of Pro-vitamin A

The standard procedure described by Rodriguez-Amaya (2004) was used for the provitamin A determination. One gram (1 g) of the sample was mixed with 50 mL of acetone (acetone refrigerated at 4 °C for 2 h before use), added slowly, and filtered using cotton wool, which was plugged into a fume chamber. The extraction of β-carotene was repeated until the sample from the mortar was devoid of colour. About 40 mL of petroleum ether was put in a separating funnel and acetone was added. Distilled water was added slowly along the neck without shaking to avoid emulsion formation. The two phases were then left to separate, and the lower aqueous layer was discarded. The sample was washed 3-4 times with distilled water (approx. 200 mL) each time to remove residual acetone. In the last phase, washing was done, ensuring that no amount of the upper phase was discarded. Then, the upper layer was collected into a 50 mL flask using an anhydrous sodium sulphate filter arrangement to remove residual water. The absorbance was determined at 450 nm using a UV-visible spectrophotometer model BioMate-6 (Sigma Aldrich). The concentration of β-carotene was calculated using the equation of the standard curve (Rodriguez-Amaya, 2004).

Mineral determination

The standard procedure described by Onwuka (2005) was used for the determination of the mineral content of the sample. One gram of the sample was digested (ashing). Calcium and potassium were determined from the digest using the flame photometry method. The heavy metals, such as iron, zinc, and manganese, were determined using the atomic absorption spectrophotometry method.

Determination of dough characteristics

Loaf Volume

The small seeds displacement method described by Al-Saleh and Brennan (2012) was used for the determination of the loaf volume of the dough sample. A container was used to measure the volume using rapeseed grains. Rapeseeds were poured into the container of known volume until the bottom was covered. The loaf was placed inside the container, which was then filled to the top with more seeds. The extra rapeseeds, which equal the loaf volume, were measured in a graduated cylinder. The specific volume of the loaf was calculated using Equation 1.

$$\text{Specific volume} = \frac{\text{Loaf weight}}{\text{Loaf volume}}$$

The Loaf Weight

An electronic weighing balance was used to determine loaf weight. The kneaded dough samples were cut into sizes using a stainless steel kitchen knife and were weighed directly on a digital electronic balance (Al-Saleh & Brennan, 2012).

The Oven Spring

The oven spring of the dough sample was measured using the procedure described by Al-Saleh and Brennan (2012). The difference in dough height before and after baking was determined for oven spring

Sensory evaluation of the bread samples

The sensory evaluation of the bread samples was carried out using the method reported by Iwe (2002). Thirty (30) panelists drawn randomly from the staff and students of the University of Agriculture and Environmental Sciences Umuagwo, Imo State, Nigeria, were used to carry out the organoleptic assessment under a controlled environment to avoid biased results. The organoleptic attributes assessed were the taste, the aroma, the texture, the crust colour, the crumb colour, and the overall acceptability. The coded bread samples sliced at 3-4 cm thickness were presented to the panelists on white ceramic flat plates. The panelists were instructed to rate the bread samples based on a 9-point hedonic scale ranging from 9=liked extremely to 1=disliked extremely. A round table panel discussion was conducted to obtain views and comments from panelists on the product.

Statistical analysis

All analysis was conducted in triplicate, and the significant differences obtained from the results were calculated using Fisher's least significant difference (LSD) test in a one-way Analysis of Variance (ANOVA). The Statistical Package for Social Sciences (SPSS version 20.0 Inc. USA) was used for the statistical analysis.

RESULTS AND DISCUSSION

Provitamin A and mineral content of composite flour

Table 1 presents the provitamin A and mineral content of the composite flour blend from wheat flour and orange-

Table 1. Provitamin A and mineral content of composite flour

Bread sample	Provitamin-A (mg/100 g)	Calcium (mg/100 g)	Potassium (mg/100 g)	Phosphorus (mg/100 g)	Magnesium (mg/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)
A	5.62^{d}	10.99^{d}	310.47^{d}	7.24^{d}	50.10^{b}	3.38^{b}	8.01^{b}
B	22.03^{c}	12.03^{c}	341.54^{c}	7.70^{c}	41.01^{c}	2.98^{c}	7.44^{c}
C	38.92^{b}	13.46^{b}	352.10^{b}	9.48^{b}	33.64^{d}	2.11^{d}	7.01^{d}
D	50.31^{a}	14.88^{a}	367.43^{a}	11.57^{a}	31.08^{e}	2.01^{e}	6.87^{e}
E	4.79^{e}	10.29^{e}	281.32^{e}	6.11^{e}	55.03^{a}	3.66^{a}	8.37^{a}
LSD	0.0216	0.0184	0.6422	0.0192	0.0225	0.024	0.020

Mean scores with different letters on the same column are significant ($p<0.05$)
Key:
Sample A = 90:10% wheat-OFSP composite flour
Sample B= 80:20% wheat-OFSP composite flour
Sample C= 70:30% wheat-OFSP composite flour
Sample D= 60:40% wheat-OFSP composite flour
Sample E= 100% wheat flour
OFSP= orange flesh sweet potato flour

flesh sweet potato flour (OFSP). There was a significant difference ($p<0.05$) in the values provitamin A and mineral contents of the composite flour studied. Provitamin A content of the flour increased as the substitution of OFSP flour in the blend increased (10% to 40%). Flour sample A, which contained 10% OFSP flour, had 5.62 mg/100g, which increased steadily to 22.03 mg/100g, 38.92 mg/100g, and 50.31 mg/100g provitamin A in flour samples B, C, and D, incorporated with 20%, 30% and 40% respectively. These values found on composite flour were higher than 4.79 mg/100 g of provitamin A in 100% commercial wheat flour. This result indicated that the incorporation of OFSP flour could be responsible for this observation and also suggests the potential of OFSP flour as a rich dietary source of provitamin A, which is β-carotene. The result obtained in this work was similar to earlier research conducted on composite bread reported by Igbabul *et al.,* (2014). In addition, the result provitamin A in this work corroborates the finding of Mutuku *et al* (2019), who reported the importance of β-carotene content of orange-flesh sweet potato on weaning food prepared from maize-based diet for infants. Micronutrients such as β-carotene in food are essential nutrients required for maintaining immune function in human nutrition (Stephensen, 2001). Koletzko *et al*. (2008) further reiterated the nutritional importance of β-carotene in the maintenance of a healthy skeletal system, skin, teeth, and tissue, also promoting good eyesight. Recommended dietary allowances for vitamin A vary according to age, ranging from 350 to 400 µg per day for 6-month-old to 3-year-old infant (Koletzko *et al*. 2008; Booth *et al*. 2001). However, the β-carotene found in the samples in the studied were relatively higher than the recommended daily allowance reported by Koletzko *et al*., (2008).

Mineral content, calcium, potassium, and phosphorus increased while magnesium, iron, and zinc decreased as the percentage partial incorporation of OFSP flour into wheat flour changed from 10 to 40 proportion in the composite flour. The calcium increased from 10.99 mg/100g to 14.88 mg/100g, while the 100% wheat flour had 10.29 mg/100g. Also, potassium increased from 310.47 mg/100g to 367.43 mg/100g, which is higher than 281.32 mg/100g of the 100% wheat flour; phosphorus increased from 7.24 mg/100g of sample A (10% added OFSP) to 11.57 mg/100 g of sample D (40% added OFSP). On the other hand, magnesium decreased steadily from 50.10 mg/100g to 31.08 mg/100g while iron and zinc content of the composite flour changed value gradually from 3.38 mg/100 g to 2.01 mg/100g and 8.01 mg/100g to 6.87mg/100g. The result suggested that, the incorporation of OFSP flour increased calcium, potassium, and phosphorus, while magnesium, iron, and zinc contents reduced in the flour blends. The result pattern found on mineral content may be due to the effect of processing, complementary synergy of the chemical composition of the raw materials (wheat and sweet potato), food formulation proportions, and chemical interactions of component to component during formulation and processing. Therefore, the values of some mineral content in experimental flour are higher than those of wheat flour, which implies that inclusion of

Table 2. Physical properties of composite bread dough from orange flesh sweet potato

Bread sample	Loaf volume (cm^3)	Loaf weight (g)	Loaf specific volume
A	271.08^{b}	180.62^{d}	1.39^{b}
B	220.31^{c}	197.03^{c}	1.17^{c}
C	212.27^{d}	210.65^{b}	0.98^{d}
D	160.43^{e}	234.10^{a}	0.71^{e}
E	285.71^{a}	175.09^{e}	1.60^{a}
LSD	0.024	0.020	0.013

Mean scores with different letters in the same column are significant ($p<0.05$)

Key:
Sample A = 90:10% wheat-OFSP composite bread dough
Sample B = 80:20% wheat-OFSP composite bread dough
Sample C = 70:30% wheat-OFSP composite bread dough
Sample D = 60:40% wheat-OFSP composite bread dough
Sample E = 100% wheat bread dough
OFSP = orange flesh sweet potato

orange-flesh sweet potato improves the micronutrient content of the composite flour. The trend of micronutrient values in this work was in agreement with James *et al.* (2017), who reported a desirable effect of Bambaranut incorporation on the mineral content of wheat-bambaranut-cassava composite flours. Balk *et al.* (2017) reported that calcium is one of the micronutrients that plays a vital role in many processes in the human body; it helps in muscle contraction, builds strong bones and teeth, and regulates heartbeat. The recommended daily allowance for most adults is 1000 g/day and increased to 1200 g/day for women over 50 years old and men over 70 years old (Food & Nutrition Board, 2010). Considering the values of calcium found in the flour blends, it may consequently help in meeting the recommended daily allowance in bread. Potassium is required in an amount not less than 100mg/day (Murray *et al*., 2000). Its deficiency causes impaired neuromuscular function of the skeletal, smooth, and cardiac together with muscular weakness, paralysis (Murray *et al*., 2000).

Physical properties of composite bread dough from orange flesh sweet potato

The physical properties of dough made from wheat-orange-flesh sweet potato flour are shown in Table 2. There were significant ($p<0.05$) differences observed in loaf volume, loaf weight, and loaf-specific volume in all samples. The loaf and specific volume reduced from 271.08 cm³ and 1.39 of sample A (10% OFSP composite flour) to 160.43 cm³ and 0.71 of sample D (40% OFSP composite flour), respectively. The reduction in volume was noticed as the percentage incorporation of OFSP flour increased in the blends. The values in this work corroborate with results reported by Onuegbu *et al*., (2013); Oyinloye *et al*., (2022), and Forimentini *et al*., (2022) for bread produced from different composite flours. Loaf and specific volume of dough is depend on the gluten content of wheat flour (Oyinloye *et al*., 2022). Consequently, the gradual reduction in loaf and specific volume could be due to the incorporation of orange-flesh sweet potato flour, which may have reduced the concentration of gluten content in wheat flour for bread production. Although the highest 285.71 cm³ and 1.60 loaf and specific volume, respectively, were found on the control sample E produced from 100% wheat flour. The loaf weight gradually increased among samples, with the values ranging from 175.09 to 234.10g. The values obtained were similar to reports of Igbabul *et al.* (2014); Oyinloye *et al.* (2022), and Olagunju *et al*. (2020), Oyinloye *et al*. (2022) stated that the level at which CO_2 is retained during fermentation influences dough loaf weight. This implies that a higher dough loaf weight from composite flour could be due to the incorporated sweet potato flour, resulting in bread samples with dense texture. The sweet potato flour contained little or no gluten content, the compound that is responsible for dough

Table 3. Sensory properties of wheat flour bread with partial Orange flesh sweet potato flour

Bread sample	Crust colour	Taste	Aroma	Crumb texture	Overall acceptability
A	6.85^{b}	6.20^{b}	6.25^{bc}	7.25^{ab}	6.90^{b}
B	6.80^{b}	6.15^{b}	6.50^{ab}	6.15^{bc}	6.80^{b}
C	6.80^{b}	6.35^{b}	6.45^{abc}	6.80^{b}	6.85^{b}
D	5.65^{b}	5.65^{b}	4.85^{c}	5.35^{c}	5.25^{c}
E	8.70^{a}	8.35^{a}	7.95^{a}	8.40^{a}	8.70^{a}
LSD	0.469	0.579	0.583	0.513	0.460

Mean scores with different letters on the same column are significant ($p<0.05$)
Key:
Sample A = 90:10% wheat-OFSP composite bread
Sample B = 80:20% wheat-OFSP composite bread
Sample C = 70:30% wheat-OFSP composite bread
Sample D = 60:40% wheat-OFSP composite bread
Sample E = 100% wheat bread
OFSP= orange flesh sweet potato

elasticity during the kneading process in bread production. The indication from this study suggests that the level of incorporation of the OFSP flour should be closely monitored in order not to affect the physical properties of bread dough despite its nutritional values added to the dough (Table 1).

Sensory properties of wheat flour bread with partial orange flesh sweet potato

The sensory properties of loaves produced from wheat-orange-flesh sweet potato composite flour are presented in Table 3. There was no significant difference in the mean scores of sensory properties of bread samples evaluated apart from crust colour. The mean scores for crust color of experimental samples ranged from 5.65 to 6.85, but no significant difference (p>0.05), with the exception of the control sample, which was 8.70 (very much liked). The crust colour developed in bread may be attributed to the degree of browning condition, which occurs as a result of the reaction between sugar and the amino group (Millard reaction) in the presence of high temperature during baking. Although the indication still shows that the control sample was the most preferred in terms of appearance (colour). Taste is an important sensory attribute that influences the overall acceptability of bread. The mean scores for the taste of composite bread varied slightly, ranging from 5.65 to 6.20, but not significantly (p>0.05), while the control sample recorded 8.35 as the highest. Also, in terms of the aroma of the bread, the control sample scored 7.95, the highest compared to a range of 4.85 to 6.25 found on experimental samples. Aroma is an attribute that has an influence on the acceptability of baked products prior to the taste of bread samples.

The result from the crumb texture showed that the control sample (100% wheat flour) with 8.40 highest score was most preferred followed by 7.25 of sample A (90:10% wheat-OFSP flour but not significant difference (p>0.05). Sample D (60:40% wheat- OFSP) had the 5.35 least score. It is obvious that the texture of the bread was affected by the increased proportion of sweet potato flour in the blends. The lowest score on crumb texture of sample D could be attributed to 40% OFSP flour incorporated, which affected the crumb texture. The general acceptability of samples revealed that the mean score 8.70 of control sample E was the highest and significantly different (p<0.05) from other samples was most preferred and was significantly different from other samples. Other samples A, B, C have scores 6.90, 6.80, and 6.85, respectively, and were not significant (p<0.05). The scoring test on sensory properties shows that the proportion of incorporation should be monitored at higher level (30-40%) despite its nutritional benefits in the blends. However, incorporation of non-wheat flour up to 20% level will significantly reduce total dependent on imported wheat flour for bakery production especially in developing sub-Saharan Africa countries

CONCLUSION

This research work further discloses the potential of orange-flesh sweet potato as a source of non-wheat for the formulation of composite flour and subsequently bread production, most especially in developing sub-Saharan African countries where wheat is grown in limited quantity compared to its demand in food formulation and production. Scientific evidence from this work showed that orange-flesh sweet potato flour can be incorporated up to a 20% level as a composite with wheat flour without any significant difference in the organoleptic characteristics of both composite and 100% wheat bread samples. This will provide a great relief on foreign exchange incurred by bakers on imported wheat flour. In addition, micro-nutrient results revealed the potential of orange-flesh sweet potato, especially the high concentration of β-carotene and minerals recorded in the study. This improved quality of the composite flour as a result of orange-flesh sweet potato incorporation consequently increased the nutritional value of the bread, which thereby serves as a means of guiding against hidden hunger experienced in many developing countries of the world. The use of orange flesh sweet potato in bread production would promote production, value addition, and increase utilization of the crop in Nigeria and other countries where is grown substantially. This would create wealth, prevent vitamin A deficiency, and enhance food security.

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