AUCTORES
Globalize your Research

Journal of Nutrition and Food Processing

Akinsola, A.O *

Open Access

Research Article

Nutritional characteristics and sensory properties of orange fleshed sweet potato-based complementary food fortified with pigeon pea (Cajanus cajan) and tigernut (Cyperus esculentus) composite flours

Akinsola, A.O*., Oyeleye, B.R., Taiwo-Oshin, M.A., Afonja, T.E., Gbadegesin, I, A. & Odunewu, A. A

Department of Home Economics, Federal College of Education (Special), Oyo, Nigeria.

Corresponding author: Akinsola, A.O, Department of Home Economics, Federal College of Education (Special), Oyo, Nigeria.

Received date: January 02, 2025; **Accepted date:** January 21, 2025; **Published date:** February 10, 2025

Citation: Akinsola, A.O., Oyeleye, B.R., Taiwo-Oshin, M.A., Afonja, T.E., and Gbadegesin I, A, et al, (2025), Nutritional characteristics and sensory properties of orange fleshed sweet potato-based complementary food fortified with pigeon pea (Cajanus cajan) and tigernut (Cyperus esculentus) composite flours, *J. Nutrition and Food Processing*, 8(2); **DOI:10.31579/2637-8914/290**

Abstract:

The study evaluates nutritional characteristics and sensory properties of orange fleshed sweet potato-based complementary food fortified with pigeon pea and tigernut composite flour. Standard processing and analytical methods were used in material preparation and analyses for the composite flour blends. The composite flours were blended in ratio of 100:0:0, 60:30:10, 65:25:10, 70:20:10, 75:15:10 and labeled A, B, C, D and E, respectively. Result shows that there was significant improvement ($p < 0.05$) in the proximate composition of all the composite flours determined. Significant ($P<0.05$) difference exists across the samples for Ca, Fe, P, K, Na and Mg with values ranging from 38.12 to 54.55 g/100g, 2.87 to 4.18 g/100g, 48.16 to 68.60 g/100g, 89.40 to 148.17 g/100g, 1.83 to 3.13 g/100g and 92.60 to 119.57 g/100g, respectively. There was significant difference ($p < 0.05$) among all samples for all the vitamin assayed with values ranging from 1432.14 to 1746.85 (RAE), 0.06 to 0.17 g/100g, 0.03 to 0.10 g/100g, 0.05 to 0.12 g/100g and 13.42 to 17.26 g/100g for vitamin A, B1, B2, B3 and C, respectively while negligible amounts of antinutritional factors obtained ranged from 0.42 to 1.71 mg/100g, 0.17 to 1.14 g/100g, 0.81 to 1.67 g/100g, 1.79 to 1.42 g/100g and 0.38 to 1.54 g/100g for phytate, oxalate, tannins, amylase and trypsin inhibitors, respectively. Sensory evaluation mean scores revealed substantial overall acceptability of all the formulated complementary food samples while sample with 25 % pigeon pea and 10 % tigernut was most preferred by the panelists. The quality of OFSP-based complementary samples were greatly improved by pigeon pea and tigernut fortification and could be nutritional beneficial to infants and young children.

Key words: complementary food; composite flour; fortification; infants, nutritional beneficial; young children

Introduction

The development of quality complementary foods from local and readily accessible raw materials has received considerable attention in many developing countries especially Nigeria in order to reduce dependant on foreign currency and guarantee quality complementary foods are given to infants and young children in addition to breast milk when breast milk nutrients become insufficient for their energy and growth needs (Olorode et al., 2017). In developing West African countries such as Nigeria, the introduction of complementary food typically usually starts between the ages of three to six months (i.e. within six months of exclusive breast feeding). Complementary food is an important phase in the transition from breast feeding to family foods in form of semi-liquid porridge prepared from staple cereals and tubers such sweet potato, cocoyam, Irish potato, etc. Orange fleshed sweet potato, OFSP (Ipomoea batatas) has considerable antioxidant activity and very rich in carotenoids and β-carotene (containing 24.2 – 7.9 mg/100 g of β-carotene on dry basis), a precursor of vitamin A (Alam et al., 2016) which protects the body from several diseases, such as night blindness and other serious diseases. Orange fleshed sweet potato roots are source of fibre, starch, sugar, vitamin A, iron, calcium and several other minerals (Browser et al., 2017) potentially improve vitamin A level in growing children in developing countries (Laurie et al., 2015).

Pigeon pea (Cajanus cajan) seeds can be used as a vegetable and cooked in curries or used to make relishes. The dry seeds have several products according to Nwosu et al. (2013) such as tempe and ketchup. Pigeon pea flour mixed with wheat to improve the protein level of baked products) and clear noodles of a quality higher than that of mung bean are made from dehulled seed. Fresh seeds contain vitamins, especially provitamin

A and vitamin B complex per 100 g edible portion, its dry seeds contain 7-10.3 g water, 14-30 g protein, 1-9 g fat, 36-65.8 g carbohydrates, 5-9.4 g fibre and 3.8 g ash. The energy content averages 1450 kJ/100 g while tigernut (Cyperus esculentus) is a high dietary fibre tuber crop which could be utilized in the treatment and prevention of many disease including colon cancer, coronary heart diseases, obesity and gastro intestinal disorder as reported by (Oke et al., 2016). Its flour has been observed to be rich source of quality oil, vitamin E and some useful minerals such as iron and calcium which are essential for body growth and development (Oke et al., 2019). Therefore, addition of pigeon pea and tigernut flour in complementary food formulations for indigenous tubers will improved its protein quality, micronutrients, vitamin A and dietary fibre. Vitamin A deficiency has far reaching consequences and can lead to common illness in children such as vision and immune impairment It is thus, a priority in health policy to improve vitamin A and pro-vitamin A status in these vulnerable groups especially children (Akinsola et al., 2018).

It is inevitable necessary to study ways and means of developing inexpensive but equally nutritious traditionally produced complementary food that may be within the reach of the under privilege, using locally available cereals, legumes and cottage technologies in its production. The formulation of quality complementary foods from local and readily available raw materials such as orange flesh sweet potato, pigeon pea and tigernut is expected to provide protein based weaning foods that are of high quality and inexpensive. Therefore, the main objective of this study was to determine the nutritional characteristics and sensory properties of orange fleshed sweet potato-based complementary food fortified with pigeon pea and tigernut composite flour.

Materials and Methods

Materials

Orange fleshed sweet potato roots were purchased from a popular farm market in Offa, Kwara State while pigeon pea and tigernut (yellow variety) were purchased at Ajegunle market, Oyo, Oyo State, Nigeria.

Production of orange fleshed sweet potato (Ipomea batata) flour

The orange fleshed sweet potato flour was produced according to the standard method of Singh et al. (2008) described by Alawode et al. (2017). The orange fleshed sweet potato tubers were peeled and cut into thin slices manually with sharp knives. The sweet potato slices were soaked in 1 % potassium metabisulphite solution for a period of five minutes to avoid browning and intensify its colour, then dried in a cabinet dryer set at 55±5 °C for 48 hours. The dried orange fleshed sweet potato chips were milled into flour using laboratory hammer mill (Fritsch, D-55743, Idar-Oberstein, Germany) to fine powder. The milled flour obtained were sieved using 250 µm screen, packaged in a sealed plastic film and stored in a closed plastic container till further use.

Production of pigeon pea (Cajanus cajan) flour

The modified method described by Okolie et al. (2022) was used for pigeon pea seed. The pigeon peas were cleaned to remove extraneous elements such as stones, deformed bean and pest-infested beans. The seeds were washed and steeped in tap water for 24 hours and dehulled. Dehulled seeds were dried in the cabinet dryer at 55±5 °C for 48 hours. The seeds were dry milled after cooling into flour using the laboratory hammer mill (Fritsch, D-55743, Idar-Oberstein, Germany) to fine powder. The milled flour obtained was sieved using 250 µm screen, packaged in a sealed plastic film and stored in a closed plastic container till further use.

Production of tigernut (Cyperus esculentus) flour

Tigernut flour was produced by the method described by Oke et al. (2017). After removing stones, pebbles and other unknown materials from the tigernut and clean under running tap water. The cleaned nuts were then dried in a cabinet dryer at 55±5 °C for 48 hours. The dried nuts were milled in a laboratory hammer mill (Fritsch, D-55743, Idar-Oberstein, Germany) to fine powder. The milled flour obtained was sieved using 250 µm screen, packaged in a sealed plastic film and stored in a closed plastic container till further use.

Formulation of OFSP, pigeon pea and tigernut composite flour

The OFSP-based complementary flours were mixed in proportion of 100:0:0; 75:15:10; 70:20:10; 65:25:10; 60:30:10, respectively and coded as sample A, B, C, D and E. Sample B – E was blended using a Kenwood mixer (Model: HC 750D, Kenwood, UK) to produce homogenized composite flour while sample A served as control and contained 100 % OFSP flour. The composite flours of the four samples were formulated with equal tigernut flour obtained and stored at room temperature (28±2 oC) in an airtight low-density polyethylene bag for further analysis.

Methods

Determination of proximate composition of OFSP, pigeon pea and tigernut composite flour

Proximate composition (moisture, protein, fat, fibre, ash) of each sample was carried out using Association of Official Analytical Chemistry (2016) while carbohydrate content was determined by difference. Gross energy value of each sample was determined by calculation from fat, carbohydrate and protein content using the Famakin et al. (2016) method:

Gross energy, KJ/100 gm (Dry matter) = (Protein x 16.7) + (Lipid x 37.7) + (Carbohydrate x 16.7)

Determination of mineral content of OFSP, pigeon pea and tigernut composite flour

The mineral concentration (Ca, Fe, K, Na, P, Mg) was determined using the Atomic Absorption Spectrophotometer (Model: 6405 UV/VIS, Jenway, UK) according to AOAC (2016). The ash obtained after incineration at 500°C was dissolved in aquaregia (10 mL nitric acid +30 mL HCl) solution and boiled for 30min. The mixture was transferred into a 250mL volumetric flask and boiled again for 30min. The mixture was filtered into 100mL volumetric flask and made up to the mark with distilled water and injected into the Spec equipped with a UV detector set at 254 nm. The peaks of the minerals in the samples were calculated in relation to the peaks of standard minerals.

Determination of vitamin content OFSP, pigeon pea and tigernut composite flour

Vitamin A, B1, B2, B3 and C were evaluated using HPLC (Model: BLC-10/11, BUCK Scientific, USA) techniques as described by AOAC (2016). For each sample, 3.0 g was mixed with 5 mL of n-hexane and 20 mL of HPLC grade water. The mixture was homogenized at 12000 rpm and centrifuged (3500 x g) for 30 min, followed by sequential filtration through whatman No 1 filter paper and 0.45 µm membrane. Then, 15 µL of the supernatant was injected into the HPLC equipped with a UV detector set at 254 nm. The peaks of the vitamins in the samples were calculated in relation to the peaks of standard vitamins.

Determination of Anti-nutrients of OFSP, pigeon pea and tigernut composite flour

Selected anti-nutritional factors such as phytate, oxalate, tannins were determination using method described by Nwosu (2013) while amylase and trypsin inhibitor contents were determined as described by Figueira et al. (2003) and Famakin et al. (2016), respectively.

Sensory evaluation of the OFSP, pigeon pea and tigernut composite flour

The complementary food samples were prepared into gruel and presented to twenty semi-trained nursing mothers, lecturers and mothers of in School of Secondary School, Vocational and Technical programmes, Federal College of Education (Special), Oyo. Each sample was reconstituted, coded and evaluated for preference using the method of Akinsola et al. (2018). They were asked to score the complementary food samples for appearance, aroma, taste, texture and overall acceptability, respectively. Each panelist sat apart from one another for sensory evaluation. Water was provided to rinse mouths before and after tasting each of the samples. The panelists were presented with a score sheet using 9-point hedonic scale where 1 is disliked extremely and 9 liked extremely.

Statistical Analysis

All data were statistically analyzed using SPSS version 17.0 for analysis of variance, while Duncan multiple range test (DMRT) was used to separate means where there is a significant difference. For each sample, triplicate determinations were carried out.

Results and Discussions

Proximate composition of OFSP, pigeon pea and tigernut composite flour samples

The result of proximate composition of oranges fleshed sweet potato (OFSP) based complementary food fortified with pigeon pea and tigernut flour is as shown in Table 1. The result indicates significant improvement in all the samples nutrients at alpha 0.05 except carbohydrate which reduces significantly as pigeon pea % increases in the formulation. Moisture content (M.C) reduced among the formulated complementary food samples compared with control sample (sample A). M.C values obtained was relatively lower than 10 % which indicated a good shelf life and nutrients dense complementary food products. Low M.C is a pre-requisite for longer storage ability of a food product since it will prevent quick mouldy of the blended flour. Protein values of the study were lower than the value (13-14 g/100g) recommended by Anigo et al. (2009). It was observed during the study that a protein of 10-12 g/100g dry weight significantly provides good protein nutrient to a baby of 6-23 months when a novice observation was carried out using a nearby maternity home to test the sample products. Samples with 20 %, 30 % and 30 % pigeon pea addition agreed with the work of Anigo et al. (2009) and Idowu et al. (2017). Fat content of all the samples provides more than 28 % of energy value of the baby food compared to FAO/WHO (1994) recommendation of 13 % of total energy provided by the food sample. Ash content of the complementary food samples was the residual organic material after ashing the food samples indicate indirectly amount of mineral content of the samples. There is statistical differences ($p<0.05$) in the total ash content of the complementary food samples (3.73-5.09 g/100g) compared with control sample (2.62 g/100g). However, the values were within the recommended value ≤ 5 % of codex alimentarius value (Zlotkin et al., 2010) except sample E (5.09 g/100g). There was a significant increase in crude fibre of the complementary food samples which may helps in colon cleaning of the consumers (babies), cholesterol deposit and reduces constipation in the young growing baby. The crude ash and fibre content of all the samples increased significantly as a result of addition of pigeon pea and tigernut flours, respectively. Carbohydrate (CHO) value of the samples decreased significantly ($p<0.05$) from sample A (78.94 g/100g) to sample E (68.86 g/100g) due to proportional increases in pigeon pea and tigernut flours added to the blends. Energy value of the samples indicates an increasing trend with increase addition of pigeon pea flour in the formulation. The formulation with 25 % pigeon pea recorded the highest energy value. The value reported by this study fall within RDA recommended for young infants and children by FAO/WHO (1994). This may be as a result of addition of pigeon pea and tigernut to the formulated baby food protein content. It is general knowledge that carbohydrate content in any food is inversely proportional to protein content in any food products.

Parameter (100 %)	Sample A	Sample B	Sample C	Sample D	Sample E
Moisture content	9.24±0.00	9.63±0.16	9.18±0.21	8.72±0.02	8.84±0.11
Protein	5.81±0.00	8.67±0.02	10.40±0.12	10.83±0.11	11.40±0.00
Crude fat	1.62±0.03	3.69±0.00	4.71±0.03	4.37±0.12	5.62±0.01
Crude ash	2.62±0.11	3.73±0.20	4.81±0.10	4.09±0.11	5.09±0.11
Crude fibre	1.77±0.02	2.54±0.21	3.14±0.03	2.75±0.10	3.18±0.00
Carbohydrate	78.94±0.00	71.74±0.16	69.67±0.21	67.33±0.02	64.86±0.11
Gross energy, KJ/100g	1476±0.00	1480±0.02	1501±0.12	1482±0.11	1485±0.00

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p< 0.05$). All the samples were in ration of OFSP, pigeon pea and tigernut, respectively. Sample A: 100:00:00; Sample B: 75:15:10; Sample C: 70:20:10; Sample D: 65:25:10; Sample E: 60:30:10.

Table 1: Proximate composition of OFSP, pigeon pea and tigernut composite flour samples

Mineral content of OFSP, pigeon pea and tigernut composite flour samples

Table 2 shows mineral content result of OFSP based complementary food samples fortified with pigeon pea and tigernut composite flours. The result indicates an increase trends in all the samples compared with control sample: Ca (38.12 - 54.55), Fe (2.87 - 4.18), P (48.16 - 68.60), K (89.40 - 148.17), Na (1.83 – 3.13) and Mg (92.60 – 119.57 g/100g), respectively. The Ca content significantly ($p<0.05$) differed from across the samples. the formulation of 30 % pigeon pea has the highest value (54.56 g/100g) than the control sample (38.12 g/100g). This study result is higher than RDA of ≤ 435.51 mg/100g dry weight weaning food (Zakpaa et al., 2010). Iron content increases from 2.87 g/100g in control sample to 4.18 g/100g in sample E. Studies have shown that iron is necessary for the formation of hemoglobin that plays an important roles in oxygen-carrier in human body, oxidation of macronutrents and normal functioning of central nervous system. Iron content of all the samples falls below 10 mg/100g for infants and young children as recommended by Institute of Medicine, IOM (2005). Phosphorus content was statistically differ across the samples with sample E having highest value compared to other samples. Phosphorus plays an important role in various cell including bone formation, growth and brain development while potassium value of the composite flours increases as pigeon pea addition increase in the blends. Likewise, potassium values in the study are higher than RDA of 120 mg/100g (IOM, 2005). Sodium content of the samples increases with increase in pigeon pea inclusion. Its values ranged from1.83 mg/100g (sample A) to 3.13 mg/100g (sample E). Sodium is crucial in fluid and acid-base balance; osmosis, regulates muscle, nerve irritability and glucose absorption while potassium is an essential constituent, apart from osmosis fluid balance, in regular heart rhythm and nerve impulse conduction; cell metabolism (Akinsola et al., 2021). The potassium values of all the samples were higher than the sodium values which is an indication of good health promoter by inhibit hypertension according to Chen et al. (2010) who reported that intake of diets with higher sodium to potassium ratio has been related to the incidence of hypertension. Magnesium content ranged from 92.60 mg/100g in sample A to 119.57 mg/100g in sample E. Research works have shown that magnesium is required in normal functioning of muscle and nervous system, support healthy immune system, regulate blood sugar levels and promote normal blood pressure (Mlitan et al., 2014).

Mineral, mg/100g	Sample A	Sample B	Sample C	Sample D	Sample E
Calcium, Ca	38.12± 0.00	43.24± 0.01	50.63± 0.07	49.11± 0.01	54.55± 0.07
Iron, Fe	2.87± 0.01	3.41± 0.06	3.82± 0.01	4.03± 0.14	4.18± 0.63
Phosphorus, P	48.16± 0.01	55.39± 0.01	65.17± 0.07	61.25± 0.03	68.60± 0.06
Potassium, K	89.40± 0.01	103.11± 0.03	143.36± 0.28	137.23± 0.01	148.17± 0.07
Sodium, Na	1.83± 0.01	2.11± 0.00	2.83± 0.14	2.45± 0.03	3.13± 0.01
Magnesium, Mg	92.60± 0.01	104.12± 0.06	114.19± 0.01	110.65± 0.14	119.57± 0.63

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p< 0.05$). All the samples were in ration of OFSP, pigeon pea and tigernut, respectively. Sample A: 100:00:00; Sample B: 75:15:10; Sample C: 70:20:10; Sample D: 65:25:10; Sample E: 60:30:10.

Table 2: Mineral content of OFSP, pigeon pea and tigernut composite flour samples

Vitamin content of OFSP, pigeon pea and tigernut composite flour samples

Vitamins content of all the samples are statistically ($p<0.05$) differs and increase compared to control sample. Sample E with 30 % pigeon pea addition had the highest value in all the samples vitamins determined. The calculated vitamin A results obtained in this study was higher than the value obtained by Sengev et al. (2016) who work on crayfish inclusion in maize based complementary food and 300 µg/day reported by IOM (2005) work. Vitamin A is reported to be an essential biochemical activities for improving vision and maintaining body tissues among other functions (Jackson et al., 2018). Significant difference was observed in all the samples for vitamin B1 as pigeon pea inclusion increases. The result shows similarity to the work of Sengev et al. (2016). This study results fall within RDA of 0.2 – 0.9 mg/day for infants and young children as reported by FAO/WHO (1998). Vitamin B1 is useful in the generation of energy from carbohydrate (Fattal-Valevski, 2011). Vitamin B2 and B3 of the samples also shows increase from control sample to 30 % pigeon pea addition to the blends. Both vitamin B2 and B3 values obtained in the study fall within the recommended value of 0.13 – 4.22 mg/100g (Mariam, 2005) who work on acha based complementary food. Vitamin B3 aids normal functioning of tissues, particularly skin, gastrointestinal tract and nervous systems; used with other vitamins in converting carbohydrates to energy (Akinsola et al., 2021). Vitamin C content of the formulated samples are significant difference at alpha 0.05 compared with the control sample. Its values ranged from 1.84 mg/100g n sample A to 2.73 mg/100g in sample E, respectively. This result is in line with work of Mariam (2005) and Sengev et al. (2016), respectively. Akinsola et al. (2021) reported that vitamin C is essential for the formation of collagen; prevent oxidation of other vitamins; aids in metabolism of amino acids and calcium; stops internal bleeding; prevent infections, colds, reduces allergies; heals wounds and burns (Akinsola et al., 2021)

Vitamin, mg/100g	Sample A	Sample B	Sample C	Sample D	Sample E
A Calculated (RAE*)	1423.14± 0.64	1581.33± 0.01	1627.11± 0.01	1746.85± 0.01	1664.25± 0.01
Thiamin, B_1	0.11± 0.01	0.18± 0.01	0.23± 0.01	0.26± 0.01	0.27± 0.01
Riboflavin, B_2	0.08± 0.01	0.12± 0.01	0.14±0.00	0.14± 0.01	0.16± 0.01
Biotin, B_3	0.10± 0.06	0.13± 0.02	0.16±0.01	0.18± 0.01	0.21± 0.02
Ascorbic acid, C	1.84± 0.42	2.09± 0.01	2.30±0.00	2.52± 0.01	2.73± 0.01

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p< 0.05$). All the samples were in ration of OFSP, pigeon pea and tigernut, respectively. Sample A: 100:00:00; Sample B: 75:15:10; Sample C: 70:20:10; Sample D: 65:25:10; Sample E: 60:30:10. *: 6 µg of β-carotene equal 1 retinol activity equivalent and 1 retinol equivalent of 1 vitamin A activity FAO/WHO/UNU (1985).

Table 3: Vitamin content of OFSP, pigeon pea and tigernut composite flour samples

Anti-nutrient factors of OFSP, pigeon pea and tigernut composite flour samples

Table 4 shows results of anti-nutrient factors of OFSP, pigeon pea and tigernut composite flour blends. All the selected anti-nutrient factors determined decrease across the samples with sample E having the least value except in trypsin inhibitor value which increases from sample A (0.38 TIU) to sample E (1.54 TIU), respectively. This may be as result pigeon pea addition which increases the crude protein content of the formulated samples. Decrease in phytate value from sample A to sample E could be as a result of addition of pigeon pea and tigernut flours to the formulated complementary food samples. This result agreed with the work of Alawode et al. (2017) who work on OFSP, sorghum and soya beans complementary food. Oxalate values shows statistical differences ($p<0.05$) in the composite blends flour. Oxalate content of the samples D and E are lower than the critical value of 0.25 mg/100g reported by Woldegiorgis et al. (2015). Phytate and oxalate has been reported to form indigestible complexes with minerals in the human body and make it unavailable for digestion. However, preprocessing and adequate processing method has been shown to reduce its value. Hence, it is wiser to give food meant for eating to undergo at least minimal processing before injection. Tannin content decrease from 0.81 – 0.52 mg/100g from sample A to E, respectively. The values obtained in this study were lower than critical value of 3 mg/100mg reported by Woldegiorgis et al. (2015). Amylase inhibitors values (1.79 – 1.42 AIU) of the formulated samples shows decrease from control sample to sample E while trypsin inhibitors value (0.38 1.54 TIU) which is statistically below the critical value of 0.25 mg/100g reported by Woldegiorgis et al. (2015). This value will pose no danger to health and nutrients bioavailability by the authors. Both amylase and trypsin inhibitors have been shown to hinder availability of carbohydrate (amylose and amylopectin) and protein (amino acids) for body uses. Hence, its low content in food material or product makes such food of high nutritional value for human consumption.

Anti-nutrient factor, mg/100g	Sample A	Sample B	Sample C	Sample D	Sample E
Phytate	0.62± 0.01	0.47± 0.00	0.38± 0.02	0.31± 0.00	0.26± 0.01
Oxalate	0.47± 0.01	0.36± 0.00	0.29± 0.01	0.22± 0.00	0.14 ± 0.01
Tannins	0.81± 0.01	0.76± 0.00	0.62± 0.01	0.56± 0.00	0.52± 0.01
Amylase inhibitors (AIU)	1.79± 0.01	1.49 ± 0.00	1.28± 0.01	1.11± 0.00	0.69± 0.01
Trypsin inhibitors (TIU)	0.08± 0.00	0.13± 0.00	0.15± 0.00	0.18± 0.00	0.22± 0.00

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p< 0.05$). All the samples were in ration of OFSP, pigeon pea and tigernut, respectively. Sample A: 100:00:00; Sample B: 75:15:10; Sample C: 70:20:10; Sample D: 65:25:10; Sample E: 60:30:10.

Table 4: Anti-nutrient factors of OFSP, pigeon pea and tigernut composite flour samples

Sensory property of the OFSP-based complementary food samples

The result of sensory evaluation of OFSP based complementary food with pigeon pea and tigernut flours is as shown in Table 5. Statistical differences ($p<0.05$) were observed in the sensory mean scores of appearance, aroma, taste, texture and overall acceptability of the samples. Sample D (25 % pigeon pea) was best rated in terms of appearance and aroma while sample A (0 % pigeon pea) was least rated in terms of taste. This shows that addition of pigeon pea and tigernut flours to the blends improve its taste and aroma inclusive. Texture of sample E was least rated which may be as a result of pigeon pea addition that affect OFSP textural structure. Overall acceptability mean scores for the formulated samples indicates tasters preferences for sample D. This may be as a result its appearance, aroma and taste which rating (5.97) is second to sample C (6.01), respectively.

Parameter	Sample A	Sample B	Sample C	Sample D	Sample E
Appearance	$6.09±0.34^{d}$	$5.76±0.31^{b}$	$6.56±0.22^{a}$	$6.88±0.34^{d}$	$5.46±0.41^{b}$
Aroma	$4.76±0.17^{cd}$	$6.02±0.40^{b}$	$5.88±0.26^{b}$	$6.34±0.17^{cd}$	$5.35±0.24^{cd}$
Taste	$5.12±0.32^{b}$	$5.14±0.47^{a}$	$6.01±0.20^{a}$	$5.97±0.32^{b}$	$5.69±0.45^{b}$
Texture	$5.35±0.34^{a}$	$5.67±0.33^{a}$	$6.45±0.21^{a}$	$6.62±0.34^{a}$	$5.12±0.38^{a}$
Overall acceptability	$5.43±0.03^{a}$	$6.18±0.42^{a}$	$6.87±0.20^{a}$	$7.03±0.03^{a}$	$5.86±0.42^{a}$

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p< 0.05$). All the samples were in ration of OFSP, pigeon pea and tigernut, respectively. Sample A: 100:00:00; Sample B: 75:15:10; Sample C: 70:20:10; Sample D: 65:25:10; Sample E: 60:30:10.

Table 5: Sensory property of the OFSP-based complementary food samples

Conclusion

The study results in proximate composition, mineral profile, vitamins, antinutrients factors and sensory attributes indicates that fortification of OFSP flour with pigeon pea and tigernut flours for complementary food formulation improves its macro and micro nutrients bioavailability for infants and young children. Moreover, sensory attributes mean scores shows that all the fortified samples were generally accepted by the panelists than the control sample which is 100 % OFSP flour. However, in term of overall acceptability sample D that contained 25 % pigeon pea and 10 % tigernut flours is best accepted.

Funding and conflict of interest

The project was self-funded by the authors; there was no direct funding for the research. We declare no conflict of interest.

References

1. Akinsola, A. O, Segilola, V.O., Ayoola, R.B. and Gbadegesin, I.O. (2021). Nutritional Quality And Sensory Properties Of Instant Plantain Flake Enriched With Egg Parts. Researcher 13(1):41-50.
2. Akinsola, A., Segilola, V., Oloso, S., Durojaiye, O. (2018). Quality evaluation of plantain-African yam bean flour blends and sensory properties of its cooked (amala) paste. Research Journal Food Science and Nutrition, No. 3. – p. 31-40.
3. Alam, M.K., Rana, Z.H. & Islam, S.N. (2016). Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange-fleshed sweetpotato varieties grown in Bangladesh. Foods, 5(3), 64-65.
4. Alawode, E.K., Idowu, M.A., Adeola, A.A., Oke, E.K. & Omoniyi, S.A. (2017). Some quality attributes of complementary food produced from flour blends of orange flesh sweetpotato, sorghum, and soybean. Croatian Journal of Food Science and Technology, 9 (2), 122 – 129.
5. Anigo KM, Ameh DA, Ibrahim S, Danbauchi SK. (2009). Nutrient composition of commonly used complementary foods in North Western Nigeria. Afr J. Biotec, 8(18), 4211 – 4216.
6. AOAC (2016). Official Methods of the Association of the Agriculture Chemists. Guidelines for standard method performance requirements.
7. Browser, T.J., Ojwang, F., Sahs, R., & Brandenberger, L. (2017). Promotion of orange flesh sweet potato by demonstration of acceptance and food product development. African Journal of Food Science, 11(12), 383-388.
8. Chen, X., Xia, L, Zhou, H., Qiu, G. (2010). Chemical composition and antioxidant activities of Russula griseocarnosa sp. nov. Journal Agriculture and Food Chemistry, 58, 6966-6971.
9. Famakin, O., Fatoyinbo, A., Ijarotimi, O.S., Badejo, A.A., Fagbemi, T.N. (2016). Assessment of nutritional quality, glycaemic index, antidiabetic and sensory properties of plantain (Musa paradisiaca)-based functional dough meals. J Food Sci Technol, No. 53(11). – p. 3865–3875.
10. FAO/WHO. (2002). Human vitamins and mineral requirements. Report of a joint FAO/WHO expert consultation on zinc. FAO Food and Nutrition paper 56, FAO/WHO, Rome, Italy.
11. FAO and World Health Organization (1998). “Vitamin and mineral requirements in human nutrition Second edition,” World Heal. Organ., pp. 1–20.
12. FAO/WHO. (1994). Food standards programme Codex Alimentarious Commission. Foods for special dietary uses (including infants and children).
13. FAO/WHO/UNU. (1985). Energy and Protein Requirements. FAO/WHO Nutrition Meetings, Report Series 724. Geneva, Food and Agriculture Organization / World Health Organization.
14. Fattal-Valevski, A. (2011). "Thiamin (vitamin B1)". Journal of Evidence-Based Complementary and Alternative Medicine, 16 (1): 12–20.
15. Figueira, E.L.Z., Blanco-Labra, A., Gerage, A.C., Ono, E.Y.S., Mendiola-Olaya, E., Ueno, Y., and Hirooka, E.Y. (2003). New amylase inhibitor present in corn seeds active in vitro against amylase from Fusarium verticillioides. Plant Diseases, 87, 233-240.
16. Idowu1, M.A., Adeola, A.A., Olaniyan1, D.J., Oke, E.K & Omoniyi, S.A. (2017). Quality evaluation of cocoyam-cowpea flour blends and sensory attributes of their cooked paste (Amala), Annals. Food Science and Technology, 18(2), 183-191.
17. Institute of Medicine, IOM (2005). Dietary reference intake: Water, potassium, sodium, chloride and sulfate. National Academy press, Washington, DC.
18. Jackson R.M., Daniel N. S., Glaston M. K., Ariel K.B. (2018). Nutritional and Functional Properties of Mushroom (Agaricus bisporus & Pleurotusostreatus) and Their Blends with Maize Flour. American Journal of Food Science and Technology, 2018, 6 (1), 33-41.
19. Laurie, S., Faber, M., Adebola, P. & Belete A. (2015). Biofortification of sweetpotato for food and nutrition security in South Africa. Food Research International, 76, 962-970.
20. Mariam, S. (2005). Nutritive Value of Three PotentialComplementary Foods Based on Cereals and Legumes. African Journal of Food and Nutrition Series 5(2): 1-14
21. Mlitan, A. M., M. S. Sasi, and A. M. Alkherraz. (2014). Proximate and minor mineral content in some selected basil leaves of Ocimumgratissimum L, in Libya. International Journal of ChemicalEngineering andApplications 5:8–17.
22. Nwosu, J.N., Ojukwu, M., Ogueke C.C., Ahaotu I., Owuamanam C. (2013). The Antinutritional properties and ease of dehulling on the proximate composition of pigeon pea (Cajanus cajan) as affected by malting. International Journal of Life Sciences, No. 2(2). – p. 60-67.
23. Oladele, A. K., & Aina, J. O. (2007). Chemical composition and functional properties of flour produced from two varieties of tiger nut (Cyperus esculentus). African Journal of Biotechnology, 6, 2473–2476.
24. Olorode, O.O., Oke, E.K., Agbebi, P.A., Alabi, A.A. & Akinwande, F.F (2022). Functional, pasting and sensory properties of complementary food from orange fleshed sweetpotato- roasted african yam bean-tigernut composite flour using response surface methodology, Food and Environment Safety, 4, 273 -291
25. Oke, E.K., Idowu, M.A., Adeola, A.A., Abiola, T.O. & Adeniji, I.O. (2019). Evaluation and storage studies of sausage roll produced from wheat-tigernut flour blends. Croatian Journal of Food Technology, Biotechnology and Nutrition, 14 (3-4), 82-90.
26. Oke, E.K., Idowu, M.A., Sobukola, O.P. & Bakare, H.A. (2017). Quality attributes and storage stability of bread from wheat–tigernut composite flour. Journal of Culinary Science and Technology, 1-14.
27. Oke, E.K, Idowu, M.A & Omoniyi, S.A. (2016). Proximate, functional, pasting and rheological properties of wheat- tigernut composite flour. Annals Food Science and Technology, 17(2), 411-420.
28. Okolie, P.I., Coker, M.T., Okolie, E.C., Oke, E.K., Agboola, K.A. & Abayomi, S.O. (2022). Physiochemical and quality evaluation of kokoro (A maize-based snack) made from blends of yellow maize, fermented African yam bean and rice flour. Applied Food Research, 2, 100104.
29. Sengev, I. A., Nwobi I and Sule, S. (2016). Effect of Crayfish Inclusion on the Chemical and Sensory Properties of Ogi

Prepared from Maize, Millet and Sorghum. International Journal of Nutrition and Food Sciences. 2016; 5(6): 378-383.

30. Singh, S., Ria, C.S., & Saxena, D. C. (2008). Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. African Journal of Food science, 2, 65-73.
31. Woldegiorgis, A. Z., Abate, D., Haki, G. D. and Ziegler, G. R. (2015). Major, Minor and Toxic Minerals and Anti-nutrients Composition in Edible Mushrooms Collected from Ethiopia. Food Processing Technology. 6:134–142.
32. Zakpaa HD, Mak-Mensah EE, Adubofour J. (2010). Production and characterization of four produced from ripe "apem" plantain (Musa sapientum L. var. paradisiacal; French horn) grown in Ghana. J. Agric Biotec and Sust Dev, 2(6), 92 – 99.
33. Zlotkin S, Siekmann J, Lartey A, Yang Z. (2010). The role of the Codex Alimentarius process in support of new products to enhance the nutritional health of infants and young children. MIYCN SUPPLEMENT: Programs and policies to improve maternal, infant and young children. Fd Nutr Bull, 31(2), S97 – S206.

DOI:10.31579/2637-8914/290