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Production and quality evaluation of bread from blend of biofortified cassava, wheat and dry date flours

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Abstract

In this study, quality evaluation was carried out on bread made from a blend of wheat, biofortified cassava, and dry date flours. Bread samples, designated A through E were produced using various flour blend ratios. Cassava flour samples were subjected to functional and anti-nutritional analysis while proximate, β-carotene, mineral, and sensory contents were evaluated on the bread samples. The result of analysis showed that in the water absorption capacity (WAC), oil absorption capacity (OAC), bulk density, foaming capacity, and foaming stability, sample BCF (biofortified cassava flour) had values of 1.98%, 2.55%, 0.72%, 1.98%, and 92.77%, respectively, while sample OCF (Ordinary cassava flour) had values of 2.0%, 1.55%, 0.76%, 7.31%, and 88.38%, respectively. The hydrogen cyanide (1.71 mg/100 g), tannins (0.16 mg/100 g), and oxalates (0.08 mg/100 g) found in BCF were significantly ($p<0.05$) higher than those of OCF, which were 2.04 mg/100 g, 0.12 mg/100 g, and 0.16 mg/100 g, respectively. The moisture contents ranged from 4.50-6.35%, crude protein from 10.0-11.29%, fat from 8.43-10.44%, ash from 1.77-3.65%, crude fiber from 2.0-3.48%, and carbohydrate from 67.73-70.16%. The moisture, crude protein, and carbohydrate contents decreased significantly ($p<0.05$) as the level of biofortified cassava flour substitution increased. There was a significant ($p<0.05$) increase in the level of β-carotene with increase in biofortified cassava flour substitution. The values of minerals were calcium (27.81–31.40 mg/g), potassium (43.64-52.63 mg/g), sodium (20.41–28.74 mg/g), iron (0.83–1.11 mg/g), zinc (0.60-0.91 mg/g), and copper (0.25-0.32 mg/g). Samples showed good sensory properties, although sample A was preferred.

Keywords: Biofortified cassava; Bread; Date; β-carotene; Wheat; Flour

1. Introduction

Bread is a wheat-based fast and convenient food. It is often produced by baking dough, which primarily consists of wheat flour, water, yeast, and salt [1]. In Nigeria and around the world, it is a highly significant staple food. It was once regarded as the most significant human good, ranking third only to food and water. One of the most popular foods consumed worldwide is bread, and the technique used to make it is arguably among the first technologies ever discovered [2]. In periods of severe food scarcity, it is thought to be the most affordable and essential supplemental food.

The rate of bread consumption in Nigeria and the world has increased over the years. This has placed a huge pressure on wheat flour importation and consequently the price of wheat flour has skyrocketed. The attendant effect has been the astronomical increase in prices of bread, especially in Nigeria. To this end, the Nigerian government and the Food and Agriculture Organization (FAO) have promoted the use of composite flours and blends of wheat-less flours or meals for the production of aerated items like bread and biscuits in an effort to reduce or completely eliminate imports of wheat. Efforts have been made to utilize flours from cereal grains such as corn, tubers such as yam, and root crops such as cassava.

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Cassava (*Manihot esculenta Crantz*) is a perennial woody shrub with an edible root and was first cultivated in South America and introduced to Nigeria in the sixteenth century [3]. The cassava root is composed of carbohydrate and is therefore mainly a source of energy. According to Montagnagnac *et al.*[4], the starch content ranges from 32 to 35% of the mass of fresh roots to 80 to 90% of the bulk of dry roots. Except for vitamin C, which is present in relatively large amounts in each edible section (between 15 and 45 mg/100g), the vitamin content, including vitamin A, of the roots is low [5]. However, yellow-fleshed cassava variety which is a product of biofortification is rich in β-carotene, a precursor of vitamin A.

The production of bread from blend of biofortified (yellow-fleshed) cassava, wheat, and date flours was an idea borne out of the desire to increase the diversification in the use of yellow-fleshed cassava. Nigeria has invested huge resources in the research of biofortified cassava and has comparative advantage in its production. The idea was also spurred by the desire to curb vitamin A deficiency (VAD) in Nigeria among children and mothers using bread which is a staple as a vehicle.

Nigeria has an alarming rate of micronutrient deficiencies which have persisted for several decades. Vitamin A deficiency is one of the most prevalent of them. Vitamin A deficiency is a public health problem in Nigeria and requires concerted efforts to mitigate. According to the data from the nationwide food consumption and nutrition survey conducted by Maziya-Dixon *et al.*[6], 29·5 % of children under 5 years old were classified as vitamin A deficient, with serum retinol concentrations below 0·7 μmol/l , which is attributed to inadequate dietary intake. Due to the high rate of the vitamin A deficiencies among children, concerted efforts were made by the ministry of health to checkmate it as it was viewed as a public health problem. To this end, several strategies such as vitamin A supplementation and food fortification to reduce VAD prevalence were implemented. Food-based approaches have been reviewed and judged to have a promising role in integrated strategies [7]. Pro-vitamin A biofortified (yellow-fleshed) cassava has the potential of contributing significantly to improving the vitamin A status especially among pregnant women and children in rural communities. The objectives of this study were to evaluate the beta carotene in bio-fortified cassava flour, and the nutritional quality of bread from blend of wheat, biofortified cassava, and dry date flours. The study also sought to investigate the effect of bio-fortified cassava flour substitution on consumer acceptability.

2. Material and methods

2.1. Collection of sample and preparation

The wholesome freshly harvested yellow-fleshed cassava (*Manihot esculanta Crantz*) roots of the variety TMS 07/0593 (UMUCASS 36) were procured from the National Root Crop Research Institute, Umudike, Nigeria. Wheat flour and other baking ingredients were obtained from commercial stores at Afikpo, (latitude 5° 53′ 33.3″ N and longitude 7° 56′ 7.2″ E) Nigeria. The dry dates were procured from a commercial store in Lokoja, Kogi State of Nigeria.

2.1.1. Biofortified cassava flour Preparation

The yellow-fleshed cassava roots of variety TMS 07/0593 were sorted to select only the wholesome ones. They were peeled, reduced to small sizes by cutting, and then washed with potable water. This was followed by steeping in distilled water (1:10, w/v) at ambient temperature for 3 days. The cassava were then pulped, dewatered and then dried in a hot air oven (SM9053, Uniscope, England) at 50 °C for 6 h before milling using an attrition mill. It was packaged in a polythene bag and stored in a cool dry place. The processing is as shown in figure 1.

2.1.2. Date flour Preparation

The date fruits were sorted, deseeded and then washed with potable water. The fruits were then soaked in water containing sodium bisulfite ($NaHSO_3$) for 24 hours. This was to maintain the color and prevent the onset of browning reaction during warming process. The fruits were then boiled in water at a temperature of 80-90 °C for 10 minutes; thereafter the water was drained. The date fruits were then dried in a hot oven (SM9053, Uniscope, England) for 6 hours at 50°C to a constant weight. The dried fruits were ground using attrition mill into flour. The flour was sieved through a 65 mm sieve mesh to obtain the fine date flour.

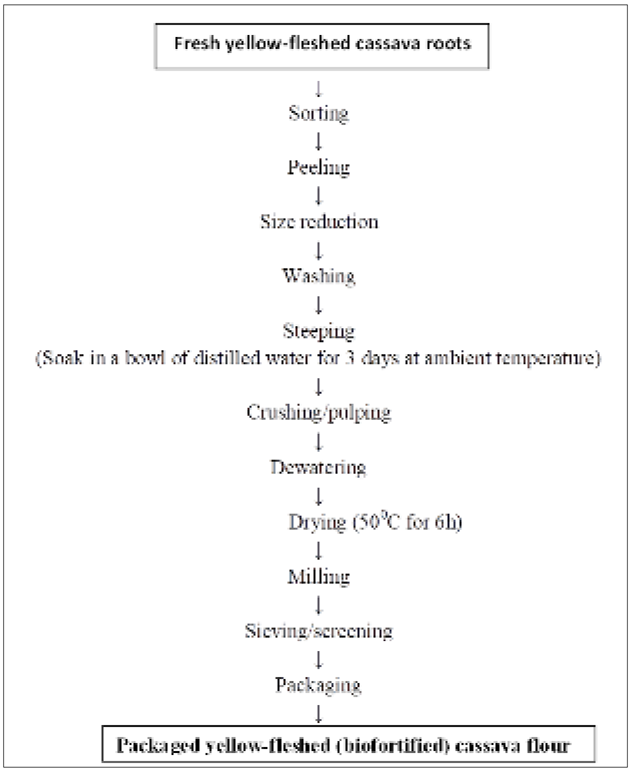

Figure 1 Flow chart for processing of yellow-fleshed cassava flour

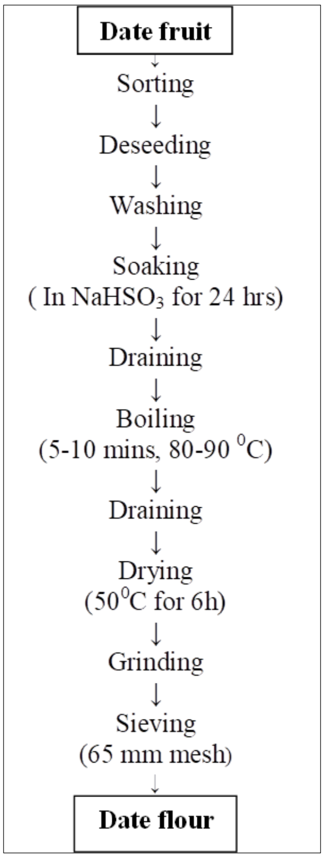

Figure 2 Flow chart for date fruit flour processing

2.2. Formulation of composite flour from wheat, biofortified cassava, and dry date flours for bread production

Flour mixtures were formulated from wheat, bio-fortified cassava, and dry date flours as shown in Table 3.0. Each mixture was sieved using a sieve with mesh size 212 µm to obtain a homogeneous mixture. The formulated flour mixtures were used in the production of bread. As shown in Table 1, five (5) distinct samples, coded A through E, were produced by employing the straight dough method. The ingredients which included composite flour (wheat, bio-fortified cassava, and dry date), sugar, salt, yeast, water, margarine, and bread improver were weighed accordingly. Composite flour (1 Kg) blend was mixed with 140 g of sugar, 20 g of salt, 15 g of yeast, 40 g of margarine, and 480 ml of potable water in a mixer for 20 minutes and then kneaded to obtain an elastic dough. The dough was cut, weighed, molded and placed in baking pans that had been greased with melted margarine. The dough was covered and allowed to proof for 45 minutes under a warm environment. The proofed dough was baked in the oven at the temperature of 160 ^{0}C for 35 minutes.

Table 1 Formulation of composite flour from wheat, bio-fortified cassava, and dry date flours for bread production

Sample	**Wheat flour (g)**	**Biofortified cassava flour (g)**	**Dry date flour (g)**
A(Control)	100	0	0
B	90	5	5
C	85	10	5
D	80	15	5
E	75	20	5

3. Analysis

3.1. Proximate analysis

The Total moisture content, total ash, fat, crude protein, total dietary fiber and total carbohydrates were determined as described by AOAC [8]. Carbohydrate was determined by a difference as illustrated in equation below:

$$\text{Carbohydrate (\%)} = 100 - (\text{moisture} + \text{ash} + \text{fat} + \text{fiber} + \text{protein})$$

3.2. Functional analysis

3.2.1. Bulk density

The bulk density of the bio-fortified cassava flour was determined according to the method of Danbaba *et a*l. [9] with modifications. The sample (100.00±0.05 g) was weighed and gently filled in 250 mL graduated cylinder. The bottom of the cylinder was gently tapped ten times until there was no further diminution of the sample level. Bulk density was expressed as the weight of sample per unit volume of sample (g/mL). Measurements were made in triplicate.

3.2.2. Water and Oil Absorption Capacities (WAC and OAC)

The WAC and OAC were calculated using the approach given by [10]. One gram of flour was combined with distilled water (10 mL; refined soy bean oil for OAC) and incubated at 30°C for 30 min. After that, the centrifugation was done at 3000 rpm for 30 min. The sediment's weight was calculated. The WAC and OAC were determined as a percentage of the wet weight of the flour according to:

$$\%\text{WAC} = \frac{\text{Weight of the water added to the sample} - \text{Weight of the water removed from the sample}}{\text{Weight of the flour sample} \times 100},$$

While,

$$\%\text{OAC} = \frac{\text{Weight of the oil added to the sample} - \text{Weight of the oil removed from the sample}}{\text{Weight of the flour sample} \times 100},$$

3.2.3. Foam capacity

The foam was determined by the method of Coffman and Garcia [11]. A known weight of the bio-fortified cassava flour sample was dispersed in 100 ml distilled water. The resulting solution was homogenized for 5 min at high speed. The volume of foam separated was noted. The foaming capacity was calculated as follows:

$$\text{Foam capacity (\%)} = (B-A)/A \times 100$$

Where A = volume before homogenization (ml), B = volume after homogenization (ml)

3.3. Anti-nutritional analysis of cassava flours

The hydrogen cyanide contents were determined using the alkaline picrate method as described by [12], while the tannin content was determined using the method published by [13] with minor modifications. Oxalate determination was carried out following the method described by [12].

3.4. β –carotene Determination

The β -carotene contents of the samples were determined using the method described by Chaturvedi and Nagar [14].

3.5. Sensory evaluation of the samples

The coded samples were presented to ten (10) trained panelists for sensory evaluation. The panelists scored the taste, color, appearance, texture, aroma, and overall acceptability of the samples using a 7-point Hedonic scale where seven indicates like very much while one indicates dislike very much [15]

3.6. Mineral analysis

Mineral elements of the samples (calcium, potassium, sodium, iron, zinc, and copper) were analyzed with the aid of an atomic absorption spectrophotometer, Buck Scientific (210VG), after digestion.

3.7. Statistical analysis

Completely Randomized Design (CRD) was the method used in the investigation. Analysis of variance (ANOVA) was performed on the collected data at $p<0.05$. Statistical Product for Service Solution (SPSS) version 20 was utilized to compare the treatment means using Duncan's New Multiple Range Test (DNMRT).

4. Results and discussions

4.1. Functional properties of biofortified cassava (TMS 07/0593) and TMS 419 flours

The result of the functional analysis carried out on the biofortified cassava flour (BCF) and ordinary cassava flour (OCF) is shown in Table 2 below: The ability of a material to absorb water when submerged in it is known as water absorption, and it is symbolized by its water-absorbing capacity (WAC). Water absorption capacity is a crucial functional feature in food formulations particularly for dough and finished products [16]. The water absorption capacity of samples BCF (1.98 %) was found to be lower than that of OCF (2.00 %). However, there was no significant difference ($p>0.05$) between BCF and OCF. The ability of flours to absorb water is another helpful sign of whether protein could be added to aqueous food formulations, particularly when handling dough. Sample BCF's lower water absorption capacity than sample OCF suggests that the protein in the sample has a lower charge density and is more hydrophobic overall, which encourages interaction. Therefore, sample BCF may be more beneficial as a functional ingredient to promote viscosity in viscous foods, such as baked goods.

The term "oil absorption capacity" describes a material's capacity to absorb oil from a mixture. It is the flavour retaining capacity of flour which is an important element in food formulations. Oil absorption capacity of samples BCF and OCF were 2.55 % and 1.55 % respectively and showed significant difference ($p<0.05$) between the samples. The high oil absorption capacity of sample BCF can enhance food's flavor, moisture content, and fat content.

The result showed that the bulk density of samples BCF and OCF were 0.72 g/ml and 0.76 g/ml respectively. Bulk density (BD) is a key factor in determining which flours are suitable for the ease of packaging and transportation of foods and it is a measure of how heavy flour is [17]. Though there was no significant difference in the samples bulk densities, the higher bulk density in sample OCF suggests that it contained more fiber. A lower amount of food samples might be packaged in a constant volume due to the sample BCF's decreased bulk density level, guaranteeing more affordable packaging.

The foaming capacity of BCF was 1.98 % while that of OCF was 7.31 %. There was a significant difference ($p<0.05$) between the samples. The amount of inter-facial area that a protein can make is referred to as its foam capacity. A combination of many gas bubbles trapped in a liquid or solid is called foam. The result also showed that sample BCF recorded higher foam stability of 92.77 % than sample OCF that had 88.38 %. It was noted that there was an inverse relationship between the samples in terms of foaming capacity and foaming stability.

Table 2 Functional properties of biofortified cassava (TMS 07/0593) and TMS 419 flours

Sample	Water absorption capacity (%)	Oil absorption capacity (%)	Bulk density (g/ml)	Foaming capacity (%)
BCF	1.98a ± 0.01	2.55a ± 0.01	0.72a ± 0.01	1.98a ± 0.01
OCF	2.00a ± 0.01	1.55b ± 0.03	0.76a ± 0.02	7.31b ± 0.85

Values are mean ± standard deviation of duplicate determinations. Values with the same superscripts in the same column are not significantly different at 5% significant level using analysis of variance (ANOVA) and Duncan test. BCF: Biofortified cassava flour; OCF: Ordinary cassava flour

4.2. Anti-nutritional factors in BCF (TMS 07/0593) and OCF (TMS 419) cassava flours

Table 3 shows the anti-nutrient contents of sample BCF (TMS 07/0593) and sample OCF (TME 419). Significant difference ($p<0.05$) was observed between the samples in terms of cyanide contents. While BCF had a cyanide content of 1.71 mg/100 g, the OCF had a cyanide content of 2.04 mg/100 g. This result showed that cyanide was higher in the bitter variety than the yellow-fleshed variety. The values, however, are lower than that of the 10 mg HCN equivalent/kg dry weight of food that is the recommended by Food and Agriculture Organisation of the United Nations and World Health Organization [18]. Ekop [19] states that cyanide ingestion can result in either acute or chronic cyanide poisoning or neuropathy.

Table 3 Anti-nutritional factors of BCF (TMS 07/0593) and OCF (TMS 419) cassava flours

Sample	Hydrogen cyanide (mg/100g)	Tannins (mg/100 g)	Oxalate (mg/100 g)
BCF	1.71^{a}±0.01	0.16^{a}±0.02	0.08^{a}±0.02
OCF	2.04^{b}±0.00	0.12^{b}±0.01	0.16^{b}±0.01

Values are mean ± standard deviation of duplicate determinations. Values with the same superscripts in the same column are not significantly different at 5% significant level using analysis of variance (ANOVA) and Duncan test. BCF: Bio-fortified cassava flour; OCF: Ordinary cassava flour

Sample BCF showed a higher tannin level of 0.16 mg/100 g when compared to sample OCF which showed tannin content of 0.12 mg/100 g. The result showed that there was a significant difference ($p<0.05$) between the two cassava varieties. The presence of tannins can bind and precipitate proteins, reducing their indigestibility, and interfere with the absorption of iron and other minerals. The oxalate contents of sample BCF and OCF were 0.08 mg/100 g and 0.16mg/100 g respectively. The result showed that there was significant difference ($p<0.05$) between the samples in terms of oxalate contents. Oxalates have the ability to bind to various minerals such as calcium, magnesium, or iron, decreasing their bioavailability.

4.3. Proximate composition of samples

The result of the proximate analysis conducted on the bread from blend of wheat, biofortified, and dry date flours are shown in Table 4. The results showed that the moisture contents ranged from 4.50-6.35 %. While the bread from 100% wheat flour (A) had the highest moisture content of 6.35 %, sample E with 15% bio-fortified cassava flour had the least moisture content of 4.50 %. There was a progressive decrease in the moisture contents as the level of yellow fleshed cassava flour increased. There was also significant difference ($p<0.05$) among the samples. This result agrees with the work of Okoye and Ezeugwu [20] who reported a progressive decrease in moisture content as the quantity of yellow fleshed cassava flour was increased in bread made from wheat, Bambara nut and biofortified cassava flours.

The samples' crude protein levels varied from 10.00 to 11.29 %. Sample E had the lowest moisture content (10.00 %), while sample A had the highest crude protein level (11.29 %). The amount of crude protein decreased significantly ($p<0.05$) as the amount of biofortified cassava flour increased. This was anticipated since wheat is a grain and has higher protein content than cassava, a root crop, even though wheat's main source of protein is gluten, which is required for baking. Therefore, the protein concentrations reduced as the cassava flour was added to the wheat flour to dilute it.

The fat contents of the samples ranged from 8.43-10.44 %. While sample A (control) had the lowest fat content of 8.43 %, sample B had the highest fat content of 10.44 %. The increased fat content in samples B-E could be attributed to the fat contents in date fruit. The result showed that significance difference ($p<0.05$) existed among samples A, B, and C while samples D and E showed no significant difference ($p<0.005$). The ash contents of the samples ranged from 1.77-3.65 %. Sample A had the lowest ash content of 1.77 % while sample E had the highest ash content of 3.65 %. There was a progressive increase in the amount of ash contents in the samples as the level of yellow-fleshed cassava flour increased. The yellow-fleshed cassava flour could have contributed to the ash contents in the samples. The samples' high ash concentration can be a sign of an increase in the mineral contents. There was significant difference ($p<0.05$) among the samples.

The values of the crude fiber ranged from 2.00-3.48 % among the samples. While sample A had the lowest crude fiber content of 2.00 %, sample E had the highest value of 3.48 %. As the level of biofortified cassava flour increased in the samples, the value of the crude fiber also increased. There was a significant difference ($p<0.05$) between the value of sample A and the values of other samples. The increase recorded could be attributed to the biofortified cassava flour. This corroborates the report of [21], that yellow-fleshed cassava flour is high in crude fiber.

The carbohydrate contents of the samples according to the results showed that figures ranged from 67.73-70.16 %. Sample A had the highest carbohydrate content of 70.16 % while sample E had the lowest carbohydrate content of 67.73 %. There was a progressive decrease in the carbohydrate contents of the samples as the level of yellow-fleshed cassava flour increased. There was a significant difference ($P<0.05$) among all the samples. The energy value (421.92Kcal) for sample A was significantly ($p<0.05$) higher than that of other samples.

Table 4 Proximate composition and β-carotene contents of bread from blend of wheat, biofortified cassava, and dry date flour blends

Sample	Moisture content (%)	Crude protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)	Energy Value (Kcal)	B-Carotene (mg/100g)
A	$6.35^{a} \pm 0.02$	$11.29^{a} \pm 0.02$	$8.43^{e} \pm 0.00$	$1.77^{e} \pm 0.01$	$2.00^{d} \pm 0.00$	$70.16^{a} \pm 0.01$	$421.92^{a} \pm 0.01$	$0.17^{e} \pm 0.02$
B	$5.70^{b} \pm 0.02$	$10.61^{b} \pm 0.00$	$11.37^{a} \pm 0.01$	$2.01^{d} \pm 0.00$	$2.05^{d} \pm 0.01$	$68.26^{c} \pm 0.01$	$421.11^{b} \pm 0.01$	$0.34^{d} \pm 0.01$
C	$5.49^{c} \pm 0.02$	$10.57^{c} \pm 0.02$	$10.94^{b} \pm 0.21$	$2.24^{c} \pm 0.01$	$2.23^{c} \pm 0.01$	$68.53^{b} \pm 0.01$	$414.90^{c} \pm 0.01$	$0.45^{c} \pm 0.02$
D	$5.07^{d} \pm 0.02$	$10.51^{d} \pm 0.02$	$10.89^{c} \pm 0.00$	$2.39^{b} \pm 0.00$	$2.86^{b} \pm 0.01$	$68.28^{c} \pm 0.00$	$414.50^{d} \pm 0.01$	$0.57^{b} \pm 0.03$
E	$4.50^{e} \pm 0.00$	$10.20^{e} \pm 0.01$	$10.44^{d} \pm 0.01$	$3.65^{a} \pm 0.01$	$3.48^{a} \pm 0.00$	$67.73^{c} \pm 0.00$	$398.58^{e} \pm 0.01$	$0.64^{a} \pm 0.01$

Values are means ± standard deviation of duplicate determinations. Means on the same column with the same superscripts are not significantly different (P<0.05). Sample A = Bread made with 100% wheat flour; Sample B = Bread made with 90% Wheat flour + 5% yellow fleshed cassava + 5% date flour; ;Sample C = 85% Wheat flour + 10% yellow fleshed cassava + 5% date flour Sample D = 80% Wheat flour + 15% yellow fleshed cassava + 5% date flour Sample E = 75% Wheat flour + 20% yellow fleshed cassava + 5% date flour

The β-carotene contents of the samples according to the results, ranged from 0.17-0.64 mg/100g. It was observed that there was significant ($p<0.05$) increases in the amount of beta carotene as the level of biofortified flour increased. While the control (sample A) had the lowest value of 0.17 mg/100g, sample E had the highest value of 0.64 mg/100g. There were significant differences among all the samples. The significant presence of beta carotene in samples with varying degrees of biofortified cassava flour inclusion is an indication that bio-fortified cassava is rich in beta carotene. Beta carotene is a precursor to vitamin A which is an essential micro nutrient required for vision and immune system. The result showed that bread made with bio-fortified cassava flour could be used as a vehicle for the prevention of vitamin A deficiency.

4.4. Sensory scores of the bread samples

The result of the sensory analysis conducted on the bread samples are shown in Table 5.

4.4.1. Taste

The taste scores of the samples ranged from 4.60-6.30. While sample A had the highest score of 6.30, sample E had the lowest score of 4.60. Sample B was equally highly scored at 6.10 and showed no significant difference with sample A. The result showed a progressive decrease in scores as the level of bio-fortified cassava flour increased. This is an indication that at a higher level substitution of wheat flour with bio-fortified cassava flour inclusion, the taste tended to be objectionable. However, at 5% cassava flour inclusion, tasteful bread comparable with the control would be generally acceptable.

4.4.2. Colour

The colour scores for the samples decreased with increasing level of bio-fortified cassava flour substitution. While sample A scored highest with a figure of 6.30, sample E with a score of 4.10 had the lowest value. Samples B and C mean scores were found to be not significantly different (p<0.05) from sample A with sample B particularly showing greater closeness to sample A. However, there was significant difference between sample A and samples D and E. The result showed that while colour of the bio-fortified cassava flour affected the colour of the finished product, sample B compared favourably with the control.

4.4.3. Appearance

According to Table 5, mean scores for appearance of the samples ranged from 3.70-6.30. While sample A had highest score of 6.30, sample E had lowest score of 3.70. As the level of bio-fortified cassava flour substitution increased, the mean scores decreased. There was significant difference (p<0.05) between sample A and samples C, D, and E. However, there was no significant difference (0.05) between sample A and sample B.

Table 5 Sensory characteristics of bread from wheat, biofortified cassava, and dry date flours

Sample	Taste	Colour	Appearance	Texture	Aroma	Overall Acceptability
A	$6.30^{a} \pm 0.67$	$6.30^{a} \pm 0.48$	$6.30^{a} \pm 0.67$	$6.40^{a} \pm 0.51$	$6.20^{a} \pm 0.63$	$6.50^{a} \pm 0.52$
B	$6.10^{ab} \pm 0.56$	$6.10^{a} \pm 0.73$	$5.90^{ab} \pm 0.99$	$6.90^{a} \pm 0.73$	$6.00^{ab} \pm 0.81$	$6.00^{ab} \pm 0.66$
C	$5.50^{bc} \pm 6.84$	$5.70^{a} \pm 0.67$	$5.40^{bc} \pm 0.84$	$5.20^{b} \pm 0.91$	$5.40^{bc} \pm 0.89$	$5.50^{b} \pm 0.52$
D	$5.20^{cd} \pm 1.03$	$4.70^{b} \pm 0.94$	$4.70^{c} \pm 0.67$	$5.50^{c} \pm 0.70$	$4.80^{c} \pm 1.03$	$5.70^{c} \pm 0.67$
E	$4.60^{d} \pm 0.83$	$4.10^{b} \pm 0.73$	$3.70^{d} \pm 0.67$	$3.40^{d} \pm 0.51$	$3.50^{d} \pm 0.70$	$4.30^{d} \pm 1.11$

Values are means ± standard deviation of duplicate determinations. Means on the same column with the same superscripts are not significantly different (P<0.05). Sample A = Bread made with 100% wheat flour; Sample B = Bread made with 90% Wheat flour + 5% yellow fleshed cassava + 5% date flour; ;Sample C = 85% Wheat flour + 10% yellow fleshed cassava + 5% date flour Sample D = 80% Wheat flour + 15% yellow fleshed cassava + 5% date flour Sample E = 75% Wheat flour + 20% yellow fleshed cassava + 5% date flour

4.4.4. Texture

The sensory scores in terms of texture showed a range of 3.40-6.90 in values. It was observed that sample B had the highest mean score of 6.90 while sample E had the lowest mean score of 3.40. While the mean score at 5% bio-fortified cassava flour inclusion, further increases showed a progressive decrease in the mean scores. There was no significant difference between sample A and sample B but there were significant differences (p<0.05) between sample A and samples C, D, and E.

4.4.5. Aroma

In terms of aroma, the mean scores of the samples ranged from 3.50-6.20. While the control (sample A) had the highest mean score of 6.20, sample E had the least mean score of 3.50. Sample B was found to be favourably comparable to sample A. There were significant differences (p<0.05) between sample A and samples C, D, and E.

4.4.6. Overall Acceptability

From the result obtained as shown in Table 5, the acceptability of the bread samples decreased as the level of bio-fortified cassava flours substitution increased. Sample A had the highest acceptability score of 6.50 while sample E had the lowest acceptability score of 4.30. While the acceptability score of sample B was comparable with sample A, there were significant differences between sample A and samples, C, D, and E.

4.5. Mineral Composition of the samples

The minerals of the bread are presented in Table 6. The calcium ranged from 27.81-31.40 mg/g. There was significant difference ($p<0.05$) among the samples. The potassium ranged from 43.64-52.63 mg/g, sodium from 20.41-28.74 mg/g, iron from 0.85-0.91 mg/g, zinc from 0.60-0.91 mg/g, and copper from 0.25-0.32 mg/g. The result showed that there were significant differences between the control sample (A) and other samples in all the minerals evaluated. There were significant reductions in the amount of iron and zinc as the level of biofortified cassava flour substitution increased. Low content of these minerals in biofortified cassava flour might be responsible for this observation. However, there were significant increase in the amount of calcium, potassium, sodium, and copper as the level of biofortified cassava flour increased. The rich mineral composition of date may have been responsible for this change. Minerals are vital nutrients that the body requires in order for some organs to function properly.

Table 6 Mineral composition of bread from blend of wheat, biofortified cassava and dry date flours

Samples	Ca (mg/g)	K (mg/g)	Na (mg/g)	Fe (mg/g	Zn (mg/g)	Cu (mg/g)
A	$27.81^{e} \pm 0.00$	$43.64^{e} \pm 0.01$	$20.41^{e} \pm 0.00$	$1.11^{a} \pm 0.01$	$0.91^{a} \pm 0.00$	$0.25^{c} \pm 0.10$
B	$28.74^{d} \pm 0.00$	$45.28^{d} \pm 0.01$	$21.62^{d} \pm 0.01$	$1.06^{b} \pm 0.00$	$0.82^{b} \pm 0.02$	$0.28^{bc} \pm 0.01$
C	$29.41^{c} \pm 0.00$	$45.82^{c} \pm 0.02$	$23.43^{c} \pm 0.00$	$0.90^{c} \pm 0.00$	$0.71^{c} \pm 0.01$	$0.29^{ab} \pm 0.01$
D	$30.44^{b} \pm 0.00$	$49.60^{b} \pm 0.00$	$25.40^{b} \pm 0.00$	$0.85^{d} \pm 0.00$	$0.65^{d} \pm 0.01$	$0.31^{ab} \pm 0.01$
E	$31.40^{a} \pm 0.00$	$52.63^{a} \pm 0.02$	$28.74^{a} \pm 0.00$	$0.83^{d} \pm 0.02$	$0.60^{c} \pm 0.00$	$0.32^{a} \pm 0.01$

Values are means ± standard deviation of duplicate determinations. Means on the same column with the same superscripts are not significantly different ($P<0.05$). Sample A = Bread made with 100% wheat flour; Sample B = Bread made with 90% Wheat flour + 5% yellow fleshed cassava + 5% date flour; ;Sample C = 85% Wheat flour + 10% yellow fleshed cassava + 5% date flour Sample D = 80% Wheat flour + 15% yellow fleshed cassava + 5% date flour Sample E = 75% Wheat flour + 20% yellow fleshed cassava + 5% date flour; Ca=calcium; K=potassium; Na=sodium; Fe=iron; Zn=zinc; Cu=copper

5. Conclusion

Vitamin A deficiency (VAD) is prevalent in Nigeria especially among children and breast feeding mothers. Biofortified cassava which is rich in beta carotene could be processed into flour and blended with wheat and date flours as composite flour in bread production. Bread can be a veritable vehicle for the prevention and control of vitamin A deficiency and the result from this work showed that bread of acceptable nutritional and sensory qualities comparable with the control can be produced with 5% substitution with bio-fortified cassava flour. It is recommended that further research should be conducted to ascertain the bioavailability of the vitamin A in bread produced with 5% bio-fortified cassava flour fortification.

Compliance with ethical standards

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The authors declared no conflicts of interest.

Authors' contributions

Kenneth Chigozie Asadu: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Writing— original draft; Writing—review & editing. Chidubem Teresa Chukwu: Data curation; Methodology.

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