



Nutritional Attributes of Baked Products from Composite Flour of Wheat and Pigeon Pea

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Authors' contributions

This work was carried out in collaboration among all authors. Authors KA and FOM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KA POA, IAA and OMT managed the analyses of the study. Author KA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The goal of this study was to develop bread and biscuit from mixture of wheat and pigeon pea flours and examine the nutritional quality of the two products. The composite flour blend was formulated using wheat and pigeon pea flours in ratio 90:10, 80:20 and 70:30 (wheat: pigeon pea). The samples produced were designated as PWB₁, PWB₂ and PWB₃ for bread while for biscuit the designations were PWB₁, PWB₂ and PWB₃ respectively. For the control samples 100% of wheat flour was used and the samples were designated as PWB₀ for bread and PWB₀ for biscuit. Samples were analyzed for proximate, minerals and vitamins content using standard analytical procedures of AOAC. Mean data were compared using ANOVA at P< 0.05. The Crude protein (CP), Fat and Ash content of PWB₀ (%) were; 10.19, 2.26 and 1.91, respectively. PWB₁, PWB₂ and PWB₃ ranged from 11.69-14.21 CP, 2.82-3.69 fat and 2.09-2.62 ash. PWB₁, PWB₂ and PWB₃ ranged from 14.40-16.19 CP, 8.02-8.15 fat and 1.53-2.01 ash. The proximate composition of bread

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and biscuit made from composite flour improved significantly at 70:30 formulation ($P=0.05$) compare to the control. The calcium, potassium and zinc content of PWB_0 (mg/100 g) were; 54.95, 261.70 and 0.30 respectively. PWB_1 , PWB_2 and PWB_3 ranged from 75.50-116.30, 276.05-351.40 and 0.37-0.43. PWb_0 , PWb_1 , PWb_2 and PWb_3 also followed similar trend. Similarly, there was significant increase in β -carotene, thiamine, and riboflavin as the levels of pigeon pea flour increased. Addition of pigeon pea flour to wheat flour clearly enhanced the nutritional composition of the two products except for the reduction in iron and iodine content.

Keywords: Pigeon pea; wheat; bread; biscuit; nutritional composition; composite flour.

1. INTRODUCTION

Wheat occupies around 10 million hectares of land in Africa. It is a chief crop for several countries and an imported commodity in all of Africa. In all African countries, consumption of wheat has continued to increase because of a growing population, shifting food inclinations and socioeconomic change connected with urbanization [1]. Wheat is an excellent food and in various forms may enhance nutritional status among vulnerable individuals. Supplementation of wheat with cheap commodities such as cereals or legumes has resulted in products of superior nutritional value. Pigeon pea (*Cajanus Cajan*) plant is a legume belonging to the family of "Fabaceae" or "Leguminosae". It is an essential underutilized legume in southwest Nigeria. Locally, it is called "otili" [2]. It is rich in protein, dietary fibre, and vitamins and minerals. In its totality, 100 g of mature raw pigeon peas provides 114% of the daily requirement of folate. The levels of saturated fat, cholesterol, and sodium in Pigeon pea are low [3]. Therefore, pigeon pea, like other legumes is a healthy substitute for meats. In combination with grains, pigeon peas make up a well-balanced human diet [3].

Growing affluence and expansion coupled with population rise experienced in many parts of sub-Saharan Africa in recent years have resulted to an increase in the consumption of wheat-based products like bread and biscuit [4]. The consumption of snacks such as biscuits is common in Nigeria, especially among school children and different categories of office workers. Because of busy work schedules, some office workers now consume biscuits not only between meals, but as regular meals with beverages like tea, coffee, juices and bottled drinks [5]. Bread is also one of the chief foods of many Nigerians and the second most consumed non-indigenous food after rice [6]. Bread is

produced from wheat flour, which has low protein content and, like most cereals, is limiting in lysine. Baking using wheat alone (like bread and biscuits) does not provide the complete amino acids, thus, the need to blend with legume flour [7].

We therefore designed this study to produce bread and biscuit from wheat-pigeon pea composite flour and determine their nutritional composition. Thus, combining wheat and pigeon pea to form composite flour in the production of baked product such as bread and biscuit will enhance the nutritional content of the products.

2. MATERIALS AND METHODS

Red variety of pigeon pea (*Cajanus cajan*) was purchased for the analysis from Central market located at Ahmadu Bello way – Gombe road, Kaduna north, Kaduna State, Nigeria. Wheat flour and all other baking ingredients such as fat, sugar, baking powder, yeast and flavourings were also obtained from the same source.

2.1 Pigeon Pea Flour Preparation

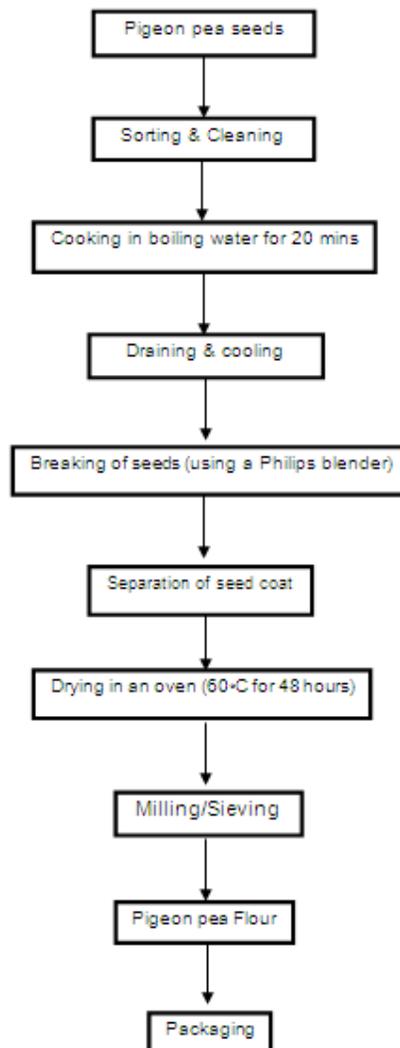
The pigeon pea flour was produced as described by Ojinnaka et al. [8]. Pigeon pea seeds were sorted, cleaned and cooked in boiling water for 20 minutes; it was then drained and cooled. The seed coats were de-hulled using a Philips blender and dried in an oven at 60°C for 48 hours. The dried pigeon pea seeds were allowed to cool at room temperature, milled to pass through a 1mm sieve and packaged in an air tight container.

2.2 Formulation of Composite Flour

Four blends were prepared by mixing pigeon pea flour (PF) with wheat flour (WF) using a blender as shown in Table 1. The blends were kept in plastic airtight containers at room temperature pending laboratory analysis.

Table 1. Formulation of composite flour

Formulation	Pigeon pea flour (g/100 g)	Wheat Flour (g/100 g)
Sample 1	0 g	100 g
Sample 2	10 g	90 g
Sample 3	20 g	80 g
Sample 4	30 g	70 g

**Fig. 1. Flowchart for the production of pigeon pea flour**

2.3 Production of Biscuit

Biscuits were prepared using the modified recipe for digestive biscuits as described by Fasoyiro et al. [9]. The fat and sugar were mixed until fluffy. Water was added while mixing continued for about 40 minutes. Flour, baking powder, nutmeg, vanilla flavouring and salt were slowly introduced into the mixture. The dough was rolled and cut

into circular shapes of 5 cm diameter. Baking was carried out at 160°C for 15 min. Biscuits were prepared from 100% wheat flour to serve as a control.

2.4 Production of Bread

Bread samples were prepared using the method of [7]. All dry ingredients were mixed together by

rubbing method. The ingredients were weighed appropriately using a salter weighing scale. The yeast was creamed in a basin with three quarters of the water. A hole was made in the centre of the flour blend and dissolved yeast was added. This was covered with a cheese cloth and left at 35°C for yeast fermentation of the mixture. The remaining water, butter, sugar and salt were added and kneaded using a mixer. The dough was returned to the basin, covered with a cheese cloth and left at 35°C to proof (to double its size) for 90 minutes. The proofed dough was punched down, kneaded and cut into small rolls. It was transferred to a greased oven pans, allowed to proof for 30 minutes. These were baked in a preheated oven at 220°C for 25 minutes.

2.5 Proximate Composition of Bread and Biscuits

Protein, fat, ash and fibre were determined according to the methods described by AOAC, 2005 while carbohydrates were determined by difference.

2.6 Nutritional Analysis of Bread and Biscuits

The baked products were analysed for mineral and vitamin composition. Calcium, sodium and potassium were determined using flame photometer. Manganese, zinc, magnesium, and iron were determined using BUCK 200 atomic absorption spectrophotometer [10]. Phosphorus was determined using vanado-molybdate colorimetric method. Iodine was determined by the method of Moxon and Dixon, whereas the vitamins analysed were beta carotene, vitamins B₁, B₂, B₃, B₆, B₉ and vitamin C.

2.7 Statistical Analysis

All experiments were replicated three times. Data were expressed in the form of means ± standard deviation (SD). The data were analysed using SPSS for Windows, version 20.0 (SPSS Inc. Chicago, IL.US). The difference was of statistical significance at $p < 0.05$.

3. RESULTS AND DISCUSSION

We designed this study to produce bread and biscuit from wheat-pigeon pea composite flour and to determine their nutritional composition. The results of the proximate composition of bread and biscuit samples

produced from various blends of wheat- pigeon pea composite flour was presented in Table 2a & 2b. The moisture, crude protein, crude fat and ash content of the bread samples increased significantly ($P=0.05$) as the percentage of pigeon pea flour increased with values ranging from 11.43–14.13 g/100 g, 10.19–14.21 g/100 g, 2.26–3.69 g/100g and 1.91–2.62 g /100 g respectively, while carbohydrate and crude fibre composition decreased. We observed similar trend in the biscuit samples (Table 2b). There was a slight increase in the moisture content of bread prepared from wheat-pigeon pea composite flour. The increase in moisture content could be because of increasing protein level from increasing pigeon pea flour addition [11], also, another author confirmed that grain's protein attracts moisture [3]. Moisture contents in the biscuits samples were low. This result agreed with [12] who reported similar observations in cookies produced from mixtures of fermented pigeon pea, germinated sorghum and cocoyam flours. The low moisture content will slow down microorganisms' growth and extend the shelf life and quality attribute of the biscuit.

There was an increase in crude protein content as the proportion of pigeon pea flour in both bread and biscuit samples increased; showing that the addition of pigeon pea flour to wheat flour would improve the nutritional quality of bread and biscuit. In term of proximate composition, PWB₃ and PWB₃ gave the best formulations. Addition of pigeon pea flour to "Gurundi", a wheat-based snack with coconut water and grated coconut [5] showed similar trend to the present study. The crude protein content reported by Ojinnaka et al. [8] with the use of African breadfruit, wheat and pigeon pea composite flour blends in cookie production is in contrast to this study. Legumes are good complements to cereals, tubers and roots, studies have shown that legumes contain high levels of lysine, which is a limiting amino acid in cereals [13]. The high protein content in the pigeon pea complemented the wheat-based bread and biscuits in this study. This is of nutritional significance in developing countries, such as Nigeria, where many people can hardly afford food rich in protein especially fish and meat because of poverty and costs. The crude fat content of the bread was relatively low, which is desirable for the samples because high amount of fat can speed up spoilage by promoting rancidity leading to the production of off flavours and odours. A similar trend with the use of Decorticated Pigeon Pea–wheat flours in

production of Bread [14]. The low fat seen in the bread is suitable for those susceptible to obesity, obesity-related diseases and health conscious individuals [15].

3.1 Mineral Composition of Bread and Biscuit from Wheat-pigeon Pea Composite Flour

The mineral composition of bread and biscuit samples produced from various blends of wheat-pigeon pea composite flour was presented in Table 3a & 3b. The result showed that there was a significant increase ($P=0.05$) in sodium, calcium, potassium, magnesium, zinc, manganese and phosphorus as the percentage of pigeon pea flour increases in both bread and biscuit, whilst iron and iodine content decreased slightly from 3.13 mg/100 g to 2.65 mg/100 g and 0.33 mg/100 g to 0.31 mg/100 g respectively. Although there were slight decreases in iron and iodine content, PWB₃ and PWB₃ were still the formulations. The visible increase in the values of sodium, potassium, calcium, magnesium, zinc, manganese and phosphorus in bread and biscuit samples implied that both the pigeon pea and wheat were a good complement because pigeon pea is rich in iron, calcium, potassium and manganese [16]. However, a decrease in sodium and potassium content was observed as the percentage of pigeon pea increases, while calcium and magnesium content increased with increase inclusion of pigeon pea. Potassium is a micronutrient essential to health & well-being; it performs diverse biological functions in the human body. It is important in the maintenance of normal blood pressure, muscular and neurological function. The requirements of a child in the age range of 9–13 years are 1.5 g/day, 4.5 g/day, 1300 mg/day and 240 mg/day of sodium, potassium, calcium and magnesium, respectively. Hence, 100 g of 10% pigeon pea

complemented bread will supply about 1.5%, 6%, 6% and 8% of recommended dietary allowances for sodium, potassium, calcium and magnesium, and 100g of 10% pigeon pea complemented biscuit will supply about 59.3%, 7%, 7% and 14% of recommended dietary allowances for sodium, potassium, calcium and magnesium needed by a 9–13-year-old. Calcium is an essential and required nutrient for bone health and maintenance, neuromuscular activity, blood coagulation and normal cardiac function [17]. Calcium serves as a second messenger for nearly every biological process stabilizes many proteins, and its deficiency is associated with many diseases [18].

3.2 Vitamin Composition of Bread and Biscuit from Wheat-pigeon Pea Composite Flour

The vitamin composition of the baked products from wheat-pigeon pea composite showed a significant increase ($p<0.05$) in β -carotene, thiamine, riboflavin, niacin, pyridoxine, folic acid and vitamin C with PWB₃ and PWB₃ giving the best formulation. (Table 4a & 4b). The vitamin content of bread and biscuit samples increased (especially in niacin, folic acid and vitamin C) with an increase in the level of pigeon pea flour. According to Saxena and Sultana [19], pigeon pea is rich in water-soluble vitamins like thiamine, riboflavin, niacin. It contains five times more β -carotene and three times more vitamin C than ordinary peas [16]. According to Semba [20] Vitamin A helps in the epithelia lining of the eyes, respiratory, urinary and intestinal tract. We need vitamin C for collagen synthesis, the protein that serves so many connective functions in the body. Among the body's collagen-containing materials and structures are the framework of bone, gums and binding materials in skin and muscle or scar tissue.

Table 2a. Proximate composition of bread produced from wheat-pigeon pea composite flour (g/ 100 g)

Parameters	PWB ₀	PWB ₁	PWB ₂	PWB ₃
Moisture Content	11.43±0.20 ^a	12.67±0.17 ^b	13.44±0.04 ^c	14.13±0.04 ^d
Crude Protein	10.19±0.03 ^a	11.69±0.20 ^b	12.47±0.05 ^c	14.21±0.06 ^d
Crude Fat	2.26±0.02 ^a	2.82±0.10 ^{ab}	3.07±0.74 ^b	3.69±0.39 ^c
Ash	1.91±0.06 ^a	2.09±0.02 ^{ab}	2.25±0.09 ^b	2.62±0.19 ^c
Crude Fibre	2.35±0.07 ^b	2.19±0.02 ^{ab}	2.10±0.03 ^a	2.05±0.14 ^a
Carbohydrate	68.84±0.25 ^c	68.70±0.08 ^c	67.70±0.13 ^b	65.20±0.12 ^a

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different ($P=0.05$)

PWB₀ – Bread from 100% wheat flour (control), PWB₁ – Bread produced from composite flours of 90% wheat and 10% pigeon pea flour, PWB₂ – Bread produced from composite flours of 80% wheat and 20% pigeon pea flour

PWB₃ – Bread produced from composite flours of 70% wheat and 30% pigeon pea flour

Table 2b. Proximate composition of biscuit from pigeon pea-wheat composite flour

Parameters	PWb ₀	PWb ₁	PWb ₂	PWb ₃
Moisture Content (%)	7.85±0.01 ^a	8.11±0.00 ^b	8.26±0.01 ^c	8.45±0.09 ^d
Crude Fat (%)	6.36±0.02 ^a	8.02±0.07 ^b	8.03±0.16 ^b	8.15±0.00 ^b
Crude Protein (%)	12.50±0.02 ^a	14.40±0.13 ^b	15.84±0.04 ^c	16.19±0.23 ^d
Crude Ash (%)	1.26±0.03 ^a	1.53±0.01 ^b	1.62±0.01 ^c	2.01±0.00 ^d
Crude Fibre (%)	2.83±0.02 ^a	2.40±0.02 ^b	2.20±0.01 ^c	1.84±0.13 ^d
Carbohydrate (%)	68.67±0.05 ^a	64.11±0.11 ^b	65.63±0.30 ^c	63.75±0.20 ^d

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different (P=.05)

PWb₀ – Biscuits from 100% wheat flour (control), PWb₁ – Biscuits produced from composite flours of 90% wheat and 10% pigeon pea flour, PWb₂ – Biscuits produced from composite flours of 80% wheat and 20% pigeon pea flour, PWb₃ – Biscuits produced from composite flours of 70% wheat and 30% pigeon pea flour

Table 3a. Mineral composition of bread from pigeon pea-wheat composite flour

Parameters	PWB ₀	PWB ₁	PWB ₂	PWB ₃
Sodium (mg/100 g)	20.40±0.14 ^a	21.90±0.28 ^a	29.10±0.28 ^b	34.04±1.18 ^c
Calcium (mg/100 g)	54.95±0.35 ^a	75.50±0.00 ^b	91.35±1.06 ^c	116.30±0.57 ^d
Potassium (mg/100 g)	261.70±0.28 ^a	276.05±0.07 ^b	349.10±0.57 ^c	351.40±1.27 ^d
Iron (mg/100 g)	3.13±0.01 ^b	2.65±0.01 ^a	2.71±0.07 ^a	3.11±0.00 ^b
Magnesium (mg/100 g)	16.49±0.03 ^a	18.31±0.01 ^b	21.28±0.42 ^c	25.88±0.04 ^d
Zinc (mg/100 g)	0.30±0.00 ^a	0.37±0.01 ^b	0.40±0.00 ^c	0.43±0.01 ^d
Manganese (mg/100 g)	0.19±0.01 ^a	0.19±0.00 ^a	0.21±0.01 ^b	0.31±0.00 ^c
Phosphorus (mg/100 g)	195.78±0.48 ^a	215.13±0.10 ^b	230.63±0.72 ^c	306.87±0.39 ^d
Iodine (mg/100 g)	0.33±0.00 ^d	0.27±0.00 ^a	0.28±0.01 ^b	0.31±0.01 ^c

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different (P=.05)

Table 3b. Mineral composition of biscuit from pigeon pea-wheat composite

Parameters	PWb ₀	PWb ₁	PWb ₂	PWb ₃
Sodium (mg/100 g)	41.45±0.35 ^a	44.25±0.35 ^b	44.75±0.07 ^b	49.15±0.49 ^c
Calcium (mg/100 g)	76.95±1.91 ^a	86.30±0.28 ^b	90.40±1.27 ^c	98.20±0.14 ^d
Potassium (mg/100 g)	317.55±1.63 ^a	320.10±0.00 ^a	382.15±1.91 ^b	395.25±0.21 ^c
Iron (mg/100 g)	3.61±0.00 ^d	2.64±0.00 ^a	2.75±0.00 ^b	2.83±0.00 ^c
Magnesium (mg/100 g)	28.57±0.01 ^a	32.66±0.18 ^b	41.00±0.18 ^b	33.97±0.21 ^c
Zinc (mg/100 g)	0.60±0.00 ^a	0.62±0.01 ^b	0.63±0.01 ^c	0.65±0.00 ^d
Manganese (mg/100 g)	0.35±0.01 ^a	0.35±0.00 ^a	0.37±0.00 ^b	0.48±0.00 ^c
Phosphorus (mg/100 g)	251.49±0.99 ^a	262.45±1.02 ^b	294.87±0.38 ^c	338.95±1.75 ^d
Iodine (mg/100 g)	0.38±0.06 ^c	0.30±0.01 ^a	0.35±0.07 ^b	0.36±0.12 ^{bc}

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different (P=.05)

Table 4a. Vitamin composition of bread from pigeon pea-wheat composite flour

Parameters	PWB ₀	PWB ₁	PWB ₂	PWB ₃
β- carotene (IU/100 g)	0.07±0.00 ^a	0.09±0.00 ^b	0.09±0.00 ^b	0.10±0.00 ^c
Thiamine (mg/100 g)	0.19±0.00 ^a	0.21±0.00 ^b	0.23±0.00 ^c	0.30±0.00 ^d
Riboflavin (mg/100 g)	0.40±0.00 ^b	0.39±0.00 ^a	0.41±0.00 ^c	0.41±0.00 ^c
Niacin (mg/100 g)	5.53±0.00 ^a	6.74±0.00 ^b	7.15±0.02 ^c	6.28±0.00 ^d
Pyridoxine (mg/100 g)	0.98±0.00 ^a	1.09±0.01 ^b	1.18±0.01 ^c	1.22±0.01 ^d
Folic acid (mg/100 g)	83.45±0.35 ^a	85.20±0.14 ^b	100.5±0.00 ^c	112.45±0.07 ^d
Vitamin C (mg/100 g)	4.66±0.00 ^a	5.27±0.01 ^b	5.31±0.00 ^c	6.05±0.00 ^d

Mean data with the same superscript in the same row are not significantly different (P=.05)

Table 4b. Vitamins composition of biscuit from wheat-pigeon pea composite flour

Parameters	PWb ₀	PWb ₁	PWb ₂	PWb ₃
β- carotene (IU/100 g)	0.10±0.00 ^a	0.10±0.00 ^a	0.11±0.00 ^b	0.13±0.00 ^c
Thiamine (mg/100 g)	0.37±0.00 ^a	0.37±0.01 ^a	0.39±0.00 ^b	0.41±0.00 ^c
Riboflavin (mg/100 g)	0.43±0.00 ^a	0.51±0.00 ^b	0.53±0.00 ^c	0.56±0.00 ^d
Niacin (mg/100 g)	5.72±0.01 ^a	6.10±0.00 ^b	6.18±0.00 ^c	7.02±0.00 ^d
Pyridoxine (mg/100 g)	1.31±0.00 ^a	1.35±0.00 ^b	1.52±0.00 ^c	1.54±0.00 ^d
Folic acid (mg/100 g)	74.95±0.21 ^a	90.65±0.21 ^b	93.55±0.07 ^c	96.75±0.35 ^d
Vitamin C (mg/100 g)	5.94±0.00 ^a	6.27±0.00 ^b	6.85±0.01 ^c	7.09±0.01 ^d

Mean data with the same superscript in the same row are not significantly different ($P= .05$)

3.3 Anti-nutrient Composition of Bread and Biscuit from Pigeon Pea-wheat Composite Flour

The levels of anti-nutrient in the bread and biscuit are presented in Tables 5a and 5b, respectively. There was a significant increase ($p<0.05$) in tannin, phytate and oxalate content as the percentage of pigeon pea flour increased. Also, there was no significant difference ($p>0.05$) in the trypsin inhibitor content in the bread samples. The anti-nutrient composition of biscuit samples produced from various blends of wheat- pigeon pea composite flour (Table 5b). The anti-nutrient composition ballooned ($p<0.05$) as the percentage of pigeon pea flour increased, with the trypsin inhibitor having the highest values. Specifically, tannin, phytate, oxalate and trypsin inhibitor ranged from 0.10 mg/100 g to 0.18 mg/100 g, 0.51 mg/100 g to 1.07 mg/100 g, 1.31 mg/100 g to 3.79 mg/100 g and 2.72 TIU/mg to 4.03 TIU/mg respectively.

The anti-nutrient content increased with the progressive increase in proportion of pigeon pea flour in both bread and biscuit samples. The

increase may be because anti-nutrients are more associated to legumes than cereals [5]. The mean values appeared to be low and in close agreement with those of [21], using pigeon pea, cocoyam and sorghum flour blends in cookie production. Anti-nutrients in pigeon-pea reduced significantly during processing than other legumes such as soybeans, peas and field beans [22]. The presence of anti-nutrient in food influences bioavailability of nutrients. According to Doherty et al. [23], Phytic acid in food reduced nutrient quality since it binds with "di" and "tri" cation such as iron, calcium and zinc and also with proteins at pH less than their isoelectric points. Tannins affects the availability of amino acids, utilization of protein and inhibit the activities of digestive enzymes [24]. High trypsin inhibitor levels increased the size of pancreas and inhibit child's growth [22]. The lethal doses of phytate, tannin, oxalate and trypsin inhibitor ranged from 250–500 mg/100 g and 6% of body weight, 200 mg/kg and 2.50 g/kg, respectively [5]. Thus the bread and biscuit samples were within the safe levels, from the standpoint of anti-nutrients.

Table 5a. Anti-nutrient composition of bread from pigeon pea-wheat composite flour

Parameters	PWB ₀	PWB ₁	PWB ₂	PWB ₃
Trypsin (TIU/mg)	2.75±0.25 ^a	2.81±0.66 ^{ab}	2.92±0.01 ^{ab}	3.16±0.01 ^b
Tannin (mg/100 g)	0.13±0.00 ^a	0.15±0.00 ^b	0.15±0.00 ^b	0.20±0.00 ^c
Phytate (mg/100 g)	0.70±0.01 ^a	0.78±0.02 ^b	0.86±0.01 ^c	0.93±0.01 ^d
Oxalate (mg/100 g)	1.89±0.11 ^a	2.10±0.02 ^{ab}	2.19±0.02 ^b	2.84±0.17 ^c

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different ($P= .05$)

Table 5b. Anti-nutrient composition of biscuit from pigeon pea-wheat composite flour

Parameters	PWb ₀	PWb ₁	PWb ₂	PWb ₃
Trypsin (TIU/mg)	2.72±0.00 ^a	3.07±0.05 ^b	3.15±0.01 ^b	4.03±0.02 ^c
Tannin (mg/100 g)	0.10±0.00 ^a	0.11±0.00 ^b	0.12±0.00 ^c	0.18±0.00 ^d
Phytate (mg/100 g)	0.51±0.00 ^a	0.82±0.01 ^b	0.87±0.01 ^c	1.07±0.01 ^d
Oxalate (mg/100 g)	1.31±0.01 ^a	2.62±0.01 ^b	2.95±0.01 ^c	3.79±0.03 ^d

Values are means ± standard deviations of triplicate determinations. Means with the same superscript in the same row are not significantly different ($P= .05$)

4. CONCLUSION

Complementing wheat flour with pigeon pea flour in the production of bread and biscuit improved the proximate, mineral and vitamin composition of the formulated products. Although, the level of anti-nutritional factors tends to increase with increasing amount of pigeon pea, this would not pose serious issue since it is within the safe level. Production of wheat-based baked products from wheat-pigeon pea composite flour would reduce overdependence on wheat flour and improve pigeon pea utilization which is indigenous and under-used in Nigeria.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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