

Effect of Processing Methods on the Quality of Flour and Bread from African Breadfruit Kernel Flour

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Abstract

The consumer demand for composite flour bread is increasing. African breadfruit seed with high protein quantity and quality is a good complement for composite flour bread. The study investigated the effect of processing methods on the quality of African bread fruit seed flour (ABKF) for bread making. Flours were prepared from boiled, toasted and fermented African bread fruit kernels and evaluated for their chemical composition and functional properties. Each of the flours (30%) was used to substitute 70% wheat flour in breads, which were assessed for their physical, chemical and sensory properties. Breads from untreated ABKF and 100% wheat flour (WF) served as controls. Toasting increased the protein, ash and crude fiber contents of ABKF. Fermentation increased the protein content while boiling decreased it. Toasting, fermentation and boiling significantly decreased ($P < 0.05$) the oxalates, phytates, tannins and HCN contents of the seed. All the treatments improved ($P < 0.05$) water absorption capacity (125-180%) of ABKF in relation to the control. Only fermentation reduced ($P < 0.05$) oil absorption capacity but improved foaming and emulsification properties of ABSF. Breads containing toasted ABKF had higher weight, height, length and volume than the other breads. Breads containing fermented ABKF had the highest proofing ability and specific loaf volume. Toasting and fermentation improved the flavour of bread more than the other treatments. However, the breads containing fermented ABKF received significantly lower ($P < 0.05$) scores for crust colour, crumb colour and texture than the other breads. Breads containing toasted ABKF had significantly higher ($P < 0.05$) scores for flavour, texture, taste and overall acceptability than the other breads including 100% WF bread. These results suggested that toasted ABKF could be used as wheat flour supplement in bread making.

Keywords: African breadfruit, chemical composition, functional properties, sensory quality, supplemented bread, processing

Introduction

Bread is conventionally produced from wheat which grows well only in the temperate region. This makes bread expensive in tropical countries, including Nigeria. Inspite of this, bread consumption is increasing among the populations in many parts of the world, probably due to increase in population, urbanization and convenience in the use of bread. The increased demand for bread has necessitated substitutes for wheat in bread. Successes have been achieved with the use of flours from cereals, roots and tubers; and legumes as wheat substitutes in bread (Ayo and Nkama, 2004; Shittu *et al*., 2007; Ammar *et al*., 2009). In this regard, composite flours were either binary or tertiary mixtures of flours with or without wheat flour. This is aimed at curbing imports of wheat into tropical countries. One of such efforts was the use of African breadfruit seed to improve protein quality of bread (Akubor and Afangiden, 2005)

African breadfruit (*Treculia africana* Dcene) is a member of the *Moracea* family. The botany, seed morphology and anatomy of the tree have been described (Nwoko, 1985). The composition of the seed has been comprehensively reported by several authors where it was reported that the seed contains 17-25% protein and 11% crude fat in addition to essential vitamins and minerals (Akubor, 1997). However, like other legumes, the amino acid profile of the seed is characterized by low concentration of sulphur amino acids and high in lysine, arginine and histidine (Ekpenyong, 1985). The high contents of histidine and lysine are a factor for African breadfruit seeds for food formulations for infants. However, the very low level of sulphur amino acids would impede the optimal utilization of the seeds when consumed as sole food for babies, children and young adults. But when the seeds are consumed with cereals such as wheat as in African breadfruit-wheat bread, the inherent sulphur amino acids deficiency would be diminished (Akubor and Afanigiden, 2005).

African bread fruit seeds are traditionally processed by boiling, toasting and fermentation for the purpose of consumption and preservation. The seeds could be boiled or roasted and eaten as such or used in combination with other foods. The effects of these processing methods on some qualities of African breadfruit have been extensively investigated. Lawal (1986) has reported that toasting had no effect on the protein and niacin contents but reduced thiamin, riboflavin, ascorbic acid and beta carotene contents. Toasting and boiling reduced trypsin inhibitors in the seeds (Giami *et al*., 2001). Fermentation improved the *in Vitro* protein digestibility of African bread fruit seeds (Ariahu *et al*., 1999). The functional properties which would provide useful information for specific food applications are also affected by toasting. High temperature and prolonged toasting was not desirable for processing African breadfruit seeds for foods like bread in which water and oil absorption are of prime importance (Akubor *et al*., 2000). The functional properties of African breadfruit seeds were reported to be pH and NaCl concentration dependent (Badifu and Akubor, 2007). Notably, the functional properties of African breadfruit seeds as affected by boiling and fermentation are unknown. There is also dearth of information in the literature on the effects of boiling, toasting and fermentation of African bread fruit seeds on the quality of formulated food products. This study therefore, assessed the effects of boiling, toasting and fermentation on the quality of flours prepared from African bread fruit seed. The quality of breads developed from composite flours containing variously treated African bread fruit seed and wheat flours were also investigated.

2.0 Materials and Methods

2.1 Procurement of raw materials

African breadfruit (*Tequila africana* Decne) seeds used for this study were purchased from Ogbete local market in Enugu Township, Enugu State, Nigeria. Commercial wheat flour (Golden Penny, 100% extraction) was purchased from Ega market in I dah Township, Kogi state, Nigeria. The wheat flour was sieved through 60-mesh sieve (British standard), packed in HDPE bags and stored at ambient temperature prior to use. The dry African breadfruit seeds were stored in jute bags in the laboratory prior to use.

2.2 Preparation of boiled African breadfruit seed flour

The African breadfruit seeds were cleaned of extraneous materials by hand picking. The cleaned seeds were boiled (100^oC, 15min) as recommended by Badifu and Akubor (2007) in a plain aluminum pot with lid. The hydrated seeds were then dehulled manually and the hulls winnowed off. The kernels were oven dried (60^oC, 24h) to constant weight, milled in attrition mill and then sieved through 60 mesh sieve. The flour was packaged in HDPE bag and stored in a refrigerator prior to use.

2.3 Preparation of toasted African bread fruit seed flour

The cleaned African breadfruit seeds (1kg) were spread thinly on aluminum tray and heated in a hot air oven (120^oC. 10min) as described by Akubor *et al*. (2000). The toasted seeds were dehulled manually and the hulls winnowed off. The kernels were milled in attrition mill, sieved through 60 mesh sieve and then stored in HDPE bags.

2.4 Preparation of fermented African breadfruit seed flour

The raw African breadfruit seeds were oven dried (60^oC, 24), milled and sieved through 60 mesh sieve. A portion of the raw flour was mixed with tap water (3:5, flour: water) and fermented in a covered plastic basin at ambient temperature (30±2^oC) for 4 days as described by Ariahu *et al*. (1999). The fermented flour was oven dried (60^oC) to constant weight, milled and sieved through 60 mesh sieve. The flour was packed in HDPE bags prior to use.

2.5 Flour blending

The wheat flour (70%) was used to substitute each of the boiled, toasted and fermented African bread fruit seed flours (Akubor and Afangiden, 2005). The mixtures were blended in a Kenwood Food processor operated at full speed for 10min. The flour blends were stored in HDPE bags prior to use.

2.6 Preparation of Breads

The bread samples were prepared using the method described by Ceserani *et al*. (1995). The recipe used for the preparation of breads was composed of flour (200g), yeast (5g), liquid (dry powder and milk + water (125ml), margarine (10g), sugar (5g) and salt (2g). The rubbing in method was adopted for the dry ingredients. The ingredients were weighed appropriately. The baker’s yeast was creamed in a basin with 31ml of the powdered milk-water mixture. A hole was made in the center of the flour blend and the dissolved yeast added. This was covered with cheese cloth and left at 35^{o}C for the yeast fermentation of the mixture. The remaining milk-water mixture (94 ml), margarine (10g), granulated sugar (sucrose) (5g) and salt (2g) were added and kneaded manually until smooth dough free from stickiness was obtained. The dough was returned to the basin, covered with cheese cloth and left at 35^{o}C until the dough doubled its size. The dough was punched, divided into even pieces and moulded into the desired shape. The moulded dough was then placed on baking sheet and covered with cheese cloth and left at 35^{o}C to proof (double in size).The proofed dough was then carefully brushed with egg wash and transferred into pans greased with liquid margarine. The doughs were baked at 220^{o}C for 10min in a baking oven, cooled and then packaged in HDPE bags prior to use.

2.7 Analytical methods

2.7.1 Physical evaluation

The height, length and width were measured with vernier caliper. Weight was determined with digital weighing balance. Volume was determined by seed displacement method (AOAC, 2010). Density was calculated as weight/volume. The proofing (leavening) ability of bread was calculated by subtracting the initial height of the dough before leavening from the final height after leavening and then multiplying the result by 100 (Ceserani *et al*., 1995). The oven spring was calculated as the difference in dough height before and after baking (Ceserani *et al*., 1995). The specific volume was calculated as volume/ weight.

2.7.2 Sensory evaluation

The bread samples were evaluated for flavour, crust and crumb colour, texture, taste and overall acceptability by a panel of 20 trained judges who were familiar with bread attributes. The bread samples were evaluated on a 7-point Hedonic scale (1=dislike extremely, 4= neither like nor dislike and 7=like extremely). The panelists consisted of members of staff and students of the Department of Food Science and Technology, Federal Polytechnic, Idah. The sensory evaluation was carried out in a sensory evaluation laboratory under florescent light in the mid-morning (10 am). The samples were presented to the panelists in three-digit coded white plastic plates. The order of presentation of the samples to the panelists was randomized. The judges were instructed to rinse their mouths with tap water in between evaluations.

2.7.3 Chemical evaluation

Moisture was determined by hot air oven drying at 105^{o}C to constant weight (AOAC, 2010). Ash, protein (N x 6.25), crude fiber and crude fat (solvent extraction) were determined by the AOAC (2010) methods 14.085, 14.086, 15:087 and 14.089, respectively. Carbohydrate was calculated by difference (100-(% Protein + % Moisture + % Ash +% Fat +% Crude fiber). Phytate was extracted with trichloroacetic acid (TCA) and precipitated as ferric salt using the procedure outlined by Lata and Eskin (1980). Oxalate was determined using the calcium oxalate precipitation method as described by Reddy and Sistrunk (1980). Hydrocyanic acid was determined by the alkaline titration method (AOAC, 2010). Tannin was determined as described by the AOAC method (2010).

2.7.4 Evaluation of functional properties

Bulk density, least gelation concentration, emulsion activity and emulsion stability were determined by the methods of Okaka and Potter (1977). Water and oil absorption capacities of flours (as is basis) were determined at room temperature following the method of Sosulski *et al*. (1976). Foaming capacity (FC) and foam stability (FS) were also measured by the method of Okaka and Potter (1977). The volume of foam at 30 sec of whipping was expressed as FC. The volume of foam was recorded one hour after whipping to determine FS as percent of the initial foam volume.

2.8 Statistical analysis

Data were subjected to analysis of variance (Steel and Torrie, 1980). Means where significantly different were separated by the least significant difference (LSD) test. Significance was accepted at $P < 0.05$. Analyses were carried out in 3 replicates.

3.0 Results and Discussion

3.1 Effect of processing on proximate composition

The effect of the various treatments on proximate composition of African bread fruit kernels are shown is Table 1. The raw African breadfruit Kernel flour (RABKF) contained 9% moisture, 18% protein, 10% fat, 4% ash, 1.5% crude fiber and 56.5% carbohydrate (wet weight basis). These values were similar to those previously documented in the literature (4,6,8,10,11) Toasting slightly increased the protein, ash and crude fiber contents, probably due to concentration effect, but decreased moisture, fat and carbohydrate contents. The fat content decreased probably due to thermal decomposition. The decrease in carbohydrate content was due to increase in overall food components (dry matter). Fermentation slightly reduced the fat, ash and crude fiber but increased protein, carbohydrate and moisture contents. Similar increases in crude protein were reported for fermented oil bean (Akubor and Chukwu, 1999) and locust bean (Odunfa, 1985). However, decreases in carbohydrate content of fermented Nigeria oil bean seeds were reported (Akubor and Chukwu, 1999). Odunfa (1985) however, reported that fermentation had no appreciable effect on the fat content of African oil bean seed. The increase in the protein content of African bread fruit seeds could be attributed to synthesis of enzymic protein (Onimawo and Akubor, 2012) and/ or due to the fact that some amino acids are produced in excess of the requirement during protein synthesis and these accumulated in free amino acid pool (Onimawo and Akubor, 2012). The increase in protein content could also be attributed to degradation of storage protein and other materials during fermentation (Onimawo and Akubor, 2012). Increased activities of lipolytic enzymes during fermentation (Odunfa, 1985) which hydrolyzed fats into fatty acids, and glycerol could explain the increase in fat in this study. Fatty acids and glycerol are used for synthesis of carbohydrate and protein or as source of energy for microorganisms involved in the fermentation.

Table 1: Effect of processing methods on the proximate composition of African breadfruit Kernel flour

Parameters (%)	Processing methods			
	Control	Toasting	Fermentation	Boiling
Moisture	9.0^{b}	7.0^{c}	7.5^{c}	10.0^{a}
Crude protein	18.0^{c} (19.8^{c})	20.0^{a} (21.5^{a})	19.0^{b} (30.9^{b})	17.0^{d} (18.9^{d})
Crude fat	11.0^{a} (13.6^{a})	10.0^{b} (10.8^{b})	10.5^{ab} (11.6^{b})	10.2^{b} (11.3^{b})
Ash	4.0^{b} (4.4^{b})	5.5^{a}(5.9^{a})	3.0^{c} (3.3^{c})	2.5^{c} (2.8^{c})
Crude fibre	1.5^{a} (1.6^{a})	2.3^{a} (2.5^{a})	1.0^{a} (1.1^{a})	1.2^{a} (1.3^{a})
Carbohydrate	56.5^{c} (62.1^{c})	55.2^{d} (59.4^{d})	57.5^{b} (63.5^{b})	59.1^{a} (65.7^{a})

Values are means of triplicate determinations. Means in parenthesis are in dry weight basis. Means within a row with the same superscript were not significantly different ($P > 0.05$) Carbohydrate was obtained by difference.

Low fat levels in foods are known to increase shelf-life. Boiling, on the other hand, decreased all the constituents of African breadfruit seeds except moisture and carbohydrate. The increase in carbohydrate content was due to loss in the other components.

3.2 Effect of processing on antinutrients

The effects of processing methods on antinutrients contents are shown in Table 2. All the treatments reduced oxalate content of the seed, in which boiled exerted greater effect. Only boiling and fermentation significantly reduced the phytates and tannins contents. Toasting was less effective on these antinutrients. Boiling, toasting and fermentation significantly ($p < 0.01$) decreased the HCN content of African breadfruit seed, toasting being most effective.

Table 2: Effect of processing methods on the antinutrients content of African bread fruit kernel flour

Antinutrient	Processing methods			
	Control	Toasting	Fermentation	Boiling
Oxalates	$2.0^{a} \pm 0.10$	$1.5^{ab} \pm 0.08$	$1.8^{a} \pm 0.09$	$1.2^{b} \pm 0.05$
Phytates	$1.8^{a} \pm 0.09$	$1.9^{a} \pm 0.07$	$1.2^{a} \pm 0.14$	$1.0^{a} \pm 0.01$
Tannins	$12.0^{a} \pm 0.12$	$11.8^{a} \pm 0.09$	$8.0^{c} \pm 0.14$	$10.0^{b} \pm 0.24$
HCN	$0.5^{a} \pm 0.04$	ND	$0.43^{a} \pm 0.04$	$0.2^{a} \pm 0.01$

Values are means (X ± SD) of 3 replications. Means within a row with the same superscript were not significantly different. ND = Not detected

The quantities of oxalate in the seeds (1.2-2 mg / 100 g) were far below the toxic level of 2.5g reported by Murno and Bassir (1969). Oxalates form insoluble complexes with Ca, Mg and Fe and thus, interfere with utilization of these mineral elements (Onimawo and Akubor, 2012). However, moderate intake of oxalate is essential for normal heart beat, neuromuscular and metabolic activities (Onimawo and Akubor, 2012). The decrease in phytates content on boiling may be due to leaching out of this compound into the boiling water and breakdown at high temperature. Leaching of phytates may be due to its hydrophilic nature (Reddy and Sistrunk, 1980). Increased activity of phytase may have caused hydrolysis of phytate in the fermented African breadfruit seeds. Ingestion of 2.5g or more of phytic acid per day has been reported to cause reduction in bioavailability of Ca, Fe and Zn (Reddy and Sistrunk, 1980). Fermentation is known to reduce these antinutrients and liberating nutrients locked in plant structures and cells by indigestible materials (Odunfa, 1985). Fermentation does not require sophisticated equipment and technology and consumes little fuel energy.

3.3 Effect of processing on functional properties of breadfruit

The effects of processing methods on functionality of African breadfruit Kernel flour (ABKF) are given in Table 3. Only fermentation reduced bulk density of ABKF, just as was documented for fermented African oil bean seed (Akubor and Chukwu, 1999). Fermentation and germination are used to modify starch structure of cereals and legumes. Long chain carbohydrates are broken down into smaller units which are less viscous. The decrease in bulk density of fermented ABKF is a factor for its use in preparation of complementary foods.

Table 3: Effect of processing methods on the functional properties of African breadfruit Kernel flour.

Functional properties	Bread fruit flour processing method			
	Control	Toasting	Fermentation	Boiling
Bulk density (g/cm^3)	0.58^{a} ± 0.10	0.85^{a} ± 0.20	0.50$^{\alpha}$ ± 0.2	0.78^{a} ± 0.2
Water absorption capacity (%)	120^{a} ± 0.09	125^{a} ± 0.10	165^{b} ± 0.1	180^{c} ± 0.1
Oil absorption capacity (%)	92^{c} ± 0.08	96^{b} ± 0.09	90^{d} ± 0.2	150^{a} ± 0.08
Foaming capacity (%)	22^{b} ± 0.20	20^{d} ± 0.3	83^{c} ± 0.2	80^{c} ± 0.2
Emulsion activity (%)	30^{b} ± 0.1	22^{d} ± 0.1	40^{a} ± 0.1	26^{c} ± 0.1
Emulsion stability (%)	15^{b} ± 0.2	10^{d} ± 0.2	50^{a} ± 0.2	12^{c} ± 0.4
Least gelation concentration (%, w/v).	10^{a} ± 0.1	6^{c} ± 0.3	8^{b} ± 0.1	8^{b} ± 0.09

Values are means (X ± SD) of 3 replications. Means within a row with the same superscript were not significantly different (P >0.05).

Fermentation is traditionally used for preparation of low bulk weaning food (Ariahu *et al.*, 1999). All the treatments increased water absorption capacity of ABKF. Only fermentation did not improve the ability of ABKF to absorb and hold oil. Water absorption of flour is dependent mainly on amount and nature of the hydrophilic constituents and to some extent on pH and nature of the protein (Onimawo and Akubor, 2012). Proteolytic activity during fermentation may have increased the polar groups which improved hydrophilicity of the ABKF proteins. During heating such as toasting and boiling, proteins are dissociated into sub-units with more water binding sites than the native or oligomeric proteins (Sosulski *et al*., 1976; Akubor and Eze, 2012). Gelatinization of carbohydrates and swelling of crude fiber during heating of African bread fruit seeds may have enhanced water absorption. Water absorption capacity describes flour-water association ability under limited water supply.

These results suggest that ABKF sample would be useful in bakery products where hydration to improve handling characteristics is needed. However, low water absorption is desirable for thin gruels for weaning infants; enhancing intake of nutrients (Ariahu *et al*., 1999). Only fermentation improved the foaming capacity of African breadfruit seeds (30%). Fermentation may have caused surface denaturation of the seed proteins and thus, reduced surface tension of the protein molecules which gave good formability (Sosulski *et al*., 1976). Heat treatment reduced nitrogen solubility of proteins by denaturation and reduced their foaming capacity (Akubor and Eze, 2012; Sathe *et al*., 1982). All the treatments reduced foam stability of ABKF. Previous reports attributed this to protein denaturation (Sosulski *et al*., 1976; Onimawo and Akubor, 2012; Akubor and Eze, 2012). Foam stability is affected by protein denaturation, with native protein giving higher foam stability than denatured proteins (Sosulski *et al*., 1976; Sathe *et al*., 1982). Foam formation and foam stability are functions of the type of protein, pH, processing methods, viscosity and surface tension (Sosulski *et al*., 1976; Sathe *et al*., 1982). Foams are used to improve texture, consistency and appearance of foods. All the treated flours may find applications in baked and confectionery products. Only fermentation improved emulsion capacity and emulsion stability of ABKF. The efficiency of emulsification by flour varies with the type, concentration and solubility of protein (Onimawo and Akubor2012; Sathe *et al*., 1982). Foam capacity is a function of total hydrophilicity whereas emulsion properties are dependent on surface hydrophilicity (Sathe *et al*., 1982). The emulsion properties of ABKF samples suggested that they would be desirable for preparing comminuted meats like sausages, cake batter, mayonnaise and salad dressing.

All the treatments decreased the least gelation concentration (LGC) of African breadfruit seeds, with toasting exerting greater effect. Toasting decreased the LGC from 10% (w/v) in the control to 6% (w/v) in the toasted flour. However, LGC decreased 8% (w/v) in the boiled and fermented flours. Gelation is an aggregation of denatured molecules. Fermentation, boiling and toasting may have denatured the seed proteins and caused more aggregation than in the untreated flour. The variations in the gelling properties of flours are linked to the ratios of proteins, carbohydrates and lipids that make up the flour (Sathe *et al*., 1982). The treated ABKF samples would be good gel forming agents because of the low LGC (6-8%, w/v), and would be useful in food systems such as puddings and snacks which require thickening or gelling.

Table 4: Effect of processing methods on dough height during proofing.

Proofing time (min)	Processing method				
	Control	Toasting	Fermentation	Boiling	100% WF
0	2.8^{a}	2.8^{a}	2.8^{a}	2.8^{a}	2.8^{a}
15	2.9^{b}	3.6^{a}	3.8^{a}	3.3^{ab}	2.9^{b}
30	2.9^{b}	3.6^{ab}	4.0^{a}	3.3^{b}	3.0^{b}
45	2.9^{b}	3.7^{b}	4.1^{a}	3.4^{b}	3.0^{b}
60	3.0^{b}	3.7^{b}	4.2^{a}	3.4^{b}	3.0^{b}
75	3.0^{b}	3.8^{b}	4.2^{a}	3.5^{b}	3.1^{b}
90	3.0^{b}	3.9^{b}	4.3^{a}	3.6^{b}	3.1^{b}
105	3.0^{b}	3.9^{b}	4.3^{a}	3.6^{b}	3.1^{b}
120	3.0^{b}	3.9^{b}	4.3^{a}	3.6^{b}	3.1^{b}

Values are means of triplicate determinations. Means within a row with the same superscript were not significantly different ($p > 0.05$). Doughs contained 70% wheat flour and 30% african breadfruit Kernel flour.

3.4 Physical properties of dough

Table 4 presents the heights attained by doughs from blends of wheat and treated African bread fruit kernel flours. All the doughs had initial height of 2.8cm. The height increased to maximum of 3.6, 3.9 4.1 and 3.1 cm for doughs containing boiled, toasted, fermented and 100% wheat flours, respectively. The dough containing fermented ABSF had the highest height. All the doughs except 100% wheat flour attained maximum height at 90 min of leavening. The wheat flour (WF) attained maximum height at 75 min proofing. Doughs containing treated ABSF samples had higher height than the 100% WF at any proofing (leavening) time. Dough height depends to some extent on the volume of gas (CO_2). Fermentation may have exposed the seed protein molecules more than the other treatments, and thus, enhanced its potential for gas retention.

3.5 Physical properties of bread

The physical properties of bread samples are shown in Table 5. The weights of breads containing boiled, toasted and fermented African breadfruit kernel flours (ABKF) were 78.1, 86.1, 86.5 and 84.95, respectively. The weight of the 100% WF bread was 75.3g while that containing untreated ABKF was 73.2g. All the treatments improved the height, length and weight of the bread when compared to the breads containing untreated ABKF. However, toasting showed greater effect on the bread length than the other treatments. The bread containing toasted ABKF (9 cm) had significantly, higher ($p < 0.05$) length than the 100% WF bread. Bread containing fermented ABKF (FABKF) had equal length (7.1cm) with that of the 100% WF bread. Bread containing fermented ABKF had the highest width (5.2cm) and this was closely followed by those containing boiled ABKF (BABKF; 4.5cm) and toasted ABKF (4.0cm).

Table 5: Effect of processing methods on the physical properties of bread prepared from wheat and African bread fruit kernel flour blends

Processing methods (bread fruit)	Physical properties							
	Weight (g)	Height (cm)	Length (cm)	Width (cm)	Volume (cm3)	Proofing ability (%)	Oven spring (cm)	Specific volume (cm^3/ g)
Control	73.2^a	2.8^b	5.8^c	3.0^c	49.0^d	20.0^d	0.1^a	0.67^a
Toasting	86.5^a	4.1^a	9.0^a	4.0^b	149.4^a	50.0^b	0.3^a	1.73^a
Fermentation	84.9^b	4.0^a	7.1^b	5.2^a	149.1^a	70.0^a	0.1^a	1.76^a
Boiling	78.1^c	3.6^a	6.0^a	4.5^b	98.0^b	50.0^b	0.3^a	1.25^a
100% Wheat	75.3^d	3.2^b	7.1^b	3.7^{bc}	86.0^c	30.0^c	0.4^a	1.14^a

Values are means of triplicate determinations. Means within a column with the same superscript were not significantly different ($p > 0.05$). Breads contained 70% wheat flour and 30% African breadfruit kernel flour.

Similarly, breads containing treated ABKF showed better proofing ability than those containing untreated ABKF and 100% WF. The proofing ability of the breads containing treated ABKFs ranged from 40 to 70%, with a mean value of 52.3%, as compared to 30% for the 100% WF bread and 20% for the bread that contained untreated ABKF. The bread containing untreated ABKF had the least volume of 49cm^3. The volume increased to 149 cm^3 in the breads containing toasted ABKF and fermented ABKF and 98cm^3 in the bread containing boiled ABKF. The volume of the 100% WF bread was 86cm^3. The bread containing fermented ABKF had the highest proofing ability (70%) and specific volume (1.74cm^3) but the lowest oven spring (1.0cm). Boiling, toasting and fermentation did improve the oven spring in relation to the untreated ABKF but had values that were lower than that of the 100% WF bread. The specific volume ranged from 1.22 to 1.74 cm^3/g for the breads containing treated ABKFs and 1.12 cm^3/g for the 100% WF bread.

3.6 Sensory Properties

The mean sensory ratings for the breads are presented in Table 6. All the treatments improved the flavour of the breads over the untreated sample. Among the treated samples, the flavour score for the bread containing BABKF was significantly lower ($P < 0.05$). Bread containing toasted ABKF received slightly higher score for flavour, except for the 100% WF bread. During toasting, volatile substances including hexanals are removed by evaporation. The removal of such grassy smell substances and the onset of Maillard reactions give rise to desirable flavour (Onimawo and Akubor, 2012). Maillard type reactions which enhanced the flavour of the bread may have occurred during toasting of African breadfruit seeds. Volatile substances that impart flavour (which may be desirable or objectionable) are formed, due to Maillard reactions, during toasting of foods (Onimawo and Akubor 2012). The toasting process also removed the undesirable flavour associated with African bread fruit seeds.

There were no significant differences ($p > 0.05$) in the score for crust and crumb colour of breads except for the fermented ABKF which was rated significantly lower ($P < 0.05$). Fermentation did not improve the texture of the bread. There was no significant difference in the texture of breads containing boiled ABKF and toasted ABKF. The bread containing 100% WF received slightly higher score for texture. Gluten formation was probably less in the ABKF based breads. The low levels of gluten in the ABKF-WF blends might have affected the proper development of the dough. Maillaid reaction is known to impart colour and flavour to food materials. The sensory ratings of the bread containing toasted African bread fruit Kernel flour were equal to or significantly higher ($P < 0.05$) than those of the 100% wheat bread. Generally, the panelists preferred the bread containing toasted ABKF to that of the 100% WF bread.

Table 6: Sensory properties of breads prepared from wheat and African bread fruit kernel flour blends

Sensory attributes	Bread fruit flour Processing method				
	Control	Toasting	Fermentation	Boiling	100% Wheat
Flavor	3.8^a	5.1^a	4.8^a	4.1^b	5.5^a
Crust colour	4.8^a	5.7^a	3.8^b	5.8^a	5.4^a
Crumb colour	4.9^a	5.1^a	3.5^b	5.1^a	5.3^a
Texture	4.0^a	$5,5^a$	3.7^b	5.5^a	5.6^a
Taste	3.0^a	6.2^a	3.7^b	3.4^b	5.8^a
Overall acceptability	3.9^a	6.1^a	3.5^b	4.0^b	5.4^a

Means (n =20) within arrow with the same superscript wer enot significantly different (p > 0.05). Breads contained 70% wheat flour and 30% African bread fruit kernel flour blends. Breads were evaluated on 7 – point Hedonic scale (1 = extremely disliked and 7 = extremely liked).

3.7 Chemical composition of breads

The chemical composition of the breads is shown Table 7. All the breads containing treated African breadfruit kernel flours (ABKFs) had moisture contents (20-22%) lower than the control (untreated) (23%). The treated ABKF based breads were higher in ash and protein contents. The ash content increased from 2.6% in the bread containing boiled ABKF to 2.8 and 3.5% for the breads containing fermented ABKF and toasted ABKF, respectively. The ash content of the control was 2.0%. Similarly, the protein contents were. 13, 14 and 15% for the breads containing boiled ABKF, fermented ABKF and toasted ABKF, respectively relative to 12% for the control. The fiber content of the breads was not significantly affected by the processing treatments, values ranged from 1.2 to 1.8%. Similarly, the carbohydrate contents of the breads (55.5-55.9%) were not significantly different (P > 0.05). The calorie content of the bread containing fermented ABKF was significantly higher (P < 0.05) than those of the other breads. Bread containing toasted ABKF had lower amount of calorie, probably due to thermal decomposition of fat.

Table 7: Proximate composition of bread loaves prepared from wheat and African bread fruit kernel flour blends

Parameters	Bread fruit flour processing method			
	Control	Toasting	Fermentation	Boiling
Crude protein (%)	12.0^d (15.0^d)	15.0^a (18.8^a)	14.0^b (17.8^b)	13.2^c (16.9^c)
Crude fat (%)	6.0a (7.8a)	4.0^c (5.0^c)	4.8^b (6.1^b)	5.0^b (6.4^b)
Ash (%)	2.0^c (2.6^c)	3.5^a (4.4^a)	2.8^b (3.6^b)	2.6^b (3.6^b)
Crude fibre (%)	1.5^a (1.99^a)	1.8^a (2.39^a)	1.2^a (1.5^a)	1.3^a (1.6^a)
Carbohydrate (%)	55.5^a (72.1^a)	55.7^a (69.6^a)	55.7^a (70.9^a)	55.9^a (71.7^a)
Calorie (Kcal/ 100g)	324 (421)	318.8 (398.6)	322 (409.7)	321.4 (411.4)

Values are means of triplicate replications. Means within a row with the same superscript were not significantly (p > 0.05) different. Values in parenthesis are on dry weight basis. Breads contained 70% wheat flour and 30% African bread fruit kernel flour blends.

3.8 Antinutrients in bread

Table 8 shows that the levels of antinurients in all the treated bread samples were lower than those of the individual flours (Table 2). The reduction would have been influenced by the baking process.

4.0 Conclusion

The results of this study showed that boiling, toasting and fermentation had variable effects on the chemical composition and functional properties of African breadfruit seed as well as the quality of bread prepared from the flour. All the treatments reduced the antinutrients in African breadfruit kernel flour. The length, height and weight of the breads prepared from African breadfruit kernel flour were improved by all the treatments. The bread containing toasted African breadfruit kernel flour received higher ratings for flavor, texture, taste and overall acceptability than the other breads containing boiled and fermented African breadfruit kernel flour and wheat flour. This suggests that toasted African breadfruit kernel flour could be used as wheat flour supplement in bread making.

Table 8: Anti-nutrient contents (mg/ 100g) of bread prepared from wheat and African bread fruit kernel flour blends

Anti-nutrients	Bread fruit flour processing methods			
	Control	Toasting	Fermentation	Boiling
Oxalates	$0.9^{a} \pm 0.01$	$0.8^{a} \pm 0.09$	$0.7^{a} \pm 0.04$	$0.3^{a} \pm 0.07$
Phytates	$1.0^{a} \pm 0.04$	$1.2^{a} \pm 0.04$	$1.0^{a} \pm 0.09$	$0.8^{a} \pm 0.10$
Tannin	$10.1^{a} \pm 0.14$	$9.1^{b} \pm 0.25$	$6.3^{d} \pm 0.25$	$8.1^{c} \pm 0.19$
HCN	ND	ND	ND	ND

ND, - not detected. Means ± SD of 3 replications. Means within a row with the same superscript were not significantly different ($p > 0.05$). Breads contained 70% wheat flour and 30% African bread fruit kernel flour blends.

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