European Journal of Nutrition & Food Safety

12(12): 28-39, 2020; Article no.EJNFS.64066
ISSN: 2347-5641

Nutrient Composition and Sensory Properties of Wheat Bread Substituted with Defatted and Undefatted Cashew Kernel (*Anacardium occidentale* Linn.) Flours

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Authors' contributions

This work was carried out in collaboration among all authors. Author NJTE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author LIB managed the analyses of the study. Author MDD managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i1230332
Editor(s):
(1) Dr. Rasha Mousa Ahmed Mousa, University of Jeddah, Saudi Arabia.
Reviewers:
(1) Amanda Silveira Reis, State University of Maringa, Brazil.
(2) J. Jeyakodi Moses, Psg College of Technology, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64066

Original Research Article

Received 20 October 2020
Accepted 24 December 2020
Published 31 December 2020

ABSTRACT

This study was undertaken to investigate the nutrient composition and sensory properties of wheat flour bread substituted with defatted and undefatted cashew kernel flours. Cashew kernel was processed into flour and thereafter divided into two portions. One portion was left undefatted while the other portion was defatted using a hydraulic press. Bread was prepared from the blends of wheat and defatted/undefatted cashew kernel flours using 90:10, 80:20, 70:30, of wheat flour to defatted cashew kernel flour (DCF) and wheat flour to undefatted cashew kernel flour (UCF), and 100% wheat flour as control. Bread samples were subjected to sensory evaluation within 30 minutes of production. Proximate analysis and amino acid profile of the bread samples were carried out using standard methods. Result of the proximate analysis of the bread samples revealed a significant ($p<0.05$) increase in ash (1.05-2.19%), protein (8.46-34.22%) and crude fibre (1.85-6.20%) with a corresponding decrease in moisture (11.05-21.28%) and carbohydrate contents (57.21-36.37%) as substitution of wheat flour with DCF and UCF increased. Amino acid

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analysis revealed that wheat/DCF composite breads were significantly (p<0.05) higher in lysine (7.00 g/100 g), phenyl alanine (3.99 g/100 g), tryptophan (0.89 g/100 g), valine (4.33 g/100 g) and methionine (1.47g/100 g) than the wheat/UCF composite bread. Similarly, wheat/DCF composite breads were significantly (p<0.05) higher in proline (3.45 g/100 g), arginine (5.68 g/100 g), tyrosine (3.78 g/100 g), alanine (4.25 g/100 g), glutamic acid (11.81 g/100 g), glycine (3.06 g/100 g), serine (4.00 g/100 g) and aspartic acid (7.32 g/100 g) indicating higher protein quality in the wheat/DCF composite breads than in wheat/UCF composite breads. Bread samples substituted with 10% UCF and 20% DCF compared favourably with the control wheat flour bread for taste, crust, colour and general acceptability. Therefore, it is recommended to use a level of substitution of 10% UCF and 20% DCF for the production of bread of adequate nutritional and sensorial qualities.

Keywords: Bread; defatted; undefatted; cashew kernel; amino acid; nutrient.

1. INTRODUCTION

Bread is a global staple food that is mainly produced from wheat flour, water, yeast and salt followed by a series of processes such as mixing, kneading, proofing, shaping and baking [1]. Bread has gained wide consumer acceptance for many years in the world and in most African countries, the consumption is on the rise in recent years. In Nigeria, an increase in the consumption of bread has been indicated by a food consumption survey [2]. It offers convenience to urban and rural consumers as it requires no preparation. The high preference for bread has also been arising from its taste and good eating quality. The ever-increasing use of this foodstuff in the tropics has increased the demand for wheat flour, which is the main ingredient in bread making. Also, with the statistics, it is expected that demand for foods based on this cereal, such as bread, will increase by 2050 as reported by Sibanda et al. [3].

Wheat flour which is the major ingredient used in the production of bread is made from wheat grain. This uniqueness of this grain for bread production is due to its gluten fraction, responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated by yeast during fermentation [4]. Sadly, wheat is a temperate crop that does not thrive in tropical areas because of soil and adverse weather conditions [5]. Wheat production in Nigeria is limited thereby resulting to importation of wheat from other wheat producing countries so as to meet local flour needs for bakery products. As a result, the country spends huge sums on importing wheat. Owing to fear over the economic inference of reliance on wheat imports in developing countries, FAO in the 1960s initiated research on the use of available local crops available for partial/total substitution of wheat flour [6]. To this end, several flours derived from local cereals, tubers, oilseeds and legumes have been used at various proportions for the production of flours and composite breads [7,8].

Cashew (*Anarcadium occidentale* Linn) is a tropical evergreen tree belonging to the Anacardiaceae family and grown in India, Brazil, East Africa and Vietnam [9]. The tree grows well on poor soil under various climatic conditions and it ranks 3rd among all tree nuts [10]. The main product from cashew tree is the cashew kernel which is highly nutritive containing 19.8% protein, 47.1% fat, 5.7% moisture and 9% iron [11]. The oil content present in cashew kernels are mainly oleic (73.73%), linoleic (13.60%) and stearic (10.20%) acids in the ratio of 1:2:1 making it useful for lowering blood serum cholesterol [12].

The cashew kernel is an important delicacy which is mainly used in confectionary and as a dessert nut such as cakes, pastries, candies and chocolates by enriching their taste and appearance [13]. They can be used to produce “kuli-kuli”, a by-product obtained after extraction of oil from the kernel [14] eaten in the roasted form, fried and sometimes salted or sweetened with sugar, garlic, ginger and honey. Gadani et al. [15] also reported that cashew kernel can be used to prepare cereal bars, cookies, candies and chocolates in flour forms while plant milk extraction from the kernels has been reported by Emelike and Akusu [10]. Cashew kernel meal is a fair source of iron, riboflavin and thiamine [16]. The defatted cashew flour is also reported to be rich in crude protein, crude fiber and ash [11]. The cashew kernel meal is also rich in essential amino acids like lysine and the sulphur containing amino acids, methionine [16]. These attributes of cashew kernel meal could therefore be exploited to upgrade carbohydrate rich bread, since there is dearth of knowledge on the effect of cashew kernel meal on the nutritional of bread.

The successful use of composite flour for bread production has been variously reported in the literature. Olaoye and Onilude [17] reported on the use of composite flour of wheat and bread fruit in bread making. The use of wheat, tiger nut and defatted sesame flour blends was also used for the production of bread [18]. Touzou et al. [19] also reported on the use of wheat and fermented cashew kernel flours for bread production. The authors recommended the use of 20% fermented cashew kernel flour for quality bread production. The present study therefore aims at investigating the nutrient composition and sensory properties of bread substituted with defatted and undefatted cashew kernels at different levels. The substitution of defatted and undefatted cashew kernels will encourage their utilization, add value to cashew, improve the socio-economic status of Nigeria's local cashew farmers and also minimize complete dependence on imported wheat flour thereby saving foreign exchange for the country.

2. MATERIALS AND METHODS

2.1 Source of Materials

The cashew kernel was collected from Uturu, Abia State, Nigeria. Wheat flour (Golden penny) and other ingredients such as sugar, margarine, baker's yeast (*Saccharomyces cerevisiae*), salt and milk were purchased from Mile 1 market, Port Harcourt, Rivers State.

2.2 Preparation of Cashew Kernel

The Cashew kernels were roasted in a hot air oven at 180°C for 40 min, cooled slightly and the testa manually removed. The covering testa were removed by squeezing and then winnowed to obtain cream colour nuts.

2.3 Preparation of Defatted and Undefatted Cashew Kernel Flour

Defatted and undefatted cashew kernel flour was prepared according to the method described by Emelike et al. [20] as shown in Fig. 1. The cream coloured nuts were milled into flour and divided into two portions. One portion of the obtained flour was dried in a hot air oven at 60°C for 12 hours, sieved and left at that stage as the undefatted cashew kernel flour. The second portion was defatted flour after drying in the oven at same temperature and time to reduce the moisture and to condition the fat molecules of the flour. The oil was extracted by hydraulic press (using muslin cloth). The flour produced was sieved, packaged and stored for further analysis.

2.4 Composite Flour Formulation

The composite flours composed of wheat and undefatted/defatted cashew kernel flours were obtained by substituting wheat flour with undefatted or defatted cashew kernel flour in the following ratios 0:100, 10:90, 20:80 and 30:70% cashew kernel/wheat flour respectively. The 100% wheat served as the control as seen in Table 1.

2.5 Recipe for Preparation of Wheat / Cashew Kernel Bread

The recipe used in the bread making process was that described by the standard method of Owuno et al (2012), with some modifications as shown in Table 2.

2.6 Preparation of Cashew Kernel / Wheat Bread

The method reported by Owuno et al. [21] was used with some modifications for production of wheat / cashew kernel bread. All the bread samples contain 10% sugar, 7% margarine, 3% yeast, 0.5% salt, 60% water. The preparation of the bread involved the replacement of part of the strong wheat flour with 10, 20 and 30% cashew kernel flours respectively. Flour, sugar, margarine and salt were mixed together manually for 3-5 min to get a creamy dough. The other ingredients, except water, were then incorporated. All ingredients were mixed in a Kenwood mixer (Model HM430) for 5 minutes until firm dough is obtained. The dough obtained was allowed to proof for 30 minutes, and then a second kneading was done for 10 minutes. The dough was moulded and transferred into an already greased aluminium loaf pan. The pan was covered with transparent film and allowed to proof for 1 hour. The dough was baked at 180°C for about 35 - 45 min in an oven. The bread samples were left at room temperature to cool.

2.7 Proximate Composition

The percentage contents of moisture, ash, crude protein, fat, and crude fibre contents of the bread samples were determined using the AOAC [22] method while carbohydrate content was determined by difference.

2.8 Determination of Amino Acid Composition of Bread

The amino acid composition of protein samples was determined according to the method described by Du et al. [23]. Protein samples were hydrolyzed with 6 M HCl under a nitrogen atmosphere for 24 h at 110°C, 20 μL of hydrolysate were loaded into an L-8800 automatic amino acid analyser (Hitachi). Amino acid compositions were expressed as g/100 g protein.

2.9 Sensory Attributes of Bread

Coded samples of the composite flour bread were presented to a twenty (20) semi-trained panelists comprising members of staff and students from the department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria for sensory evaluation. They were presented with coded samples of bread and water to rinse their mouths after tasting each of the bread samples. The samples were presented in a randomized manner such that the control sample was unidentified. The organoleptic attributes evaluated include: colour, taste, crust, texture and general acceptability using a 9-point hedonic scale as described by Iwe [24]. The degree of likeness was expressed as follows: Like extremely-9, Like very much -8, Like moderately-7, Like slightly-6, Neither like nor dislike-5, Dislike slightly-4, Dislike moderately-3, Dislike very much-2, Dislike extremely-1.

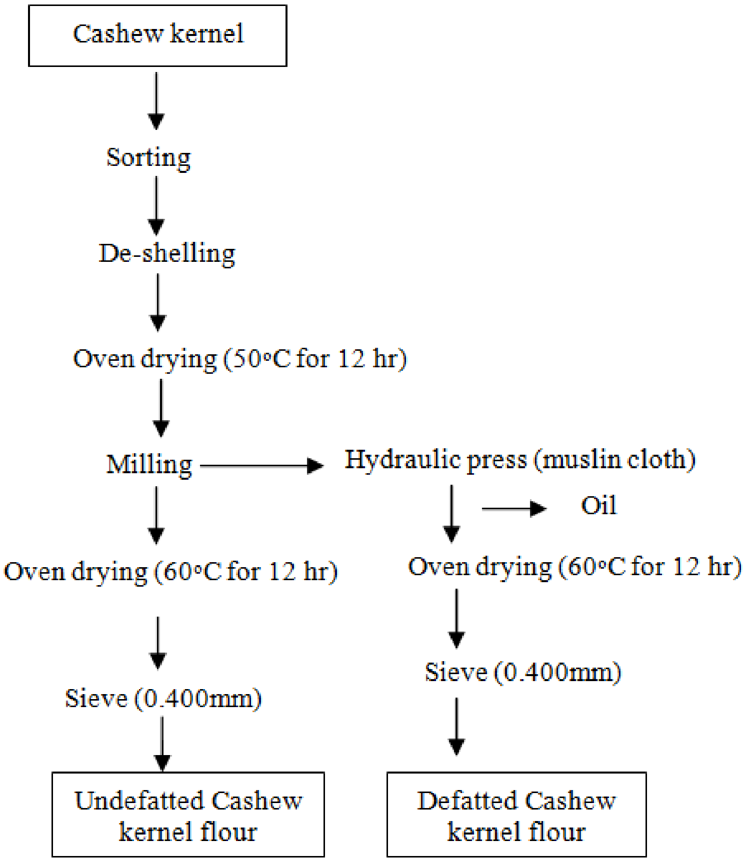

Fig. 1. Processing of undefatted and defatted cashew kernel flour
Source: Emelike et al. [20]

Table 1. Formulation of wheat/cashew kernel flour

Samples	WF:CF (%)	WF:UCF (%)	WF:UCF (%)	WF:UCF (%)	WF:DCF (%)	WF:DCF (%)	WF:DCF (%)
Ratio	100 : 0	90 : 10	80 : 20	70 : 30	90 : 10	80 : 20	70 : 30

Key Notes: WF =Wheat Flour; CF = Cashew Kernel Flour; UCF = Undefatted Cashew Kernel Flour; DCF = Defatted Cashew Kernel Flour

Table 2. Recipe for production of wheat/cashew kernel flour

Code	g/300g WF:CKF	Fat (g)	Salt (g)	Sugar (g)	Water (ml)	Yeast (g)
WF_{100}	100:0	21	1.5	30	170	10
UCF_{10}	90:10	21	1.5	30	170	10
UCF_{20}	80:20	21	1.5	30	170	10
UCF_{30}	70:30	21	1.5	30	170	10
DCF_{10}	90:10	21	1.5	30	170	10
DCF_{20}	80:20	21	1.5	30	170	10
DCF_{30}	70:30	21	1.5	30	170	10

Source: Owuno et al. [21]

2.10 Statistical Analysis

Data collected were subjected to analysis of variance (One-Way ANOVA) using the SPSS (version 21.0) software and results presented as Mean ± SD from duplicate determinations and significant variation between the means were separated using Duncan's Multiple Range Test according to the method described by Wahua [25]. All statistical tests were performed at 5% significance difference.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Composite Bread Produced from Wheat and Cashew Kernel Flours

Proximate composition of the composite bread samples produced from wheat and cashew kernel flour blends is shown in Table 3. Moisture content of the bread samples ranged from 11.05-21.28% with sample DCF_{30} having the lowest and the control sample (WF_{100}) as highest A significant decrease (p<0.05) in the moisture content of the bread samples was observed as substitution with defatted and undefatted cashew kernel flour increased. As cashew kernel flour was partially supplemented with wheat flour, it tended to bind moisture thereby decreasing the moisture content. This decrease was significant (p<0.05) among the breads substituted with defatted cashew kernel flours than for the undefatted samples. The implication is that the shelf life of the breads produced from wheat/defatted cashew kernel flour will be more stable compared to the wheat/undefatted cashew kernel flour. Bread with high moisture content encourages bacterial, yeast and mould growth thereby leading to spoilage [26]. Similar decrease in moisture was also reported by Ojinnaka and Agubolum [27] for cashew nut/wheat based cookies. The results obtained from this study were lower than that reported by Touzou et al. [19] for breads produced from wheat/fermented cashew kernel flour values (28.48-38.21%)

The fat content of the bread samples ranged from 5.27-29.15% with sample DCF_{30} having lower ash content and sample UCF_{30} as highest. A significant (p<0.05) increase in the fat content was observed as substitution of wheat flour with undefatted cashew kernel flour increased. The increased fat content of the undefatted cashew kernel/wheat flour breads compared to the defatted cashew kernel and 100% wheat flour may be attributed to the incorporation of undefatted cashew kernel which is an essential source of oil of about 47.1% [11]. The presence of high fat content in the bread produced from partial substitution of undefatted cashew kernel flour indicates high calorific value and also serves as a lubricating agent that improves the quality of the product. Fat content of the composite bread produced from wheat/defatted cashew kernel flour were significantly (p<0.05) lower that the undefatted and control samples. This is attributed to the defatting process in which fat was removed. Emelike et al. [11] reported that defatting of cashew kernel resulted to a significant decrease in the fat content. Fat plays significant role in the shelf life of food product as fat have the ability of promoting rancidity in foods leading to development of unpleasant and odorous compounds. From this research, it is evident that bread samples substituted with defatted cashew kernel flour significantly lowered the fat content showing its ability of been stored for a longer period than those produced from undefatted cashew kernel and 100% wheat flour.

Protein content of the bread samples ranged from 8.46% in control sample to 34.22% in sample substituted with 30% defatted cashew kernel flour. Increase in substitution of defatted and undefatted cashew kernel flours resulted to a significant (p<0.05) increase in the protein content of the bread samples. This increase is due to the substitution of wheat flour with cashew kernel flour. This confirms earlier reports by Emelikeet al. [11] that undefatted cashew kernel flour has a high protein content of 19.8% which could be utilized in enhancing the protein content of various food products. Protein content of the breads produced from partial substitution of defatted cashew kernel flour were significantly ($p<0.05$) higher than those from undefatted cashew kernel flours. Similarly, this could be due to the defatting process which may have resulted to increase in protein content. This supports the findings of Emelike et al. [28] that the incorporation of defatted seeds will provide a protein rich diet thereby solving the problem of energy-protein malnutrition in areas where protein rich foods are scarce. The protein content of the bread samples were higher when compared with the values (6.04-14.15%) for bread samples fortified with soy-cheese flour. It is also higher than the study of Ndife et al. [29] for breads produced from whole wheat and soya bean flour blends.

Ash content of the bread samples ranged from 1.05% in the control sample to 2.19% in sample substituted with 30% defatted cashew kernel flour. Partial substitution of wheat flour wheat defatted and undefatted cashew kernel flours resulted to a significant ($p<0.05$) increase in the ash content of the bread samples. The increase in ash content on substitution with cashew kernel flour could be due to the high ash of cashew kernels (4.7% and 1.8% for defatted and undefatted cashew kernel flours, respectively) as reported by Emelike et al. [11]. Ash content of bread substituted with 30% defatted cashew kernel flour was significantly ($p<0.05$) than all other samples. This is also due to the defatting process as Emelike et al. [11] reported high ash content in defatted cashew kernel (4.7%) as compared to undefatted flour (1.8%). This study indicates that cashew kernel flour can be used to enrich the lost nutrients in wheat flour during refining. The increase in ash content obtained from this study also shows that the bread substituted with defatted and undefatted cashew kernel flour had presence of minerals needed to speed up metabolic processes and improve growth and development. Similar increase in ash content was also reported by Ojinnaka and Agubolum [27] for cashew nut-wheat based cookies.

Crude fibre content of the bread samples ranged from 1.85-6.20% with the control sample having the least and sample substituted with 30% defatted cashew kernel flour as highest. Similarly, increase in cashew kernel flour substitution led to a significant ($p<0.05$) increase in the crude fibre content of the bread samples. Bread samples substituted with 10% defatted and undefatted cashew kernel flours and control sample were significantly ($p<0.05$) similar. The increase in crude fibre of the bread samples is due to the substitution with soursop flour. Crude fibre content of the breads produced from partial substitution of defatted cashew kernel flour at 20 and 30% levels were significantly ($p<0.05$) higher than those substituted with undefatted cashew kernel flour. This is also due to the defatting process which resulted to increase in crude fibre [28]. This further supports the findings of Emelike et al. [11] that defatted cashew kernel flour can be used to produce baked products of higher fibre content than undefatted flour. This increase in crude fibre content is in concordance with that of Ojinnaka and Agubolum [27] for cashew nut-wheat cookies. The increase in the crude fibre of the bread samples on partial substitution with cashew kernel flour implies that the breads will be of health benefits such as reduced constipation and ease in colon digestion.

There was a significant ($p<0.05$) decrease in the carbohydrate content of the bread samples as substitution with cashew kernel increased with values ranging from 36.37% in sample DCF_{30} to 57.21% in control sample. The increase in proportion of cashew kernel flour brought about a decrease in the carbohydrate content of the bread samples. This decrease was significant ($p<0.05$) for the breads produced from partial substitution of undefatted cashew kernel flour than for defatted flour. Similarly, this is attributed to the defatting process which may have resulted to increase carbohydrate content [11]. Ndife and Zakari [29] reported values (33.35-54.27%) for bread produced from blends of whole wheat and soya bean flours which is within the range obtained from this study.

3.2 Amino Acid Profile (Essential) of Composite Bread Produced from Wheat and Cashew Kernel Flours

The vital amino acid profiles of wheat and undefatted/defatted cashew kernel composite bread is shown in Table 4. The result indicated that leucine and valine were the major abundant essential amino acid, while tryptophan was the least essential amino acid in the composite samples studied. Partial substitution of wheat flour with defatted and undefatted cashew kernel flour resulted to a significant ($p<0.05$) increase in the lysine, phenyl alanine and threonine contents of the breads. The control and partially substituted samples were significantly ($p<0.05$) similar for leucine and isoleucine contents. The bread produced with partial substitution of defatted cashew kernel were significantly ($p<0.05$) higher in lysine (7.00 g/100 g), phenyl alanine (3.99 g/100 g), tryptophan (0.89 g/100 g), valine (4.33 g/100 g) and methionine (1.47 g/100 g) than the wheat/undefatted cashew kernel flour bread. This indicates higher protein quality in the wheat/defatted cashew kernel flour breads than in wheat/undefatted cashew kernel flour breads. The increase in the essential amino acid content of the bread on partial substitution with defatted cashew kernel flour could arise from the defatting process. Amino acids are compounds that combine to make proteins. Amino acids build muscles, transport nutrients in the body, prevent diseases and carry out other functions.

Lysine is an essential amino acid needed for optimal growth and its ability to help form collagen and repair tissue in the body. It also plays a vital role in maintaining energy and building muscle protein and tissue repair, making it important to those with sports injuries [30]. Leucine is an important amino acid in physiological conditions like burn, trauma, sepsis and stimulation of muscle growth [31]. Valine is essential for mental focus, muscle coordination and emotional calm. Isoleucine assists wound healing, hormone production and adjust energy levels and blood sugar. Threonine is necessary for healthy skin and teeth, aids metabolism and combats depression. Methionine is used for treating liver disorders, improving wound healing and treating depression, alcoholism, allergies, and asthma, copper poisoning, radiation side effects, schizophrenia, drug withdrawal and Parkinson's disease [32]. The result generally suggests that the diet of defatted cashew kernel composite bread can supply appreciable amount of essential amino acids needed in the body for development and maintenance.

The histidine composition of the bread samples were below the minimum requirement for standard protein in human protein (<1.9 g/100 g of protein) as reported by Oko et al. [31]. Values from this study were comparable to values (1.07-1.15 g/10 g) obtained for breads fortified with salmon fish powder as reported by Desai et al. [33]. The value of histidine (1.47 g/100 g) in bread substituted with defatted cashew kernel flour however is appreciable being a plant source which can be accessed and stored by rural as well as urban dwellers.

3.3 Amino Acid (Non-essential) of Composite Bread Produced from Wheat and Cashew Kernel Flours

The non essential amino acid profiles of wheat and defatted/undefatted cashew kernel composite bread is shown in Table 5. Glutamic acid and cysteine were the most and least abundant non crucial essential amino acids present in the samples respectively. Similarly, partial substitution of wheat flour with defatted and undefatted cashew kernel flour resulted to a significant ($p<0.05$) increase in the proline, tyrosine, cystine, alanine, glutamic acid, glycine, serine and aspartic acid contents of the bread samples. The control bread and bread sample substituted with undefatted cashew kernel flour were significantly ($p<0.05$) similar for proline, arginine, cystine, alanine, and aspartic acid contents. The bread produced with partial substitution of defatted cashew kernel were significantly ($p<0.05$) higher in proline (3.45 g/100 g), arginine (5.68 g/100 g), tyrosine (3.78 g/100 g), alanine (4.25 g/100 g), glutamic acid (11.81 g/100 g), glycine (3.06 g/100 g), serine (4.00 g/100 g) and aspartic acid (7.32 g/100 g). This also indicates higher protein quality in the wheat/defatted cashew kernel flour breads than in wheat/undefatted cashew kernel flour breads. The process of defatting also resulted to higher non-essential amino acid contents in composite wheat/defatted cashew kernel flour breads than in wheat/undefatted cashew kernel flour breads. The result from this study is comparable with the study of Griffin and Dean [34] on raw, dry-roasted, and skin-on cashew kernels (3.34 g/100 g for glutamic acid and 0.56 g/100 g for cysteine). Glutamine is essential in protein synthesis, lipids, transporting and eliminating ammonia from the body, as well as acid-base balance of bodily fluids. It was noted that arginine was the third most abundant (5.68 g/100 g). Studies have also indicated that arginine plays a role in the expansion of blood vessels in the human body. Arginine is thought to be a contributing factor to reducing the risk for cardiovascular disease. It takes part in giving out hormones, cell division, healing of wound and functioning of the immune system. The arginine in the composite wheat/defatted cashew kernel flour bread may make it necessary for it to be labelled as a heart-healthy food, addition with the monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and phytosterols [35,36,37].

Table 3. Proximate Composition (%) of the composite bread produced from wheat and cashew kernel flours

Samples	Moisture	Fat	Protein	Ash	Fibre	Carbohydrate
WF_{100}	21.28±0.33[a]	10.16±0.07[d]	8.46±0.18[g]	1.05±0.07[e]	1.85±0.07[e]	57.21±0.72[a]
UCF_{10}	19.53±0.99[b]	19.30±0.13[c]	14.64±0.14[f]	1.49±0.13[d]	1.87±0.09[e]	43.19±1.47[d]
UCF_{20}	16.52±0.21[d]	25.03±0.04[b]	16.75±0.19[e]	1.70±0.03[bc]	2.69±0.20[d]	37.33±0.66[f]
UCF_{30}	14.77±0.05[e]	29.15±0.21[a]	19.03±0.56[d]	1.80±0.01[b]	3.01±0.04[c]	32.26±0.35[g]
DCF_{10}	18.31±0.64[b]	5.27±0.08[g]	25.06±0.08[c]	1.62±0.03[cd]	2.07±0.05[e]	47.67±0.88[b]
DCF_{20}	14.68±0.09[e]	8.85±0.27[f]	29.20±0.05[b]	1.82±0.02[b]	3.76±0.13[b]	41.69±0.57[c]
DCF_{30}	11.05±0.86[f]	9.97±0.11[e]	34.22±0.65[a]	2.19±0.08[a]	6.20±0.04[a]	36.37±1.09[e]

Mean values are of triplicate determinations. Mean values within a column with different superscripts are significantly different at (p <0.05); Key; WF_{100} = 100% Wheat flour; UCF_{10} = 90% wheat/10% Undefatted Cashew Kernel Flour blends; UCF_{20}= 80% wheat/20% Undefatted Cashew Kernel Flour; UCF_{30}= 70% wheat/ 30% Undefatted Cashew Kernel Flour; DCF_{10}= 90% wheat / 10% defatted Cashew Kernel Flour blends; DCF_{20}= 80% wheat flour / 20% defatted Cashew Kernel Flour blends; DCF_{30}= 70% wheat flour / 30% defatted Cashew Kernel Flour blends

Table 4. Essential amino acid profile (g/100 g) of the composite bread produced from wheat and cashew kernel flours

Sample	Leucine	Lysine	IsoLeucine	Phenyl Alanine	Trytophan	Valine	Methionine	Histidine	Threonine
WF_{100}	6.60±0.14[a]	3.02±0.03[c]	3.21±0.41[a]	3.19±0.01[c]	0.68±0.03[b]	3.99±0.01[b]	1.07±0.04[b]	1.30±0.00[b]	3.00±0.00[c]
UCF_{10}	6.71±0.01[a]	3.16±0.06[b]	3.60±0.07[a]	3.73±0.04[b]	0.74±0.01[b]	4.09±0.06[b]	1.10±0.07[b]	1.21±0.06[b]	3.39±0.01[a]
DCF_{20}	7.00±0.71[a]	3.79±0.01[a]	3.41±0.03[a]	3.99±0.01[a]	0.89±0.06[a]	4.33±0.03[a]	1.34±0.01[a]	1.47±0.04[a]	3.08±0.01[b]

Mean values are of triplicate determinations. Mean values within a column with the same superscript are not significantly different (p>0.05); Key: WF_{100} = 100% Wheat flour; UCF_{10} = 90% wheat/10% Undefatted Cashew Kernel Flour blends; DCF_{20}= 80% wheat flour / 20% defatted Cashew Kernel Flour blends

Table 5. Non-essential amino acid profile (g/100 g) of composite bread produced from wheat and cashew kernel flours

Sample	Proline	Arginine	Tyrosine	Cystine	Alanine	Glutamic Acid	Glycine	Serine	Aspartic acid
WF_{100}	2.94±0.08[b]	5.16±0.03[b]	2.41±0.13[c]	0.73±0.03[b]	3.34±0.23[b]	10.52±0.04[c]	2.28±0.03[c]	3.30±0.14[c]	6.39±0.16[b]
UCF_{10}	3.05±0.07[b]	4.90±0.01[b]	3.10±0.07[b]	0.85±0.07[b]	3.41±0.06[b]	10.90±0.14[b]	2.42±0.04[b]	3.57±0.03[b]	6.70±0.07[b]
DCF_{20}	3.45±0.03[a]	5.68±0.04[a]	3.78±0.03[a]	1.09±0.01[a]	4.25±0.07[a]	11.81±0.01[a]	3.06±0.01[a]	4.00±0.00[a]	7.32±0.03[a]

Mean values are of triplicate determinations. Mean values within a column with different superscripts are significantly different at (p <0.05); Key: WF_{100} = 100% Wheat flour; UCF_{10} = 90% wheat/10% Undefatted Cashew Kernel Flour blends; DCF_{20}= 80% wheat flour / 20% defatted Cashew Kernel Flour blends

Table 6. Mean sensory scores of composite bread produced from wheat and cashew kernel flours

Samples	Colour	Taste	Crust	Texture	General Acceptability
WF_{100}	$8.30±1.17^{a}$	$7.85±1.42^{a}$	$7.45±0.75^{a}$	$7.70±0.88^{a}$	$8.25±0.93^{a}$
UCF_{10}	$7.80±0.81^{ab}$	$8.10±1.10^{a}$	$7.50±1.04^{a}$	$7.05±1.40^{ab}$	$7.85±1.23^{ab}$
UCF_{20}	$7.65±0.81^{ab}$	$7.55±1.10^{a}$	$6.85±1.04^{ab}$	$7.00±1.40^{ab}$	$7.45±1.23^{b}$
UCF_{30}	$7.40±1.67^{ab}$	$7.80±1.28^{a}$	$6.15±1.00^{b}$	$6.65±1.19^{b}$	$7.80±1.11^{ab}$
DCF_{10}	$7.30±1.59^{b}$	$7.50±1.00^{a}$	$6.80±1.40^{ab}$	$7.20±1.15^{ab}$	$7.40±0.88^{b}$
DCF_{20}	$7.75±1.55^{ab}$	$7.70±1.34^{a}$	$7.30±1.69^{a}$	$7.80±1.03^{a}$	$8.20±0.95^{a}$
DCF_{30}	$7.35±1.27^{ab}$	$7.65±0.99^{a}$	$6.80±1.47^{ab}$	$7.40±1.65^{ab}$	$7.35±1.27^{b}$

Mean values within a column with the same superscript are not significantly different (p>0.05); Key: WF_{100} = 100% Wheat flour; UCF_{10} = 90% wheat/10% Undefatted Cashew Kernel Flour blends; UCF_{20}= 80% wheat/20% Undefatted Cashew Kernel Flour; UCF_{30}= 70% wheat/ 30% Undefatted Cashew Kernel Flour; DCF_{10}= 90% wheat / 10% defatted Cashew Kernel Flour blends; DCF_{20}= 80% wheat flour / 20% defatted Cashew Kernel Flour blends; DCF_{30}= 70% wheat flour / 30% defatted Cashew Kernel Flour blends

3.4 Sensory Properties of Composite Bread Produced from Wheat and Cashew Kernel Flours

Table 6 shows the mean sensory scores of composite bread produced from wheat and cashew kernel flours. Sensory properties are a vital norm for assessing quality in the development of new products and for meeting consumer requirements. The 100% wheat flour bread was mostly preferred for all the sensory attributes. A decrease in the colour of the bread was observed as substitution with undefatted cashew kernel flour increased. Colour of the wheat flour bread substituted with defatted and undefatted cashew kernel flours were significantly (p<0.05) similar. The decrease in the colour of the bread samples upon substitution with cashew kernel could be due to caramelization and milliard reactions as the protein contributed by the cashew kernel flour must have reacted with sugar during the heating process. Similar findings were also reported by Ojinnaka and Agubolum [27] for cashew nut-wheat cookies. Taste of the composite bread samples were significantly (p<0.05) similar. Crust of the bread samples decreased upon substitution with undefatted cashew kernel flour. The bread samples substituted with defatted cashew kernel flour were significantly (p<0.05) with the sample. Bread samples substituted with 10% undefatted and 20% defatted cashew kernel flours compared favourably with the control bread.

Similarly, texture of the bread decreased upon substitution with undefatted cashew kernel flour. The bread samples substituted with defatted cashew kernel flour were better in texture than bread substituted with undefatted flour. This could be attributed to the removal of fat from the flour which may have resulted to increased texture. The baking conditions (temperature and time), state of the bread components such as fibers, protein (gluten), starch (whether damaged or undamaged) and the amount of water absorbed during dough mixing, contributed to final texture of the bread [38]. The decrease in texture of the bread upon substitution with undefatted cashew kernel flour could be due to dilution of gluten content since wheat flour has higher gluten content that cashew kernel flour. Ndife et al. [29] observed that baking properties of flours/organoleptic characteristic of their products were impaired because of dilution of gluten content. Ndife et al. [29] was of the view that use of artificial and organic improvers such as malt flavour, vital wheat gluten and ascorbic acid in dough formulation to improve baking and sensory qualities. General acceptability of the bread samples substituted with 20% cashew kernel flour and control sample were significantly (p<0.05) similar. This result therefore shows that the use of defatted cashew kernel flour will produce better bread which is acceptable to consumers.

4. CONCLUSION

This study showed that wheat flour can be substituted with cashew kernel flour for the production of nutritious and acceptable bread. Partial substitution of wheat flour with cashew kernel flour resulted to a significant increase in protein, ash and crude fibre with a corresponding decrease in moisture and carbohydrate contents. The composite bread substituted with defatted cashew kernel flour contained significantly higher contents of protein, ash and crude fibre than the bread substituted with undefatted cashew kernel flour. Partial substitution of wheat flour with defatted and undefatted cashew kernel flour also resulted to a significant increase in the lysine, phenyl alanine and threonine contents of the breads. The bread produced with partial substitution of defatted cashew kernel was significantly higher in lysine, phenyl alanine, tryptophan, valine and methionine than the wheat/undefatted cashew kernel flour bread. Bread samples substituted with 10% undefatted and 20% defatted cashew kernel flours compared favourably with the control wheat flour bread for taste, crust, colour and general acceptability. Bread produced from partial substitution of wheat flour with defatted cashew kernel was more preferred than those substituted with undefatted cashew kernel for texture. Therefore, bread of adequate nutritional and sensorial qualities can be produced with substitution of 10% undefatted and 20% defatted cashew kernel flours. This could be very valuable in decision making for bakery industries that want to take nutritional advantage of indigenous crops such as cashew nuts to partially or completely substitute wheat flour in baking. This will further reduce the cost of importing this cereal, add value to the cashew nut and may ultimately combat nutritional deficiencies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/64066