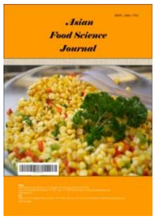

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Quality Evaluation of Composite Bread Produced from Wheat and Fermented Cashew Kernel Flours

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Authors' contributions

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

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ABSTRACT

The aim of this research was to produce bread from composite flours (fermented cashew kernel/wheat), determine their physicochemical and sensory properties. The Hagberg falling number (FN) and rheological properties of wheat flour replaced with fermented cashew kernel flour at 10, 20 30 and 40% were evaluated. The physical properties and proximate composition of loaves were determined. Also sensory characteristics of breads were evaluated. Results showed that the substitution of wheat flour with fermented cashew kernel flour negatively impacted the rheological properties and increased the falling number. Thereby, composite flours obtained from wheat flour substitution with fermented cashew kernel flour at 10 and 20 percent levels were retained for bread production. The weight, volume and specific volume of loaves varied from 208 to 229 g, 433 to 657 cm^3 and 1.80 to 3.20 cm^3/g respectively. The crude protein, fat, crude fibre,

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moisture and ash contents of the composite breads increased significantly (P<0.05) with increase in the proportion of fermented cashew kernel flour. The carbohydrate contents were observed to decrease significantly (P<0.05) from 38.08 to 56.18% with increase in the percentage of the cashew kernel flour incorporation. Sensory evaluation of the bread samples showed that substitution level of 10% fermented cashew kernel flour produced bread that was acceptable to the consumers whereas at 20% were neither like nor dislike. Therefore, it is recommended to use a level of substitution of wheat flour with fermented cashew kernel flour not exceeding 20% for bread production.

Keywords: Fermented cashew kernel; composite flour; dough rheology; bread; quality.

1. INTRODUCTION

In 2015, with 1 600 000 tons, Africa accounted for 49 % of world cashew production. However, Africa processes less than a quarter of its production [1]. Côte d'Ivoire, the world's largest producer of cashew nuts, processes only about 5 to 7 percent of its production [2].

This situation makes the income of producers unstable and dependent on the international market, which is narrow and volatile. To make the situation of high cashew production profitable, it would be necessary to transform cashew nut and consume products based on cashew kernels locally. This would contribute to improving food security in Africa and particularly in Côte d'Ivoire.

Cashew kernel flour using for the bakery and pastry products formulation offers a real potential for cashew kernels valorization because in most African countries, consumption has increased considerably in recent years [3]. This increased trend in bread consumption has been the result of a number of factors including growing population, urbanization and increased wealth in these countries [4]. Cashew kernels flour using for the bakery and pastry products formulation reduce total dependence on imported wheat flour and save foreign exchange for countries of sub-Saharan Africa. Cashew kernels contain essential nutrients such as protein, fat, fibre and appreciable amounts of minerals [5-6]. It using in bread production enhance nutrients of the bread [7].

However, tannins, phytates and oxalates have been considered as antinutritional factors because they interact with vegetable food source constituents such as carbohydrates, proteins and minerals and make them unavailable [8,9,10]. Fermentation was used to reduce these undesirable compounds, enhance phenolic compounds and nutritional qualities of cashew kernel flour [11]. Fermentation also brings change in colour, flavor and texture of the food [12]. This change enhance sensory properties of foods [13].

The aim of this research is therefore to produce bread from composite flours (fermented cashew kernel/wheat), determine their physicochemical and sensory properties.

2. MATERIALS AND METHODS

2.1 Materials

The small Pieces of cashew kernels were purchased from a local supplier based in Yamoussoukro (Côte d'Ivoire). Food ingredients including wheat flour (Type 55), baker's yeast (*Saccharomyces cerevisiae*), salt, and bread improver were purchased from a supermarket in Yamoussoukro (Côte d'Ivoire).

2.2 Methods

2.2.1 Production of fermented cashew kernel flour

The cashew kernels were sorted to get rid of foreign bodies and unhealthy almonds. They were then dried in an oven for 6 hours at 60ºC. The sorted kernels were fermented using the modified method described by Ijarotimi et al. [14]. Almonds (1 kg) are boiled at 100ºC with distilled water for 30 minutes. They were wrapped in plantain leaves to be fermented for 72 hours. The fermented kernels were dried in a ventilated oven at 65ºC for 48 hours. The fermented kernels oil was then extracted according to the modified method proposed by Sze-Tao and Sathe [15]. The oil of the previously treated kernels was extracted twice with n-hexane at a ratio of 1:1 (w / w). The oilcakes were reduced to flour using a hammer mill (YIBU, type 30, China) containing a 150 µm mesh screen. The flour obtained is placed in polyethylene bags and stored at room temperature.

2.2.2 Preparation of composite flour

Four flour blends, each containing wheat flour (WF) and fermented cashew kernel flour (FC) were prepared by mixing flours in the proportions (w/w) of 90:10 (WF10FC), 80:20 (WF20FC), 70:30 (WF30FC) and 60:40 (WF40FC) respectively, using a blender, (PHILIPS, HR2145/90). The control sample was 100% wheat flour.

2.2.3 Bakery value

Hagberg falling number was determined according to International approved methods 56-81.03 [16].

The alveograph (Chopin NG, France) was used to measure characteristics that provided insight in to the fermentation tolerance of the dough as may be exhibited during proofing stage of bread making with a built-in diaphragm pump to supply air for inflating the tested dough piece [17]. Characteristics of interest that were measured included the average resistance to expansion indicated by tenacity (P), extensibility indicated by length (L) of the alveogram curve, stability (P/L), energy input required for the mechanical deformation of the dough (W), inflation required for maximum development (G).

2.2.4 Baking process

In the bread-making process, the ingredients (yeast, salt, water, and flour) were mixed at low speed and the mass was kneaded for 15 min at high speed in a spiral kneader (MAHOT, France). Dough was separated into 250 g pieces and are left standing for 10 minutes. The pieces of dough were put in short baguette form and a second fermentation was carried for 1 hour during at 27ºC in a fermentation chamber. When the baguettes were ready-to-bake, incisions were made with a cutter. Baguettes were baked in an oven (BONGARD) at 235ºC for 30 min with steaming.

2.2.5 Determination of physical properties of bread samples

The volume was determined using the volumetric deplacement method in which the rapeseed displacement was modified by using soybean [18]. Specific volume (SV) was calculated as the ratio of volume to the weight.

2.2.6 Nutritional composition bread samples

The moisture content and fat content of the various breads samples were performed using [19]. The crude protein content was determined by estimating the nitrogen content using the Kjedahl method [20]. Ash and carbohydrates (by difference) were analyzed using the standard method of AOAC [21]. Bread samples were analyzed for fiber content according to the method described in paper [22].

2.2.7 Sensory evaluation

A panel of sixty consumers was recruited from staff and students of Institute National Polytechnique, Félix Houphouët-Boigny (INPHB), Yamoussoukro, Côte d'Ivoire. Criteria for selection were that panelists were regular consumers of bread and were not allergic to any food. Panelists were instructed to evaluate color, taste, texture, aroma and general acceptability. A 9-point hedonic scale with 1 = dislike extremely, 5= neither like nor dislike and 9= like extremely was used. Samples were coded and presented in a random sequence to the panelists as described by Meilgaard et al. [23].

2.3 Statistical Analysis

All analyses were made in triplicates. Statistical analysis was carried out using Statistica 7.1 software. Newman-keuls multiple means comparison test was used to verify differences between the samples. Likelihood level $P < 0.05$, was set as the criterion of significance.

3. RESULTS AND DISCUSSION

3.1 Bakery Value of Composite Blends with Fermented Cashew Kernel Flour

Table 1 presents the Bakery value of wheat and composite flours. Hagberg Falling Number (FN) measures the liquefaction of the gelatinized starch by the α-amylase in the test sample. The FN increased with increased wheat flour replacement. This indicates a low amylase activity of composite flours (fermented cashew kernel / wheat) which could be explained by the low starch content and / or a low presence of α-amylase in fermented cashew kernel meal. The decrease in amylase activity leads to a minimum of liquefaction of the starch and has a very high water retention capacity. As a result, compared with wheat flour, composite flours would have a higher viscosity. The consequence of this high viscosity on composite breads is a small volume because a high viscosity opposes the emergence under the effect of gas (carbon dioxide) [24]. According to Godon et al. [25] an optimal enzymatic activity which corresponds to a FN of between 200 and 300 seconds is essential for obtaining a bread of high volume, homogeneous and appreciable crumb. Moreover, according to known hyperbolic dependence of the FN on the α-amylases activity, values over 400 seconds signify such enzymatic activity is limiting to zero.

3.1.1 Rheological properties of composite flour

The alveograph is an important dough testing instrument use to evaluate the quality of wheat flours for bread making [26].

The tenacity (P) values ranged from 59 to 101 mm with the composite flour 30% and the 20% FC blend offering the least and highest resistance to expansion, respectively (Table 1). The flour is of standard quality for P between 60 and 80 mm, it is of very good quality for P situated between 80 and 100 mm [27]. Taking into account this classification, the composite flours WF10FC and WF20FC could give pastes with acceptable tenacity in bakery.

The maximum inflation (G) ranged from 9.2 to 18.2 cm^3, decreased significantly as WF was replaced with FC. The WF had significantly higher values than other blends. The inflation (G) values are lower than those recommended by Roussel [28] who reports that a bread flour must have a maximum inflation (G) between 19 and 23 cm^3.

The length (L) indicated the extensibility of the dough. The L values ranged from 17 to 67 mm with the 30% FC blend WF having the least and highest extensibility, respectively. The extensibility of composite dough reduction could be explained by the descent in gluten content due to the substitution of WF for FC.

The stability P/L (configuration ratio) ranged from 1.1 to 3.45. The wheat flour and 30% FC had the highest and lowest values, respectively.

The energy (W) ranged from 95 × 10^{-4} J in the case of the 30% blend to 208 × 10^{-4} J in the case of WF. It decline with substitution levels and the WF and offered significantly better energy. According to Liu et al. [29], a flour can be oriented to bread making when its configuration ratio P/L is in the range of 0.8 to 2. The composite flours WF10FC and the limit WF20FC could be adapted to bread making because the ratio P/L are close to 2.

In addition according to Algerian standards [30], composite flours WF10FC and WF20FC are classified as flour of good baking strength because they have their W between 130 and 180 × 10^{-4}joules.

The quantity and quality of gluten proteins are important factors in bakery. In this study, reduced gluten quantity, impacted negatively on the rheological properties of the dough. However, the composite flours WF10FC and WF20FC could be used to produce bread.

3.2 Physical Properties of Bread Samples

The weight, volume and specific volume (Table 2) of the loaves ranged from 208 to 229 g, 433 to 657 cm^3 and 1.80 to 3.20 cm^3/g respectively.

The loaf volume and specific loaf volume was observed to diminish significantly ($P<0.05$) as the proportion of FC increased from 10% to 20%. This could be due to reduction of the quantity of gluten in the dough with addition of composite flour resulting to less retention of carbon dioxide gas and a dense texture [31]. The gluten causes the dough to extend and trap the carbon dioxide produced by yeast during fermentation making the dough to be elastic and retain high volume.

The weight of the loaves increased with increase in FC. This may be as a result of higher water absorption observed in the composite flours samples during the dough kneading process. Furthermore, the reduction of trapped air causes the thickening of the dough and this gives heavy loaves [32].

3.3 Proximate Composition of Bread Samples

The proximate composition of the bread samples is shown in Table 3. The moisture, ash, protein, fat and fibre contents of the bread samples increased significantly ($P<0.05$) with elevated substitution of WF by FC. The moisture content varied from 28.48 to 38.21%, the ash varied from 0.58 to 0.81% while the protein, fat and fibre content ranged from 13.83 to 19.57%, 1.03 to 3.37% and 0.54 to 0.83% respectively. The raise of proteins, fat, ash and fibre contents could be attributed to the FC which is rich in protein, fat, minerals and fibre [33]. These results are consistence with article [34] in incorporation fermented chickpea flour to bread. The increased protein content is an indication that substitution of WF with FC greatly improved the protein and nutritional quality of the bread. Thus the enriched bread would be used to solve malnutrition problems. Cashew kernel is reported to contain all the essential amino acids [35]. High fibre is reported by Schneeman [36] to enhance the gastrointestinal tract health. It helps normal bowel movements thereby reducing constipation problems.

The inclusion of FC to the formulation decreased the carbohydrate contents with regard to the control sample. The low carbohydrate content of composite breads would be importance in reducing the risk of diabetes linked to the low glycemic index of this type of food [37].

Table 1. Hagberg falling number and alveogram of wheat flour and its composite blends with fermented cashew kernel flour

Flour blends	Rheological properties					
	FN (s)	P (mm)	G (cm^3)	L (mm)	P/L	W (10^{-4} J)
FC	ND	ND	ND	ND	ND	ND
WF10FC	315±3	67	16.1	49	1.37	178
WF20FC	333±2	101	15.5	40	2.5	132
WF30FC	351±4	59	9.2	17	3.45	95
WF40FC	364±2	ND	ND	ND	ND	ND
WF	298±3	73	18.2	67	1.1	208

ND: Not determineted; WF: Wheat flour;
WF10FC: 90% wheat flour + 10% fermented cashew kernel flour;
WF20FC: 80%wheat flour + 20% fermented cashew kernel flour;
WF30FC: 70% wheat flour + 30% fermented cashew kernel flour;
WF40FC: 60%wheat flour + 40% fermented cashew kernel flour.

Table 2. Physical properties of bread samples

	Physical properties		
Samples	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
WF20FC	229.23±4.54^c	433.43±3.67^c	1.80±0.09^c
WF10FC	221.85±2.24^b	544.31±5.57^b	2.48±0.05^b
WF	208.02±5.46^a	657.02±6.26^a	3.20±0.03^a

Values in the same column with different superscript are significantly different at P<0.05
Values are means ± standard deviation of duplicate determinations
WF: Wheat flour;
WF10FC: 90% wheat flour + 10% fermented cashew kernel flour;
WF20FC: 80%wheat flour + 20% fermented cashew kernel flour.

Table 3. Proximate composition of bread samples

Parameters	WF20FC	WF10FC	WF
Moisture (%)	38.21±0.51^b	34.25±0.86^a	28.48±0.72^c
Ash (%)	0.81±0.02^b	0.66±0.01^a	0.58±0.06^c
Protéin (%)	19.57±0.58^b	15.45±0.55^a	13.83±0.76^c
Fat (%)	3.37±0.3^a	2.17±0.15^a	1.03±0.47^b
Carbohydrate (%)	38.08±0.49^b	47.45±1.44^a	56.18±1.23^c
Crude fibre (%)	0.83±0.04^b	0.76±0.01^a	0.54±0.02^c
Energy (kcal/100g)	260.83±3.16^a	255.74±3.89^a	289.33±2.03^b

Values in the same row with different superscript are significantly different at P<0.05
Values are means ± standard deviation of duplicate determinations
WF: Wheat flour;
WF10FC 10: 90% wheat flour + 10% fermented cashew kernel flour;
WF20FC: 80%wheat flour + 20% fermented cashew kernel flour.

Table 4. Sensory properties of bread samples

Bread samples	Parameters					
	Colour (Crust)	Colour (crumb)	Texture	Taste	Aroma	Overall acceptance
WF20FC	6.40±0.50[b]	4.63±0.54[c]	6.2±0.69[c]	5.65±0.48[c]	5.25±0.44[c]	5.45±0.51[c]
WF10FC	8.38±0.60[a]	5.72±0.43[b]	7.27±0.46[b]	6.66±0.48[b]	6.27±0.46[b]	7.16±0.7[b]
WF	8.04±0.66[a]	7.5±0.38[a]	8.09±0,62[a]	7.38±0.49[a]	7.38±0.58[a]	8.66±0.57[a]

Values in the same row with different superscript are significantly different at P<0.05
Values are means ± standard deviation of duplicate determinations
WF: Wheat flour;
WF10FC: 90% wheat flour + 10% fermented cashew kernel flour;
WF20FC: 80%wheat flour + 20% fermented cashew kernel flour.

3.4 Sensory Characteristics of Bread Samples

The sensory evaluation scores are presented in Table 4. According to the performed statistical analysis, the substitution of WF significantly affected negatively crumb colour, bread texture, taste, aroma and overall acceptance. The formulation of bread substituted with 20% FC exhibited the lowest colour, texture, taste, aroma and overall acceptance scores among the three variant breads. This result may be attributed to the compactness and hardness of the bread crumb, which resulted from the low specific volume obtained from WF20FC, as mentioned earlier (Table 2). This result may be also attributed to the brown colour of the crumb as well as to the taste and aroma developed by cashew kernel fermentation. The appearance, texture and colour of the bread is an important sensory characteristic for consumers [38]. In literature, there is agreement that sensory attributes in terms of texture and overall acceptance decreased when addition of chickpea flour in bread [39]. Panelists prefer bread with the WF for the crumb colour and bread texture, taste and aroma. However, Panelists judged the WF10FC was acceptable as it received score greater than 5 of overall acceptance. The result obtained from this present study is in good agreement with that reported by Yaou et al [40].

According to these authors, the substitution of wheat flour with fermented cassava flour at a rate between 0 and 20% makes it possible to have bread accepted by the panelists.

4. CONCLUSION

This study has shown that bread of acceptable quality can be produced from composite flours at 10 % level of flour substitution fermented cashew kernel. The bread samples produced have increased nutrients of fibre, protein and ash contents which are all desirable for good health and provide nutritious bread to combat malnutrition problems and enhanced food security. Fermented cashew kernel flour using to produce bread would improve the processing and consumption of cashew kernels locally and consequently, stabilize the income of cashew nut producer. In addition, further research is needed to optimize the processing and formulation factors in FC–wheat bread manufacture to maximize the level of FC incorporation while maintaining improved quality properties and high consumer acceptability, to give a product with maximum potential nutritional.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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