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Production, Biochemical and Sensory Characterization of Cashew Almond Paste Compared to Peanut Paste Produced in Ivory Coast

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Abstract Agriculture occupies an important place in the economy of Ivory Coast, employing more than 70% of the population. In addition to cocoa, cashew is the second crop for which Ivory Coast has ranked first worldwide since 2015, with an estimated production of 702,510 Tons. The local processing rate increased from 1% (4,157 Tons) in 2008 to 9% (66,800 Tons) in 2018. This processing essentially consists of shelling cashew nuts to extract the kernels. Therefore, the objective of this work is to contribute to the processing of cashew kernels by producing cashew almond paste with a good nutritional value. The biochemical and sensory characteristics evaluated are compared to those of the commercial peanut paste. The results showed that the cashew almond paste is rich in protein, lipids and carbohydrates. The lipids of cashew almond paste (50.80 g/100g ± 0.41) are higher than those of the commercial peanut paste (40 g/100g ± 0.5). The proteins (18.90 g/100g ± 0.20) and carbohydrates (26.33 g/100g ± 0.25) of the cashew almond paste are almost identical to the proteins (25.1 g/100g ± 0.3) and carbohydrates (24.7±0.45) of the commercial peanut paste. This cashew almond paste is rich in minerals (3.41 g/100g) with in particular potassium (570.84 mg/100g ± 5.15), sodium (268.28 mg/100g ± 2.1) magnesium (242.66 mg/100g ± 2.5) and calcium (41.96 mg/100g ± 0.43). The sensory evaluation shows that the cashew almond paste has a good smell and a substantially identical taste to the taste of the commercial peanut paste.

Keywords: *cashew nut, paste, nutritional value, sensory evaluation*

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1. Introduction

The economy of Ivory Coast is based on agriculture, with cash crops such as coffee, cocoa, rubber, and oil palm in forest areas, cotton, and more recently cashews in savanna areas.

Cashew nuts were introduced to Côte d'Ivoire in the 1960 by the Technical Assistance Society for Agricultural Modernization (SATMACI) and the Forest Development Society (SODEFOR), as a part of programs to protect the environment and combat erosion and deforestation [1]. It was in the 1970 that producers became aware of the economic value of cashew nuts. The first commercial cashew plantations, with an expansion in acreage, were established in 1972 [2].

Despite its recent arrival in Ivorian agriculture, Côte d'Ivoire's cashew production in 2015 accounted for 24.2% of global production. The quantity exported was 665,000 Tons, or 94.70% of production, sold mainly to India, Vietnam, and Brazil, which have processing industries with high demand for cashew nuts. The rest of the production is locally processed. In 2017, production was 711,236 tons of cashew nuts out of a forecast of 715,000 tons [3]. This level of production represents half of West Africa's production and 22% of global production in 2017, enabling Ivory Coast to maintain its position as the world's leading cashew nut producer, a position it has held since 2015 [4].

Domestic production has more than doubled in a decade. The local processing rate rose from 1% (4,157 Tons) in 2008 to 9% (66,800 Tons) in 2018 [3]. This processing mainly consists of shelling cashew nuts to extract the kernels. This activity adds value of 100 CFA Francs/kg [5].

In addition to the income they generate, cashew nuts (shelled cashews) have an excellent nutritional value, exceeding that of soybeans. They are highly nutritious and are a good source of protein (20 to 24%), fat (40 to 57 g/100 g), including linoleic and oleic acids (20% and 60% of the fat), and significant amounts of micronutrients [6]. Given their nutritional value, cashew nuts are high value-added products. They are also used in diets alongside rice, yams, and other foods. In addition to being consumed as food, they are processed into flour for potential use in agro-industries [7]. In addition, [8] it was shown that consuming cashew nuts reduces the risk of cardiovascular disease, type 2 diabetes, and colon cancer [8].

In view of these advantages and the exponential growth in Ivory Coast cashew nut production, action must be taken to move Ivory Coast away from its position as a supplier of raw nuts and position it as a supplier of finished products. In light of this situation, the emergence of new products derived from cashew processing is necessary for Ivory Coast, hence the production of cashew nut paste.

The overall objective of this study is to produce and characterize the physicochemical and sensory properties of cashew nut paste while comparing it to commercial peanut paste.

2. Materials and Methods

2.1. Material

The plant material consists of cashew nuts harvested in the northwest of Ivory Coast in the Bafing region, specifically in Touba, and commercial peanut paste purchased in the same city.

2.2. Methods

2.2.1. Method of Production of Cashew Almond Paste

Cashew almond paste was produced at the Ivorian Tropical Technology Company (I2T) according to the process shown in Figure 1. The nuts were sorted and separated according to their shapes using a sizer. The nuts were then weighed. A quantity of 10 kg of nuts was boiled in a steam cooker for 45 minutes. After cooking, the nuts were spread out in the open air to be dried. Once dried, the nuts were shelled. Shelling was done using a BUDDHI electric sheller model NO: M-171. At the end of shelling, the almonds were separated from the shells. To separate the almonds from the shells, the use of coconut oil is necessary to avoid the effect of the cashew balsam contained in the shells of the cashew nuts. The weight of the almonds after shelling was 2.65 kg. The almonds were then oven-dried for seven (7) hours at a temperature of 70 °C. At the end of the oven-drying, the almonds were then weighed. 2.6 kg of dry almonds containing their skin were obtained. The almonds are peeled using small table knives. This gives almonds that are ready for roasting. After roasting, the almonds color was changed and became red. The almonds are then ground in a stainless steel grinder. This is how the cashew almond paste was obtained (Figure 2).

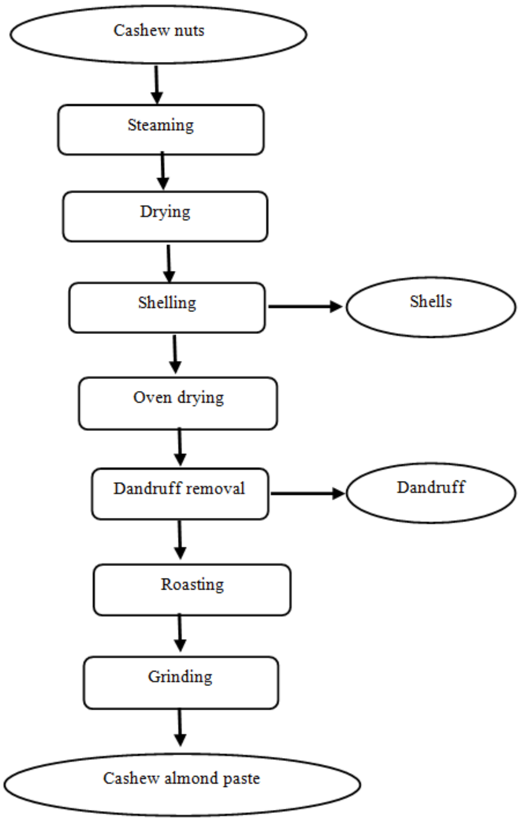

Figure 1. Cashew almond paste production diagram

Figure 2. Photograph of cashew almond paste

2.2.2. Methods for Biochemical Characterization of Dough

2.2.2.1. Determination of Protein Content

Protein measurement was performed using the Kjeldahl method [9].

2.2.2.2. Determination of Lipid Content

Total lipids were extracted using the Soxhlet method [9].

2.2.2.3. Determination of Ash Content

The ash content was determined according to method [10].

2.2.2.4. Determination of Mineral Elements

Minerals were determined using an atomic absorption spectrophotometer according to method [11].

2.2.2.5. Determination of Titratable Acidity

Total titratable acidity was determined according to the method [9].

2.2.2.6. Determination of Moisture Content

Moisture content was determined using the [12] method. A test sample of the paste was dried in a desiccator until it reached a constant mass.

2.2.2.7. Determination of the Iodine Index

The iodine index is defined as the number of grams of iodine fixed per 100 g of fat. It was determined using the Wijs method [13]. According to the experimental protocol used, an excess of iodine chloride, called Wijs' reagent, is added to the fat solution in chloroform. After a few minutes of reaction, potassium iodide and distilled water are added. The iodine released is titrated with a titrated sodium thiosulfate solution (0.1 N) in the presence of starch paste.

2.2.2.8. Determination of Acid Index

The acid value is the number of mg of KOH required to neutralize the free fatty acids contained in 1 g of oil. It was determined using the standard method ISO 660: 1996 [14].

2.2.3. Sensory Analysis

The purpose of this analysis was to determine the organoleptic characteristics and preference level of the pastes. Two tests were carried out: a descriptive and quantitative test followed by a preference test involving the ranking of different paste samples, namely cashew nut paste and commercial peanut paste.

2.2.3.1. Descriptive and Quantitative Test

The methodology used for the descriptive and quantitative test is that presented in the AFNOR V-09-A standard, which aims to identify and quantify appropriate descriptors for sensory evaluation. Fifteen students from the Biochemistry and Food Science teaching and research unit at Félix Houphouët-Boigny University were selected as tasters. These students were familiar with the product samples and had no aversion to them. The test was conducted in two phases. The first phase consisted of training the subjects in the descriptors and the scale describing the product, and practicing using the perceived evaluation scale for each of the descriptors. The second phase was the evaluation phase, which consisted of representing a 150 mm linear scale with the left end representing the lowest intensity for each descriptor evaluated and the right end representing the highest intensity. The pasta samples, coded with randomly generated numbers, were individually presented in random order to each taster. For each product, the taster was asked to mark the intensity perceived for the descriptor evaluated on the proposed scale. The results were presented in a spider chart representing the sensory profiles of the different pastas tested.

2.2.3.2. Preference Test by Ranking

The preference test was conducted with a panel of 50 untrained tasters, consisting of students from Félix Houphouët-Boigny University. The pasta was served in three spoons, each placed on a plate that had been coded with three randomly generated numbers. The samples were simultaneously presented to each taster. The tasters were asked to rank the products in order of preference using a form.

2.2.4. Statistical Analysis

All tests were performed in triplicate and the results obtained were entered into an Excel spreadsheet. These data were then transferred to STATISTICA software (version 7.1) for statistical processing. Using this software, a one-way analysis of variance (ANOVA) was performed on all the data to determine whether there were any significant differences between the calculated means. To identify significant differences, the Newman-Keuls test was used at a 5% threshold.

3. Results

Table 1 and Table 2 present the results of the physicochemical analysis of cashew nut paste. This paste is rich in lipids (50.80%), sodium (268.28 mg/100 g), magnesium (242.66 mg/100 g), and potassium (570.84 mg/100 g). . It also contains protein (18.90 g/100 g). It has an iodine index of 24.13, an acid index of 5.57, and a moisture content of 1.48%.

3.1. Comparison of the Nutritional Composition of Cashew Almond Paste and Commercial Peanut Paste

Table 3 and Table 4 compares the biochemical compositions of cashew nut paste and commercial peanut butter. Cashew nut paste is higher in fat (50.80 g/100 g) than peanut butter (40 g/100 g). The protein content of cashew nut paste (18.90 g/100 g) is lower than that of peanut paste (25.1 g/100 g). The sugar content of peanut butter (24.7 g/100 g) is similar to that of cashew nut butter (26.33 g/100 g). The copper content of peanut butter is 0.6 mg/100 g. This value is lower than that of cashew nut butter (1.28 mg/100 g).

3.2. Comparison of Pasta Sensory Profiles

Figure 3 and Figure 4 represent the organoleptic properties of cashew almond paste and commercial peanut paste. The organoleptic properties evaluated were: melting, smoothness, malleability, dark color, and flavor. The sensory profile shows that both pastes are unsalted. Cashew almond paste and peanut paste have virtually the same sweet flavor.

Table 1. Biochemical composition of cashew almond paste

Components	Quantity (g/100 g)
Lipids	50.80 ± 0.41
Proteins	18.90 ± 0.20
Moisture	1.48 ± 0.01
Ash	3.41 ± 0.04
Carbohydrates	26.33 ± 0.25
Titratable acidity	3.75 ± 0.03
Iodine index	24.13 ± 0.21
Acid index	5.57 ± 0.05

Table 2. Mineral composition of cashew almond paste

Components	Quantity (mg/100 g)
Potassium	570.84 ± 5.15
Copper	1.28 ± 0.01
Calcium	41.96 ± 0.43
Magnesium	242.66 ± 2.5
Sodium	268.28 ± 2.1
Iron	4.66 ±0.06
Zinc	5.47 ± 0.04

Table 3. Macronutrient composition of cashew almond paste and commercial peanut paste

Nutrients	cashew almond paste (g/100g)	commercial peanut paste (g/100g)
Lipids	50.80 ± 0.41^{a}	40 ± 0.50^{b}
Proteins	18.90 ± 0.20^{c}	25.10 ± 0.30^{c}
Carbohydrates	26.33 ± 0.25^{d}	24.70 ± 0.45^{d}

Means (± standard deviation, n = 3) with different lower case letters in the same row/column are different at the 5% threshold according to Tukey's test.

Table 4. Mineral composition of cashew almond paste and commercial peanut paste

Nutrients	cashew almond paste (mg/100g)	commercial peanut paste (mg/100g)
Potassium	570.84 ± 5.15^{e}	673 ± 7.21^{e}
Copper	1.28 ± 0.01^{f}	0.6 ± 0.05^{f}
Calcium	41.96 ± 0.43^{ab}	47.70 ± 0.5^{ab}
Magnesium	242.66 ± 2.5^{a}	169 ± 1.80^{c}
Sodium	268.28 ± 2.1^{ac}	472 ± 4.82^{ad}
Iron	4.66 ±0.06^{de}	2 ± 0.04^{ce}
Zinc	5.47 ± 0.04^{ef}	3 ± 0.06^{ca}

Means (± standard deviation, n = 3) with different lower case letters in the same row/column are different at the 5% threshold according to Tukey's test.

The histograms in Figure 4 show the result of the preference test performed.

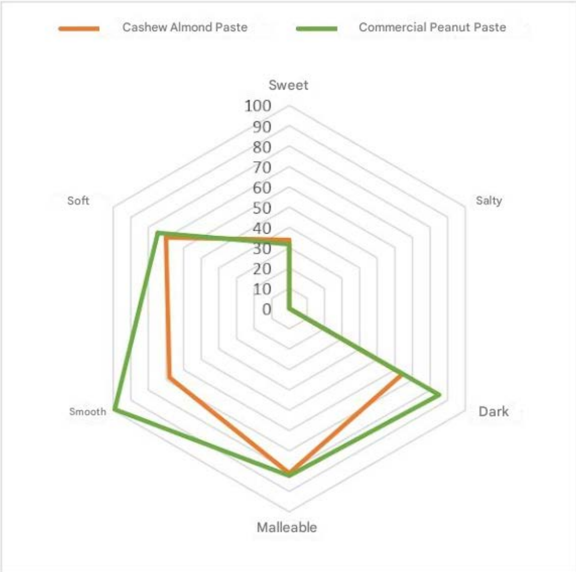

Figure 3. Sensory profiles of cashew almond paste and commercial peanut paste

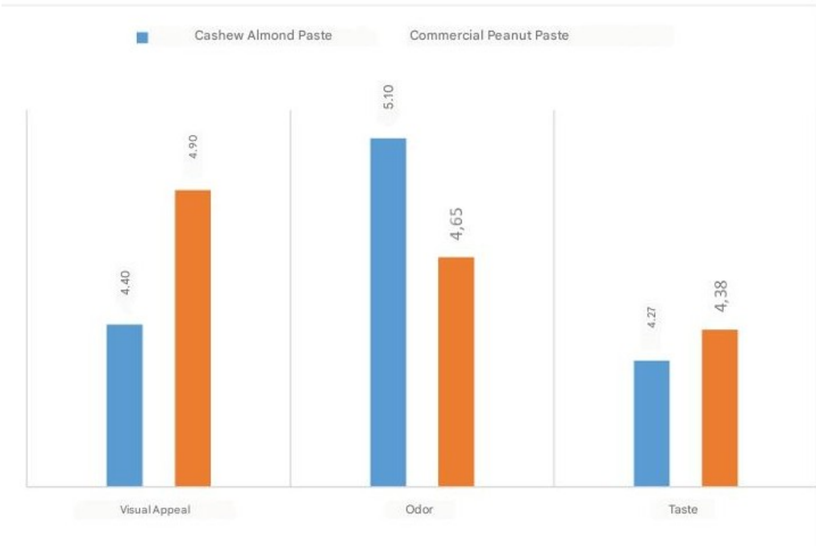

Figure 4. Histograms of preferences for cashew almond paste and commercial peanut paste

4. Discussion

The results of this study reveal that the cashew almond paste contains mineral and organic substances in quite appreciable quantities. The mineral content of cashew almond paste is 3.41%. This recorded quantity is higher than that of cereals (1.30%) which constitute the staple food of Ivorians, particularly rural populations in the north of Ivory Coast, but significantly lower than those of cotton seed (4.4%), sunflower seed (3.5%) and sesame seed (5%) [15]. This low mineral content would probably be due to the nature of cashew nuts, considered as oilseeds in the form of achene with a high level of lipids and proteins [15].

Regarding the protein content of the paste (18.90%), this is close to the value of cashew nut protein in the literature. The obtained results show that the cashew nut paste analyzed contains higher amounts of protein than those of cereals, particularly corn, sorghum, and millet, whose protein content varies from 9.5 to 11% [16].

This analysis shows that cashew almond paste could be a potential food for combating protein-energy malnutrition.

The obtained fat content in the dough (50.80%) is close to the values of that previously detected [17] and of certain oilseeds such as sunflower seed (43%), sesame seed (50%) [18].

The results of this study reveal that the analyzed minerals (calcium, magnesium, sodium, potassium, copper, iron) of the studied cashew almond paste have variable contents. It contains quite significant quantities of minerals in particular, potassium (570.84 mg/100 g), magnesium (242.66 mg/100 g), sodium (268.28 mg/100 g) and to a lesser extent calcium (41.96 mg/100 g). These minerals play a vital role in physiological functions. It has been shown that calcium and potassium play an important role in the regulation of heart rate, thus limiting the risk of strokes [19]. Calcium is one of the essential minerals in the formation and consolidation of bones and teeth [16]. The copper content (heavy metal) of the cashew almond paste analyzed is below the toxicity threshold set by the WHO [20].

Regarding magnesium, cashew almond paste has a content of 240 mg/100g. This relatively high value is an advantage for this paste. Indeed, magnesium is a cofactor participating in more than 300 enzymatic reactions, which makes it an essential element for the synthesis of carbohydrates, lipids, nucleic acids and proteins, as well as for other actions in different organs of the cardiovascular and neuromuscular systems [21]. Thus, the cashew almond paste could be used to cover the magnesium needs of adults, which are 5 to 7 mg/kg/day.

It follows from this analysis that the cashew nut almond paste has nutritional interest in view of its content of various organic and mineral constituents. Therefore, it can be recommended as a food in general and also in certain specific diets [22].

Regarding the physicochemical parameters, the iodine index of the paste (24.13) is lower than that of the literature which is 81.20. This may be due to a very thorough roasting which acted on the double bonds of the chain of fatty acids constituting the cashew almond paste.

The iodine value of the cashew almond paste fat is greater than zero (24.13 g of I2/100 g). This value reflects the presence of unsaturated fatty acids. In fact, in the analysis of fat, the iodine value is the most useful constant, because it is in relation to the values of this value that the important division of vegetable oils into drying, semi-drying and non-drying oils is based. In fact, the iodine value tells us about the degree of instauration of the fatty acids contained in a given oil. It is directly related to the degree of oxidation of an oil. Thus, the more unsaturated an oil is, the higher its iodine value [13] and this value could be used to evaluate the ease with which the oil becomes rancid, given that the more instauration it contains, the more sensitive it will be to oxygen. The iodine value of sunflower oil (110-143 g of I2/100 g) rich in unsaturated fatty acids is relatively higher than that of the roasted kernels of the cashew nuts studied. Thus, the cashew nut oil contained in the paste could be considered a good quality vegetable oil for food. Indeed, it has been shown that mono- and polyunsaturated fatty acids in fats are beneficial for health.

In addition, the acid index is also an important parameter in the characterization of fats, particularly edible oils. It allows the free acid content of an oil to be assessed, thus providing information on its quality. The relatively low acid index of the oil (5.57 mg KOH/g) confirms the stability of cashew nut oil to oxidation at room temperature. This oil will therefore be more resistant to rancidity [23]. It should be noted that the acid index of cashew nuts is approximately identical to that of olive (5.3 mg KOH/g) and soybean (6 mg KOH/g) oils, recognized as good quality oils and recommended for human consumption [24].

The results of the sensory analysis reveal that the cashew almond paste is less dark than the commercial peanut paste. This could be due to the fact that the cashew almonds were roasted in a pot unlike peanut seeds roasted using an even more suitable oven mechanism. The malleability of the cashew paste is approximately equal to that of the commercial peanut paste. This could be explained by the fact that both peanut and cashew are oilseeds. Peanut paste has a sweet taste approximately similar to cashew almond paste.

5. Conclusion

The present work shows that the produced cashew almond paste has nutritional value given its chemical composition. It is a good source of organic substances such as lipids, proteins and minerals such as magnesium, copper, potassium, etc. The sensory qualities of the evaluated cashew almond paste are substantially equal to those of the peanut paste. The cashew almond paste could be used as a spread and in addition it could also be used in preparations in the same way as a peanut paste traditionally produced in Ivory Coast. In addition, the cashew almond paste could play an important role in regulating heart rate, thus limiting the risk of cardiovascular accidents. Given the large production of cashew almonds in Ivory Coast, the consumption of the cashew almond paste could provide added value while fighting malnutrition in rural areas.

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