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Influence of Processing Methods on the Tannin Content and Quality Characteristics of Cashew By-Products

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Abstract

Cashew (*Anacardium occidentale L.*) kernel was processed using sand and gari roasting methods to study the chemical compositions, tannin reduction and sensory properties of the kernel in comparism with the reference sample (imported cashew kernel). Oil was extracted from part of the gari roasted sample. Soybean flour was processed, the oil equally extracted and the physiochemical characteristics of the oils studied. From the result, there was no significant difference (p>0.05) in all the chemical compositions studied irrespective the processing method from the reference sample. Tannic acid of the kernel was observed to reduce to 0.1% in the gari roasted kernel and showed no significant difference to the imported kernel (0.1%). However, sand roasted cashew kernel had the highest tannic acid value of 0.2%. Sensory attributes of colour, flavour and general acceptability of the gari roasted kernel (4.50, 4.70 and 4.50, respectively) compared well with the imported kernel. All the sensory attributes of the sand roasted kernel was significantly lower compared to the reference sample. The physiochemical characteristics of the golden yellow colour cashew kernel oil showed that the oil is high in acid value (1.57mg KOH/g), saponification value (218.6mg KOH/g), specific gravity at 25^{o}C of water (0.91%) and iodine value of 144.021gl$_2$/100gm. This is an indication that gari roasting method is the best processing method in terms of the tannin reduction and the sensory characteristics.

Keywords: Processing methods, Tannin content, Chemical compositions, Sensory properties, Physiochemical characteristics, Cashew kernel, Cashew oil.

Contents

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1. Introduction

Fruits such as Cashew (*Anacardium occidentale* L.) are rich in tannin and polyphenols [1] which gives it antioxidant properties and makes it an effective remedy against chronic dysentery in Cuba and Brazil [2, 3]. Cashew trees are all over Nigeria and second to almond in commercial importance [4]. Cashew is like a table starting from Lagos to Kogi, Kwara, Nasarawa, Plateau down to Enugu, Abia and Cross River States [5]. Large scale cultivation started in 1953 [6]. The total estimated output of raw cashew nut in Nigeria is 50,000 tonnes while about 5,000 – 7,000 tonnes are produced annually mainly as an export crop [7] as a result of lack of adequate processing techniques to reduce its tannin content. Cashew contains 0.64mg/100g of tannin in the case of total tannins but in condensed tannins, it is 0.18mg/100g. The main product from cashew tree is cashew kernel (true fruit), which is rich in fat and protein. Aroyeun [8] reported 18.60% and 39.90% of protein in cashew kernel and cashew kernel meal, respectively. Undefatted and defatted cashew kernels had protein values of 19.8% and 34.0%, respectively as reported by Emelike, et al. [9]. In these reports, the protein values of cashew increased after processing which leads to the removal of tannin from the resultant products.

Tannin (*Schinopsis spp.*) is water soluble polyphenolic compounds ranging in molecular weight from 500 – 3000 Daltons that have the ability to precipitate proteins. Butter [10] reviewed that tannin is any phenolic compound of sufficiently high molecular weight containing sufficient hydroxyls and carboxyls to form effectively strong complexes with protein and other macro-molecules under the particular environmental conditions being studied. Apart from the ability to precipitate protein, tannin also decreases digestibility and palatability [11]. According to FAO [12] tannin binds protein; fights digestion by inhibiting key enzymes involved in digestion and can also render iron and vitamin B_{12} unavailable. Other nutritional effects which have been attributed to tannin include damage to the intestinal tract, toxicity of tannin absorbed from the gut, interference with the absorption of iron and possible carcinogenic effect [10]. If tannin is served in excess or food high in tannin is ingested over a long period, the liver could be damaged. It has been reported that tannins have liver and kidney toxicity, some evidence has shown human oesophageal cancer on long consumption of beverage containing tannins. Scalbert [13] reviewed that tannic acids inhibits the absorption of glucose and methionine in the mouse intestine.

Recently, many researches have been carried out to reduce the annual wastage of cashew and its by-products in Nigeria. Compositional studies and physicochemical characteristics of cashew nut flour [7] nutritional enrichment of biscuits with cashew kernel meal [8] roasted and defatted cashew nut flour [14] cassava flour biscuit supplemented with cashew apple powder [15] effect of packaging materials, storage time and temperature on the colour and sensory characteristics of cashew apple juice [16] and wheat flour/cashew apple residue in cookie preparation [17] were all carried out for this purpose. This research work is therefore embarked to analyse the influence of processing methods such as sand roasting and gari roasting on the tannin content of cashew kernel. Analyse the quality characteristics which included the chemical and sensory compositions and compare it with the imported cashew kernel. Finally, mill part of the gari roasted sample, extract the oil and compare the physiochemical properties of the oil with soybean oil.

2. Materials and Methods

2.1. Materials

Mature, ripe cashew (*Anacardium occidentale L.*) apples, red and yellow varieties were harvested in an orchard at Uturu, Abia State, Nigeria. The nuts were detached from the apples and a total of twenty kilograms of cashew nuts were used for the analysis.

Soybean (*Gycine max*) was purchased from Mile 3 market in Port Harcourt, Rivers State, Nigeria. Five hundred grams of soybean was used. All chemicals used were of analytical grade.

2.2. Preparation of Cashew Kernel

Cashew kernel was processed using the method earlier reported by Emelike, et al. [9] for defatted and undefatted cashew kernel flour with some modifications. The nuts were sun dried for three days to prevent deterioration during storage. They were conditioned (mild spraying with water in a sieve) to increase flexibility and prevent scorching. The conditioned cashew nuts were divided into portions of 500g each for easy processing, placed in a metal basket and immersed in a pot of hot vegetable oil (Corn oil) for 1 min to make the shell brittle for shelling. The nuts were stirred at intervals of 10 sec to prevent burning while in the hot oil. The Cashew Nut Shell Liquid (CNSL) of the nut extracted into the pot as the volume of the oil increases in the pot. The cashew nuts were poured out after 1 min and allowed to cool for about 1h. The brittle shell was broken with wooden mallet and the kernel extracted. The kernels were pulled together which yielded 13.14kg.

2.3. Processing Methods of the Cashew Kernel and the Extraction of Cashew Kernel Oil

The cashew kernel was divided into two equal samples of 6.57kg each. One sample was roasted in gari for 30 min, cooled for a few min. The testa removed manually, sorted and packaged to get the gari roasted sample (GRS). The other sample was roasted in sand for 30 min, cooled slightly and the testa removed manually using tooth pick. It was packaged after the removal of testa to get the sand roasted sample (SRS). Gari roasted sample was divided into two, one part was milled, the oil was screw pressed from the sample and used in comparison with soybean oil to study the physiochemical properties of the oils.

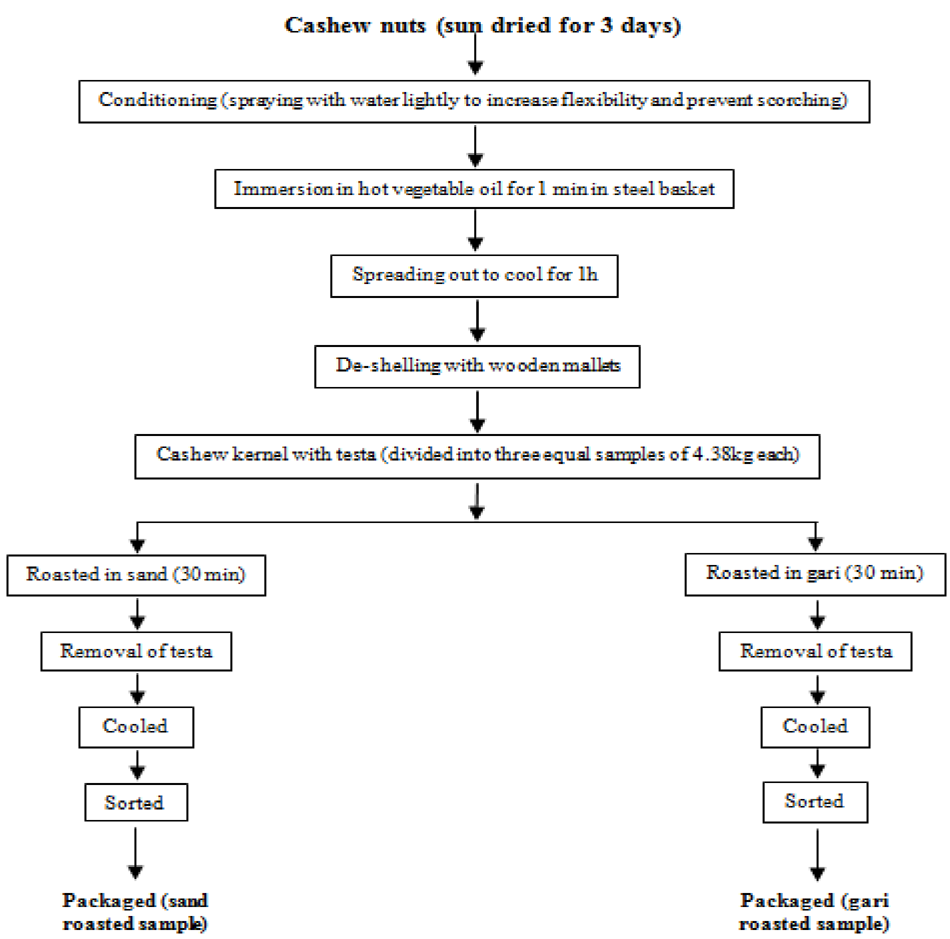

Figure-1. Flow chart for various processing methods of cashew kernel.
Source: Author's Computation.

2.4. Extraction of Soybean Oil

Soybean oil was extracted using the traditional method outlined by Aremu, et al. [18] for oilseeds with some modifications. The bean was crushed after washing and milled into paste by using Philips HR2000 blender. Water was added to the paste; the mixture was stirred and manually kneaded by hand until the oil separates to the top and sides of the utensils being used for the kneading. It was suspended in boiling water and boiled for 30 min with liberated oil floating on the surface. Further quantities of water were added after boiling to replace the evaporated water and to facilitate the floatation of the oil to the surface. The oil was carefully scooped from the surface of the water and reboiled for 5 min. It was allowed to cool in room temperature (28±2^{o}C), filtered and stored in the bottle for analysis.

2.5. Physiochemical Analysis of Cashew Kernel, Cashew Kernel oil and Soybean Oil

Moisture content of the kernel and the oils, protein, fat, crude fibre, total ash and tannin of cashew kernel were determined using the Latimer [19] method. Free fatty acid, peroxide value, saponification value, unsaponification matter, iodine value, refractive index and specific gravity were also carried out by the method of Latimer [19]. Clegg Anthrone method [20] was used in the determination of the available carbohydrate.

2.6. Sensory Evaluation

Sensory analysis of the differently processed cashew kernel was carried out using a twenty member panelist consisting of staff and students of Food Science and Technology Department, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Criteria for selection were that panelist were 16 years of age, regular consumers of cashew kernel and were neither sick nor allergic to any nut/kernel. Panelists were trained in the use of sensory evaluation procedures. At each session, samples were served on white disposable plates, properly coded with 5-digit random numbers to prevent bias. The sensory qualities evaluated were: colour, taste, flavour, attractiveness and general acceptability. A descriptive five point hedonic scale as described by Iwe [21] was used, 1 and 5 representing the least score (dislike extremely) and the highest score (like extremely), respectively. Necessary precautions were taken to prevent carryover flavour during the tasting by ensuring that panelists rinsed their mouth with water after each session of sensory evaluation.

2.7. Statistical Analysis

Results were expressed as mean values and standard deviation of five (5) determinations. Data were analysed using a one-way Analysis of Variance (ANOVA) using Statistical Packaging for Social Science (SPSS) version 20.0 software 2011 to test the level of significance ($p<0.05$). Duncan New Multiple Range Test was used to separate the means where significant differences existed.

3. Results and Discussions

3.1. Chemical Compositions

Chemical properties of locally processed cashew kernel such as sand roasted sample (SRS) and gari roasted sample (GRS) including the imported cashew kernel are shown in Table 1. From the result, SRS and GRS had protein content of 20.7 and 20.5%, respectively while the imported sample recorded protein value of 21.0%, which are not significantly different (p>0.05). This observation is in agreement with the report of Emelike, et al. [9] for the protein value of undefatted cashew kernel flour (19.8%) while that of the defatted cashew kernel flour (34.0%) was relatively high compared to the result in this study. This is because during the process of defatting, the anti-nutrient (tannin) responsible for protein binding capacity is removed thereby making protein more assessable. The fat content of SRS and GRS ranged from 50.0 – 51.0%, respectively and showed no significant difference. Fat value for the imported sample (48.4%) was significantly low compared to the locally processed samples. Fat values reported in this study for both the imported and locally processed cashew kernel are in agreement with those of undefatted cashew kernel, melon seed, groundnut, non-defatted flour of brebra seed, undefatted cashew kernel flour with the values of 53.3%, 55.2%, 48.5% and 47.1%, respectively [9, 22]. This is an indication that cashew kernel is an oil seed which can be extracted and used as an economically important material for the production of soaps and oily creams. There was no significant difference (p>0.05) between the ash content of locally processed cashew kernel with the imported sample. Pomeranz and Clifton [23] recommended that ash contents of nuts/kernels, seed and tubers should fall within the ranges of 1.5 – 2.2% to be suitable for animal feeds. Thus, ash value for sand and gari roasted cashew kernel including the imported kernel (5.2, 5.4 and 5.0, respectively) does not fit into this purpose. The sand and gari roasted kernel including the imported cashew kernel had crude fibre values of 1.4, 1.5 and 1.2 %, respectively and shown no significant difference. These values agreed with those reported by Aremu, et al. [7]; Vincent, et al. [14]; Emelike, et al. [9] for cashew nut flour, roasted/defatted cashew nut flour and sand roasted/defatted cashew kernel flour (1.2, 1.42 and1.2%), respectively. Moisture mean values of the three studied samples ranged from 4.7 – 5.0% and showed no significant difference. These values agreed with those reported by Berhanu and Amare [22] for non-defatted flour of brebra seed (4.24%). There was equally no significant difference between the sand and gari roasted cashew kernel to the imported sample with the values of 19.5, 20.0 and 20.1%, respectively. Among the two processing methods studied, the reduction of tannin content in the GRS (0.1%) compared very well with the tannin content in the imported sample (0.1%) and they were significantly high (p<0.05) when compared to the SRS (0.2%). This is an indication that cashew kernels can be locally processed using gari roasting method in other to reduce the amount of tannin acid in the kernel which has been a limiting factor.

Table-1. Comparative chemical compositions of differently processed cashew kernel

Parameters (%)	Sand roasted	Gari roasted	Imported
Protein	20.7 ± 0.10^{a}	20.5 ± 0.32^{a}	21.0 ± 0.20^{a}
Fat	50.0 ± 0.04^{a}	51.0 ± 0.04^{a}	48.4 ± 0.10^{a}
Ash	5.2 ± 0.10^{a}	5.1 ± 0.30^{a}	5.0 ± 0.01^{a}
Crude fibre	1.4 ± 0.12^{a}	1.5 ± 0.10^{a}	1.2 ± 0.20^{a}
Moisture	5.0 ± 0.04^{a}	4.9 ± 0.31^{a}	4.7 ± 0.10^{a}
Carbohydrate	19.5 ± 0.70^{a}	20.0 ± 0.04^{a}	20.1 ± 0.02^{a}
Tannin	0.2 ± 0.01^{a}	0.1 ± 0.02^{b}	0.1 ± 0.01^{b}

Results represent means ± standard deviation of five determinations. Values not followed by the same superscript along the rows are significantly different (p≥0.05).

3.2. Sensory Properties

From the result, there was no significant difference (p>0.05) in the sensory attributes of taste and attractiveness of the both processing methods studied as presented in Table 2. Sensory attributes of colour, flavour and general acceptability between the imported and gari roasted cashew kernels also showed no significant difference. This is an indication that gari roasted cashew kernel was accepted by the panelist just as the reference sample (imported kernel). This is in agreement with the reported of Aroyeun [8] who observed no significant difference in the sensory attributes of colour, taste, texture and general acceptability of biscuit produced with 10% substitution of wheat flour with cashew kernel meal to the digestive biscuit already in the market. Ebere, et al. [17] also reported no significant difference (p>0.05) between the general acceptability of cookies prepared with 100% wheat flour and those substituted with 20% cashew apple residue. Unlike flaxseed flour which significantly affected all the sensory attributes of chapattis produced from different levels of substitution as reported by Hussain, et al. [24]. This indicates that cashew kernel are useful source of raw materials, it could be milled and used in formulation of products with no sensory difference from the already existing products in the market. Gari roasting method could be suggested as the best method to be adopted in the processing of cashew kernel.

Table-2. Sensory scores for processed cashew kernel

Parameters	Sand roasted	Gari roasted	Imported	LSD
Colour	2.80^{b}	4.50^{a}	4.70^{a}	0.56
Taste	3.80^{b}	3.60^{b}	4.40^{a}	0.70
Flavour	3.90^{b}	4.70^{a}	5.00^{a}	0.51
Attractiveness	3.80^{b}	4.00^{b}	4.80^{a}	0.32
General acceptability	3.70^{b}	4.50^{a}	4.70^{a}	0.38

Means not followed by the same superscript in the rows are significantly different at 5% level of probability (p≥0.05).

3.3. Physiochemical Properties of the Oils

The utilization of oils from different sources depends mainly on their compositions and no oil from a single source can be suitable for all purposes, thus the study of their constituents is important. The comparison of the physiochemical properties of cashew kernel oil and soybean oil is shown in Table 3. From the result, the golden yellow oils have moisture values of 0.075% and 0.060% for cashew kernel and soybean oils, respectively. The moisture values of these oils are very low when compared with those of legumes ranging from 5 – 11% as reported by Aremu, et al. [18]. This is an indication that these oils can be stored for a longer time without going rancid (offflavour) than legumes though soybean oil has the tendency of lasting longer compared to cashew kernel oil. The free fatty acids in this study are 0.06% and 0.03% for Cashew kernel oil and soybean oil, respectively and they compared very well with the report of Aboki, et al. [25] for sunflower seed oil (0.042%). The quality of the oils studied is high though soybean oil is better in terms of the smoke point that will be produced during refining or cooking. Peroxide value of cashew kernel oil is 0.001meq/g while that of soybean oil is 0.010meq/g. These values are less than the peroxide values of 0.50meq/g for African bush mango seed oil [26]. High peroxide value is an indication of high levels of oxidative rancidity of the oil and also suggests low levels of antioxidant [27]. Acid value is an indication of the quality of fatty acids in the oil and the edibility of an oil and suitability for use in the paint and soap industries [18]. The acid values are 1.57mgKOH/g and 0.60mgKOH/g for cashew kernel oil and soybean oil, respectively. Acid value of cashew kernel oil falls within the ranges of jatroph curcas seed oil (1.50mg KOH/g) and groundnut seed (1.79mg KOH/g) as reported by Akintayo [28]; Ayoola and Adeyeye [29] respectively. High acid value in oil showed that it may not be suitable for use in the food industries rather useful raw material for the production of paints, liquid soap and shampoos [18]. The saponification value of cashew kernel oil is 218.6mgKOH/g while soybean oil is 189.0mgKOH/g. This result is similar to that reported by Aremu and Akinwumi [30] for cashew seed oil (212.00mgKOH/g) and the value for soybean oil closely agreed with the result reported by Akanni, et al. [31] for soybean seed oil (192.3mgKOH/g). The high saponification value of cashew kernel oil is therefore a good indication that the oil is suitable for soap making, oil-based cream and shampoos but non-edible. The value for unsaponifiable matter is 1.79meq/g for cashew kernel oil and 1.41meq/g for soybean oil. The iodine value of cashew kernel oil is 144.021 gl_2/100gm and soybean oil is 121.698 gl_2/100gm. These values are high than those of refined castor oil and brebra seed oil (84.8 gl_2/100gm and 104.48 gl_2/100gm), respectively [22, 32]. Good drying oils should have iodine value above 130 [18]. Cashew kernel oil is therefore classified as drying oil and could be useful raw material in the manufacture of vegetable oil-based cream [33]. Refractive index of 1.446 and 1.466 was observed in this study for cashew kernel oil and soybean oil, respectively. The refractive index value of oils are within the acceptable range of 1.4677 – 1.4707 for virgin, refined and refined-pomace oils according to Codex Standards for fats/oils from vegetable and plant sources Codex Alimentarius Commissionm [34]. Yahaya, et al. [35] reported that specific gravity is commonly used in conjunction with other figures (refractive index) in assessing the purity of oil. The specific gravity at 25°C of cashew kernel oil is 0.91 and 0.92 for soybean oil. This result is in agreement with the specific gravity of 0.906, 0.910 and 0.920 for soybean oil, *Moringa* seed oil and cotton seed oil, respectively [31, 36, 37]. This is an indication that cashew kernel and soybean oils are denser than water and will make the oils to flow and spread easily on the skin and therefore, they are good sources of raw material for cream production [38].

Table-3. Physiochemical properties of cashew kernel oil and soybean oil

Parameters	Cashew kernel oil	Soybean oil
Moisture (%)	0.075	0.060
Free fatty acid (%)	0.06	0.03
Peroxide value (meq/g)	0.001	0.010
Acid value (mgKOH/g)	1.57	0.60
Saponification (mgKOH/g)	218.6	189.0
Unsaponification (meq/g)	1.79	1.41
Iodine value (gl_2/100gm)	144.021	121.698
Refractive index at 40°C	1.446	1.466
Specific gravity at 25°C of water	0.91	0.92
Smoke point	165°C	---
Flash point	135°C	---
Colour	Golden yellow	Golden yellow

Results are mean values of five determinations

4. Conclusion

Processing methods studied did not utter significant changes in all the chemical compositions of the locally processed cashew kernel from the reference sample (imported cashew kernel). GRS was observed to reduce tannic acid in the kernel to 0.1% which compared very well with the tannin content in the imported kernel (0.1%). There was no significant difference between the sensory attributes of colour, flavour and general acceptability of the GRS and the imported kernel while there was significant difference in all the sensory parameters of the SRS to the imported cashew kernel. From the result of the physiochemical properties, cashew kernel oil is a good source of raw material for the production of paints, liquid soaps and shampoos while soybean oil is a good raw material for food industries.

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