

# Comparative Quality Evaluation of Oven-Roasted and Honey-Coated Cashew (*Anarcadium occidentale, L.*) Nut produced using Locally Fabricated Cashew Nut Processing Machine in Nigeria

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**Abstract**— Raw cashew nuts were processed to obtain cashew kernels. Part of the kernels was roasted using mud oven while another part was honey coated and dried. The two samples were subjected to chemical, microbial and sensory analysis to compare their quality attributes. Differences were observed in some chemical compositions of the two samples; moisture content value of the oven roasted kernel was significantly ( $p < 0.05$ ) higher than that of honey-coated kernel but generally below the maximum level of 8% for safe storage of kernels. Protein, crude fibre, ash and energy value of the honey coated sample were significantly ( $p < 0.05$ ) higher than that of oven roasted sample, while there were no significant ( $p > 0.05$ ) differences in the crude fat and fatty acids. Sodium, potassium, calcium and magnesium were significantly higher ( $p < 0.05$ ) in the oven roasted than honey coated cashew samples. However, phosphorous in honey coated kernel was significantly ( $p < 0.05$ ) higher than that of oven roasted kernel. Total viable count of the samples are within the standard limits of  $10^4$  to less than  $10^6$  cfu/g of ready-to-eat food products, Yeast and mould counts of the two samples are within the maximum standard of  $10^4$  sfu/g. From the sensory evaluation results, honey coated kernel was more acceptable than oven roasted kernel. This study revealed that there was significant difference in the chemical and sensory attributes of the oven roasted and honey coated cashew kernel and that, coating of cashew kernel with honey has an added nutritional advantage compared with oven roasted ready-to-eat cashew kernel.

**Keywords**—Cashew kernel, Honey coated, Microbial, Oven roasted, raw cashew nut.

## I. INTRODUCTION

Adequate nutrition has been generally accepted as being central to good and healthy living [35]. In recent times, people have been increasingly aware of the quality, nutritional composition and health-promoting components of foods, proper processing and value addition of such food is necessary in order to obtain or retain maximum nutritional benefits from it [52; 47]. Nuts played an important role in diets of many cultures and civilizations for centuries due to its high energy and nutritional value as well as its huge variety of flavors and unique taste. It has also been recognized as a class of food that are rich in important nutrients including proteins and unsaturated fatty acids [45; 10]. As a good source of chemical constituents and certain vital bioactive compounds of important health benefits in human beings. Consumption of tree nuts had been linked with several health benefits during the last years [53; 30; 43]. Among tree nuts, cashew nuts ranks third in worldwide production, Vietnam was the world's largest individual producer in 2013 with 1.1 million tons while Nigeria was the largest African exporter with 0.95 million tons and second in the world [6]. However, as of 2014, rapid growth of cashew cultivation in Côte d'Ivoire made this country the top African producer with 1,09, 583 MT [48].

Cashew is held with great esteem in many customs and cultures, it is often eaten roasted on its own, lightly salted or sugared, or covered in chocolate [6]. Globally, cashew kernel (among other nuts) is an esteemed and highly priced food delicacy valued because of its pleasant taste and flavor [24]. Scientific investigations have shown that the nut kernels have beneficial effects on health, particularly on chronic diseases such as hypertension and obesity, coronary heart

disease and diabetes due to their and high content of unsaturated fatty acids [33;29].

Roasting is a cooking method that uses dry heat, whether an open flame, roaster or other heat source. Roasting can enhance flavor through caramelization on the surface of the food. Roasting uses indirect diffused heat and is suitable for slower cooking of nuts in a larger, whole piece [9]. Temperature range of 185°C to 190°C is ideal for roasting since it is sufficiently hot to exceed the decarboxylation temperature [16]. Roasting from time in memorial remains one of the common processing methods for nuts. During the process, the nuts become more crunchy and brittle leading to an overall increase in palatability [37; 44; 2].

Honey is a natural sweet substance produced by honey bees, from the nectars of plant flowers and honey dew [12]. Honey is a supersaturated solution of sugars, of which fructose (38%) and glucose (31%) are the main contributors. Honey has a wide range of phytochemicals including polyphenols which act as antioxidants. A wide range of minor constituents is also present in honey, many of which are also known to have antioxidant properties. Bee honey is one of the few virtually totally non-allergic foods that body easily assimilates. It contains nutrients especially as energy provider [42]. It is a high-energy carbohydrate food (80–85%) and the honey sugars are easily digestible as those in many fruits [51]. In an effort to combat free-radical activity, scientists are studying the effects of increasing individuals' antioxidant levels through the diet and dietary supplements. Honey appears to act as an antioxidant in more ways than one. Antioxidant compounds found in honey includes glucose oxidase, catalase, ascorbic acid, flavonoids, phenolic acids, carotenoid derivatives, organic acids, Maillard reaction products, amino acids and proteins [8; 38]. In the body, honey can take up free radicals and contribute to better health and when used in foods, the compounds produced when honey is heated can prevent rancidity in some products [7]. Honey is primarily a high-energy carbohydrate food whose distinct flavors cannot be found elsewhere, thus, it is an enjoyable treat. The honey sugars are largely the easily digestible “simple sugars,” similar to those in many fruits. Honey can be regarded as a good food for both infants and adults [13]. Due to honey's pleasing taste, it may be more readily consumed by individuals reluctant to ingest plant derived anti-oxidants. Honey which is also sweetener can be a flavorful, supplementary source of antioxidants [25]) compared to sucrose that has no anti-oxidant value. This has prompted the coating of cashew kernel with honey as a tool for food value addition for increased utilization, improved

economic gain and enhanced nutritional benefits of the nuts.

Generally, food processing and preparation methods have been reported to have a direct effect on the quality characteristics (physical, chemical and sensory) of most foods [47; 26]. Due to the nutritional requirement and necessity of the population, there is need to critically asses both the mud- oven roasted cashew and coating of the nuts with honey after drying as a means of nutritional enhancement. Therefore, this study is aimed at comparing the effects of mud-oven roasting and honey coating on the chemical, sensory and microbiological qualities of the cashew kernels.

## II. MATERIALS AND METHODS

### 2.1 Sample Collection and Preparation

The raw cashew nuts samples used for this work were obtained from Cocoa Research Institute of Nigeria's cashew plantation at Ochaja sub-station in Kogi State, Nigeria. Some preliminary quality tests (floatation, cutting test, total useful kernels and kernel out- put ratio) were done to ascertain the wholesomeness of the raw cashew nut samples.

### 2.2 Methods

#### 2.2.1 Cashew nut processing, Roasting and Coating process

Cashew nuts were processed using the modified method of [26] with the use of locally fabricated set of Cashew nut processing machine, consisting of Steamer, Hand operated shelling machine, Mud oven and vacuum packaging machine, designed and fabricated by an indigenous company (Annacardium Engineers Ltd, Saki, Oyo State, Nigeria).

Raw cashew nuts were steam-boiled using a steam boiler at a pressure of 4.5kg/cm for 20 mins. The steamed nuts, after cooling for 24 hrs, were shelled using hand operated shelling machine. The kernel was then removed from the shell using a small metal knife. The kernels were then pre-dried in a mud Oven at temperature of 50 - 70°C for 4 hrs to allow for the easy removal of the peels from the Kernel using the small metal knife. The peeled kernels were then further dried in the mud Oven for 5 hrs at 50 - 70°C. Part of the dried nuts were oven-roasted using the mud oven at 135 to 145°C for about 20 - 30mins, until the kernel is fully brown, while the other dried kernels were coated with honey using dip method. The two samples were then packaged in plastic bottles, air-tight sealed and stored at ambient condition [28 ± 3°C and 78 ± 2% (relative humidity)

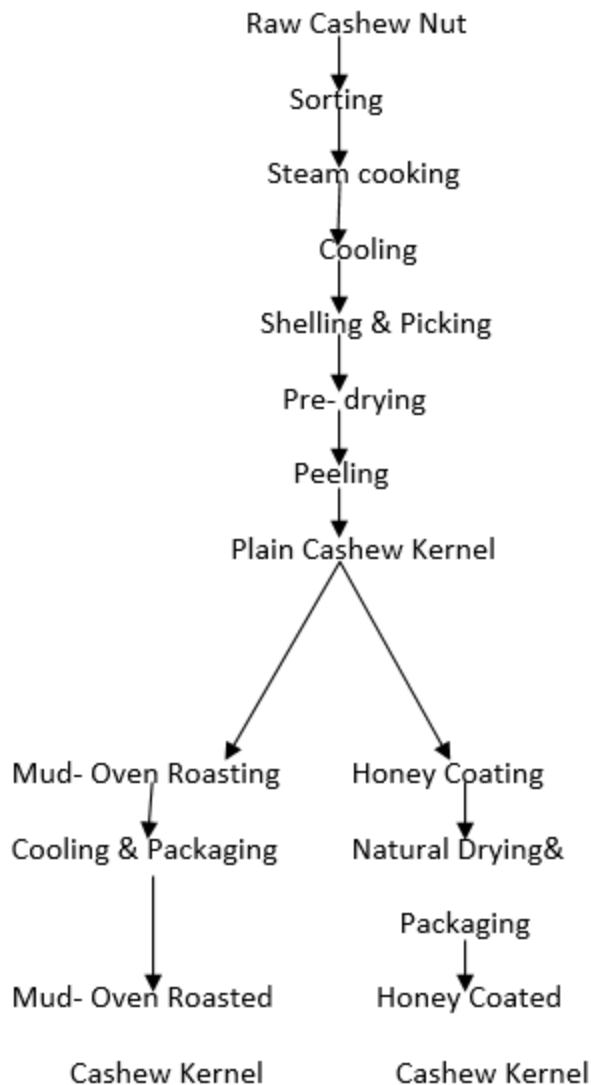


Fig. 1: flow chart for the production of mud oven roasted and honey coated cashew kernels

### 2.3 Chemical Analysis

2.3.1 Proximate analysis: Proximate compositions (moisture, protein, fat, ash and total carbohydrates) of the samples were determined using the methods recommended by the [1]. A. The nitrogen content was determined by the micro Kjeldahl method which was subsequently converted to protein by multiplying by a factor of 6.25 while the Carbohydrate content was determined by difference.

Fatty acid and metabolizable energy (KJ/100 g) were calculated using the formula described by [5] as shown below:

$$\text{Calculated fatty acids} = (0.86 \times \text{crude fat})$$

$$\text{Calculated metabolizable energy (KJ/100 g)} = ((\text{Protein} \times 17) + (\text{Fat} \times 37) + (\text{Carbohydrate} \times 17))$$

2.3.2 Mineral analysis: The minerals were analyzed by dry ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled, de-

ionized water with a few drops of concentrated hydrochloric acid. Calcium, magnesium, iron and phosphorous were determined by Atomic Absorption Spectro-photometry [3], while sodium and potassium were determined using flame photometry [11] using NaCl and KCl to prepare the standards.

2.3.3 Microbiological enumeration: Both oven roasted and honey coated cashew kernels samples were subjected to total bacteria count, yeast and mould count and coliform count tests as described by [20].

2.4 Sensory analysis: The two cashew kernel samples were subjected to sensory evaluation to determine consumer preference among them. Parameters such as color, taste, crispiness, flavor and overall acceptability were determined using a 9-point hedonic scale where (9) represented 'liked extremely' and (1) representing 'disliked extremely' [28]. The samples were presented in coded identical plates and the samples were tested individually. The order of presentation of the two samples

was completely randomized and water was provided to enable the panelists rinse their mouth after tasting each sample in order for each samples attributes to be noticeably distinct before inference could be drawn.

**2.5 Statistical analysis:** The data were analyzed using SPSS (Statistical Package for Social Scientist) version 15.0. The mean of the analyses were calculated and Analysis of Variance (ANOVA) was performed to determine the level of significant differences (5% significance level) between different mean of cashew kernel samples using Duncan Multiple Range Test.

## RESULTS AND DISCUSSION

Table 1 show the results of the chemical composition of the Oven roasted cashew (ORC) and Honey coated cashew (HCC) kernels. The ranges of the chemical compositions are moisture content (%) 7.58 to 6.04, protein (%) 18.25 to 17.37, fat (%) 43.66 to 43.28, crude fibre (%) 1.38 to 2.27, carbohydrate (%) 26.92 to 28.03, fatty acids (%) 37.55 to 37.22 and metabolizable energy (KJ/100g) 2157.24 to 2148.94. These results of the proximate composition obtained from the two cashew kernels samples shows comparison to those reported by [27] but slight differences were observed from that of [32] who has slightly higher values of protein and fat.

Table.1: Chemical composition (%) of plain roasted and honey coated cashew kernel samples

Parameter	HCC (%)	ORC (%)
Protein	18.25 <sup>a</sup>	17.37 <sup>b</sup>
Fat	43.66 <sup>a</sup>	43.28 <sup>a</sup>
Crude Fibre	2.27 <sup>a</sup>	1.38 <sup>b</sup>
Total Ash	2.53 <sup>a</sup>	1.38 <sup>b</sup>
Moisture Content	6.04 <sup>b</sup>	7.58 <sup>a</sup>
Dry Matter	93.96 <sup>a</sup>	92.42 <sup>b</sup>
N.F.E	26.92 <sup>b</sup>	28.03 <sup>a</sup>
F.Acids	35.5 <sup>a</sup>	37.22 <sup>a</sup>
Energy Value (KJ/100g)	2157.2 <sup>a</sup>	2148.94 <sup>b</sup>

<sup>a,b</sup> mean values in a column having different superscripts are significantly different ( $p < 0.05$ )

Note: HCC- honey coated cashew, ORC- oven roasted cashew

Generally, the proximate composition of the two cashew nut kernels samples obtained in this study was comparable to those reported by [49]. However, some significant differences were observed in some chemical compositions of the two cashew kernel samples. The moisture content value of the Oven roasted kernel was significantly ( $p < 0.05$ ) higher than that of honey-coated kernel. However, the moisture content of the two cashew nut kernel samples were generally below the maximum moisture content level of 8% for safe storage of kernels as stated by both [40] and [22]. This is important especially for honey coated cashew kernel, since moisture

content of bee honey represents a major importance to its stability against fermentation and granulation, the low moisture content protects honey from microbiological activity and thus it can be preserved for longer periods [4] and [15].

The protein content of the Honey coated cashew kernel (18.25%) was significantly ( $p < 0.05$ ) higher than that of Oven roasted cashew kernels (17.37%). These results are within the range stated by [37] as the protein content range of quality cashew nut. According to [42], the honey contains little protein, indicating that honey is not a good source of protein. However, the higher protein

content of the honey coated kernel sample compared to oven roasted kernel may be as a result of the coating of the sample with honey which is a way of protecting and enhancing the nutritional value of cashew nut.

Fat is an essential nutrient with a number of important functions. It carries fat-soluble vitamins and supplies essential fatty acids as well as contributes to overall energy value of foods [46] without adding to the bulk of the diet. They also play a structural role in providing fatty acids and cholesterol for the formation of cell membranes in all organs and much of fat necessary for the formation of these tissues are essential fatty acids. The total amount of fat in the diet and the amount of the different fatty acids in the diet can influence health. There was no significant ( $p > 0.05$ ) difference in the fat contents of the Oven roasted and Honey coated cashew kernels. This result is in agreement with that of [27]. This result implies that coating of cashew nut with honey does not have any significant effect on the fat content of the cashew. The fatty acid contents of the two samples also followed the same trend as that of crude fat content. This is expected since the fatty acids are the composition of crude fat.

The crude fibre is a measure of the quantity of indigestible sugars like cellulose, pentosans, lignins e.t.c that are present in foods and it helps to improve gastrointestinal function through maintenance of peristaltic movement of the intestinal tract thus, preventing constipation.[14]. Comparing the results of

Table.2: Mineral Analysis (mg/100g) of Oven roasted and honey coated cashew kernel samples

Parameter	HCC	ORC
Sodium	770.0	880.0
Potassium	710.0	780.0
Phosphorus	207.0	147.0
Iron	19.70	20.80
Calcium	3780.0	4470.0
Magnesium	530.0	650.0

<sup>a,b</sup> mean values in a column having different superscripts are significantly different ( $p < 0, 05$ )

Results of mineral analysis as shown in Table 2 indicated that minerals like; sodium, potassium calcium and magnesium are significantly higher ( $p < 0.05$ ) in the oven roasted than Honey coated cashew kernel. However,

crude fibre of the two samples studied, the crude fibre of the honey coated sample was significantly ( $p < 0.05$ ) higher than that of oven roasted sample as shown in Table 1. The result of this finding does not agree with that of a similar study reported by [5]. However, this result indicates that coating of the dried cashew nut has affected the fibre content of the nut, thus, improving its nutritional value.

The results of ash content of honey coated sample, as shown in Table 1, was significantly ( $p < 0.05$ ) higher than that of oven roasted sample. This suggests that small amount of ash found in honey as reported by [49] had a positive effect on the ash content of the honey coated cashew samples.

The gross energy in a food is defined as total chemical energy measured from complete combustion of the food in a bomb calorimeter. The gross energy value of Honey coated kernel was significantly ( $p < 0.05$ ) higher than that of oven roasted sample as shown in Table 1. This result has shown conformity with the study of [51], who found that honey, is also a high-energy carbohydrate food (80–85%) with the honey sugars being easily digestible as those in many fruits. This has made it a good source of energy as stated by [49]. This served as an improved nutritional value for cashew nuts whereby the energy level has been boosted by the coating of plain cashew with honey.

Phosphorous content of Honey coated kernel was significantly ( $p < 0.05$ ) higher than that of oven roasted kernel. This result is similar to the findings of [51].

Table.3: Populations of microorganism isolated from Honey coated and Plain roasted cashew nuts samples

S/N	Isolated microbes	Samples/Populations	
		HCC	ORC
1	Yeasts and Mould count	$6.7 \times 10^4$ sfu/g	$5.37 \times 10^4$ sfu/g
2	Total bacterial count	$1.89 \times 10^5$ cfu/g	$6.43 \times 10^4$ cfu/g
3	<i>E. coli</i>	0.00cfu/g	0.00cfu/g

HCC- Honey Coated Cashew, PRC- Oven Roasted Cashew

Nuts and nut products in general are highly susceptible to microbial contamination primarily due to their high nutritional content as well as their pH which is conducive for microbial growth and activities [17]. Contamination of cashew nuts by moulds may also occur early in the field, and deterioration could develop during prolonged storage [19]. According to [40] most stored agricultural products, including Cashew nuts are hygroscopic and will absorb moisture from the surrounding atmosphere until they reach equilibrium, and thus the storage environment is an important concern in preserving this food. This coupled with the high ambient temperature and relative humidity in the absence of proper processing might lead to problem of microbial growth in processing nut and nut products [31].

Mesophilic bacteria counts on roasted and salted Brazilian nuts ranged from  $5.3 \times 10^3$  and  $1.2 \times 10^4$  cfu/g [18]. These values do not differ widely with the findings

in this study as shown in Table 3, considering the fact that the counts of total bacteria for HCC was  $1.89 \times 10^5$  cfu/g while that of ORC was  $6.43 \times 10^4$  cfu/g.

Yeasts and mould count of  $6.7 \times 10^4$  sfu/g was recorded for HCC while  $5.37 \times 10^4$  sfu/g was obtained for ORC, these values are in consonance with the results of a similar study conducted by [34], but defers from the findings of [27] who reported lower counts of yeasts and mould of  $7.2 \times 10^2$  and  $6.8 \times 10^2$ . However, it was observed that yeast and mould count of the two samples were within the maximum standard of  $10^4$ /g set by [23] as acceptable for packaged nuts fit for human consumption. The result of the total viable count of the cashew kernel samples are within the microbial limits/standard of  $10^4$  to less than  $10^6$  cfu/g of ready-to-eat food products as reported by Fylde Borough Council in the manual of [39].

Table.4:- Mean Sensory Evaluation Scores of the Samples

Samples	Attributes				
	Colour	Taste	Flavour	Crispiness	General Acceptability
HCC	6.75b	7.10a	6.40b	6.55a	7.30a
ORC	7.15a	6.95b	6.65b	6.45b	6.65b

<sup>a,b</sup>mean values in a column having different superscripts are significantly different ( $p < 0.05$ )

HCC= Honey Coated Cashew, ORC=Oven Roasted Cashew.

The Sensory evaluation results obtained in Table 4 showed that there were significance difference in the colour, Taste, crispness and overall acceptability of the oven roasted and Honey coated Cashew kernels, while there was no significant difference ( $p > 0.05$ ) in flavor of the two samples. However, HCC was significantly ( $p < 0.05$ ) more acceptable than ORC.

### III. CONCLUSION

This study revealed that, there is significant difference in the chemical and sensory characteristics of oven roasted and honey coated cashew kernels. Also, honey coated cashew kernel has added nutritional advantage as ready-to-eat kernel, and was significantly more acceptable than oven roasted cashew by the sensory panelists.

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