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Investigation into the Effects of Storage on Mineral and Nutritional Content of Fresh and Cured Kolanut (*Cola nitida*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study evaluated the effects of storage on nutrient contents of fresh and cured kolanuts (*Cola nitida).* The cured nuts were divided into two groups with first and second groups cured for one and two months, respectively before storage at room temperature (25-27 ^{o}C). The samples were then evaluated for their proximate, mineral and vitamin compositions. The results showed that the fresh nuts had higher moisture (68.22 g), copper (2.40 mg) and zinc (35.80 mg) contents than the cured nuts. However, the two-month cured nuts had high amounts of all nutrients but low copper (0.80 mg) and zinc (1.20 mg). The storage process did not significantly ($p>0.05$) cause any loss in the

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nutritional contents (crude protein, crude fat, crude fibre, ash, carbohydrate, gross energy, vitamin B2, vitamin B3, vitamin C, caffeine, calcium, magnesium, potassium, sodium, manganese, iron, copper and zinc) of the stored kola nuts. This indicated that the kolanuts could be cured for up to two months and undergo storage at room temperature while maintaining the qualities like the fresh nuts. This would therefore, encourage the shunning of panic selling of the nuts and preservation of its extracts for the production of functional foods.

Keywords: Kolanut; storage; cured; nutrients; room temperature.

1. INTRODUCTION

Kola nut (cola) is the nut of the kola tree, found in the tropical rainforests of West Africa, most especially in the rainforest zones of southern Nigeria [1]. The genus *Cola* contained many species numbering up to 50 in West Africa. Of these, only a few are fruit bearing while majority are woody species of economic importance. Of the few fruits-bearing, notably *C. nitida* (Yoruba: *gbanja* or *goro), C. acuminata* (Yoruba: *Obi gidi* or *Obi abata)*, *C. verticillata* (Yoruba: *Obi Olooyo* or slimy kola), *C. millenii)* are of economic importance. *C. nitida* is however much more popular as kola of commerce than *C. acuminata* [1]. Some common names of *cola nitida* in Nigeria are; *Rimu* (Ufia, Benue), *Atala* (Atsakor, Edo), *Goro* (Hausas, Gombe), *Gbanja* (Ibadan, Oyo), *Goro* (Igbara-odo, Ekiti), *Oji* (Ehime Mbano, Imo), *Obi* (Ode-Ilemo, Ogun) according to a previous study [2]. Kola nut is chewed in many West African cultures, either individually or in group settings and is often used ceremonially. Kola nut contained large amounts of caffeine and are thus used as stimulant [3,4]. Caffeine in the nuts is also of health benefits as bronchodilator and cardiotonic in respiration as it stimulated and strengthened a weak heart, and as destroyer of pre-cancerous cells [5]. Cola is used in the manufacture of dyes and other cola groups of beverages – Coca cola, Pepsi cola, while kolanuts are an important part of the traditional spiritual practice of culture and religion in West Africa, particularly in Nigeria [6]. The kolanuts are also used as a sacred offering during prayers, ancestor veneration and significant life events such as naming ceremonies, wedding and funerals, hence for this use, only kolanuts that have four lobes are suitable. The kolanuts are cast upon a special wooden board and the resulting patterns are read by a trained diviner [7]. In 1800s, a pharmacist in Georgia mixed the extracts of kola, sugar and cocoa with carbonated water, tasted and called it *Coca-Cola* [*8*]. Today, Coca-Cola production company is still fond of using kola in its original recipe. Kola nut can be harvested with the hands, by plugging it at the use of harvesters. Many pods on very tall trees are beyond reach so they are allowed to drop before being picked up quickly in order to avoid insects' infestation due to the fact that its scent attract insect easily. The harvesting of kolanuts is done from September to January in order to preserve its nutrients. Therefore, the main objective of this study is to examine the effect of storage on the nutritional contents of kola nut (*Cola nitida*) consumed in Igbara-odo, Ekiti State, Nigeria.

2. MATERIALS AND METHODS

2.1 Materials

The kolanuts (*C. nitida)* were obtained from the King's market in Igbara-Odo, Ekiti State, Nigeria and authenticated at the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Nigeria. All chemicals used were of analytical grade and obtained from Sigma-Aldrich, London, United Kingdom.

2.2 Sample Preparation

Freshly harvested nuts were removed from the pod and part of it was grounded and analysed for the nutrient compositions of the fresh sample. The remaining nuts was taken through the curing process for two months using basket lined with banana leaves, stored at room temperature (25-27 ◦C) and analysed after each month.

2.3 Proximate Composition Analysis

The proximate composition was carried out at the Department of Agronomy, University of Ibadan, Ibadan, Oyo state, Nigeria. The proximate composition (moisture content, crude fiber, crude fat, total ash, and crude protein contents of the sample was determined as described [9]. The total carbohydrate content was obtained by difference. The crude protein contents were determined by micro-Kjedahl method to obtain the nitrogen content. The crude protein was then calculated as (gN x 6.25) while the crude fat was

obtained using Soxhlet apparatus. The gross energy was determined using Gallenkamp Ballistic Bomb calorimeter.

2.4 Mineral and Vitamin Compositions Analysis

The calcium, potassium and sodium contents of the experimental sample were determined using flame photometer while the magnesium, copper, manganese, iron and zinc were determined using Atomic Absorption Spectrophotometer (AAS). The vitamin C content was determined using metaphosphoric acid solution, while the vitamin B_2 using Fluorescent spectrophotometer (Perkin Elmer Model) and vitamin B3 as well as caffeine were determined using spectrophotometer as previously described [9].

2.5 Statistical Analysis

All determinations were carried out in triplicates. Data was subjected to analysis of variance (ANOVA) using SPSS (version 21, USA), while means was separated using New Duncan Multiple Range Test (NDMRT) at 5% level of significance ($p<0.05$).

3. RESULTS AND DISCUSSION

3.1 Proximate Compositions of Fresh and Cured Kolanut Samples

Table 1 showed the proximate composition and gross energy values of fresh and cured kola nuts. The result showed that fresh *Cola nitida* had the highest moisture content (68.22 g). Two-months cured nuts had the highest crude protein (6.08 g), crude fat (5.11 g), crude fibre (4.32 g), ash (1.90 g) and carbohydrate (23.78 g) contents, respectively. The least crude protein, crude fat, crude fibre, ash and carbohydrate contents were reported for the fresh nuts (4.67 g, 3.73 g, 3.35 g, 1.38 g and 18.65 g), respectively. The result (Table 1) further revealed that crude protein, crude fat crude fibre, ash and total energy contents of the samples were not significantly ($p>0.05$) different from one another. However, the gross energy was also found to be lower (309.6, 310.8, 311.3 kcal/100 g) in the fresh nuts when compared to the cured nuts. No significant difference ($p>0.05$) was also recorded for the three samples, respectively.

Kolanut lost weight due to tissue respiration and evapotranspiration. This physiological reaction is activated by high temperature and low humidity. Moisture loss therefore become remarkable [10]. Insignificant difference was recorded across the moisture content of the fresh and cured kolanuts. This however is against the findings of [8], that established the fresh nuts to significantly ($p < 0.05$) had higher moisture content than the cured ones. Moisture content of the fresh nuts was between 56.21 and 59.42% while that of the 12-week cured-nuts ranged from 53.70 to 57.99%. In the same vein, [1] reported moisture content of 57.03% for fresh kola nuts and 50.95% for 12-week cured nuts. In Ghana, Lower [11] reported moisture content of 52.45–56.84% for the fresh kola nuts but lower values (42.49–44.16%) for the nuts after 9-week curing in cane basket. This study supported the findings of [8] that established the crude fibre contents ranging from 4.26 to 6.89% for fresh nuts and 4.62 to 8.44% for the cured. Meaning that there were no significant differences in the crude fibre content in the fresh and the cured kola nuts. Considering the total ash contents, this study is similar with that of [8], that obtained 2.74–2.88% and 2.85–3.01% for the fresh and cured nuts, respectively, Besides, a similar result has been reported by [1] for fresh nuts and those cured for 12 weeks.

The nutrient composition of kola nut relatively differed from what has been reported 8.0% protein, 0.92% fat and 2.40% ash in fresh nut of kola. Odebunmi [12] reported a crude protein of 2.63%, 5.71% crude fat and 7.13% crude fibre in a stored but unspecified period of time in *Cola nitida*. Lower [11] also reported 8.00% protein, 2.69% ash and 85.61% carbohydrate in fresh *cola nitida* and 9.00% protein, 2.91% ash and 84.11% carbohydrate in cured (6 months) nuts. This study however, supported the past study [8] that reported a fat content of 0.51-0.53 and 0.49-0.60% in the fresh and cured kolanuts, respectively. The varying composition reported by various studies might be due to variations in the nutrient composition of the nuts as a result of varying season, environment, time or condition of evaluation and time of harvest [12].

3.2 Mineral Compositions of Fresh and Cured Kolanut Samples

Table 2 showed the results of the mineral content of the three samples. The result showed that the two-month cured sample had the lowest quantity of zinc than fresh kolanut. The two-month cured nuts had the highest content of all other minerals. The one-month cured kolanuts had the lowest copper (0.50 mg/100 g). The calcium, magnesium, potassium, sodium, manganese and

iron were found to be lowest in the fresh nuts compared to the cured nuts, but the highest quantity of copper and zinc were observed in the fresh nuts. However, the analysis of the variance obtained for this mineral did not indicate a significant difference at p>0.05. This study indicated the possibility of fresh nuts of cola being cured for export or future consumption. Thus, cured *cola nitida* can also be used like fresh cola for caffeine and dye extraction [13].

The increase in the mineral contents of the stored *cola nitida* except in some minerals (copper and zinc) corroborated the reports of the previous study [10] that the taste and quality of kola nuts improved with storage period.

3.3 Vitamin Compositions of Fresh and Cured Kolanut Samples

The results of vitamin and caffeine contents presented in Table 3 showed that the fresh nuts recorded the lowest vitamin B_2 (0.07 mg/100 g), vitamin B_3 (0.03 mg/100 g), vitamin C (6.38 mg/100 g) and caffeine were also obtained in the two-months cured nuts. No significant difference was observed for the vitamin B_2, vitamin B_3, vitamin C and caffeine contents of the fresh and cured nuts. The value for caffeine content (1.04 g/100 g) in fresh nut of this study did significantly different from 1.42 and 2.05% previously reported for fresh nuts and six-month cured nuts [11], respectively. More so, the relatively high

Table 1. Proximate composition of fresh and cured kola nut (g/100 g)

Parameters	Fresh Sample	One-month Sample	Two-month Sample	F-value	Sig. value
Moisture	68.22±0.04	63.88±0.08	58.81±0.06	0.006	0.994
Crude protein	4.67±0.15	5.25±0.20	6.08±0.08	1.126	0.356
Crude fat	3.73±0.04	4.32±0.05	5.11±0.08	0.689	0.521
Crude fibre	3.35±0.03	3.74±0.04	4.32±0.08	0.150	0.863
Ash	1.38±0.05	1.62±0.05	1.90±0.04	0.006	0.994
Carbohydrate	18.65±0.07	21.19±0.06	23.78±0.06	0.025	0.976
Gross energy (kcal)	309.6±0.003	310.8±0.003	311.3±0.004	0.000	1.000

***Note**: One-month Sample = Sample cured for one month; Two-months Sample = Sample cured for two months Means (n=3) with F-value greater than LSD in the row are significantly different (p<0.05)*

Table 2. Mineral content (mg/100 g) of fresh and cured kolanut

Parameters	Fresh Sample	One-month Sample	Two-month Sample	F-value	Sig. value
Calcium	8.00±0.0003	17.40±0.0003	25.40±0.005	0.393	0.683
Magnesium	44.20±0.007	164.40±0.006	263.80±0.04	0.386	0.688
Potassium	43.60±0.001	65.60±0.003	67.90±0.06	0.059	0.943
Sodium	13.40±0.0006	19.90±0.0003	26.60±0.04	0.172	0.844
Manganese	0.30±0.0004	0.80±0.0003	0.90±0.0001	0.005	0.995
Iron	11.40±0.0006	21.30±0.03	25.60±0.001	0.218	0.808
Copper	2.40±0.0003	0.50±0.0	0.80±0.0	0.700	0.933
Zinc	35.80±0.0038	1.90±0.0006	1.20±0.0003	1.206	0.333

***Note**: One-month Sample = Sample cured for one month; Two-months Sample = Sample cured for two months Means (n=3) with F-value greater than LSD in the row are significantly different (p<0.05)*

Table 3. Vitamin contents (mg/100 g) of fresh and cured *cola nitida*

Parameters	Fresh Sample	One-month Sample	Two-month Sample	F-value	Sig. value
Vitamin B_2	0.07±0.035	0.08±0.04	0.09±0.03	0.000	1.000
Vitamin B_3	0.03±0.016	0.32±0.05	0.39±0.02	0.002	0.998
Vitamin C	6.38±0.06	6.75±0.06	6.87±0.06	0.23	0.977
Caffeine	1.04±0.03	1.10±0.02	1.16±0.02	0.000	1.000

***Note**: One-month Sample = Sample cured for one month; Two-months Sample = Sample cured for two months Means (n=3) with F-value greater than LSD in the row are significantly different (p<0.05)*

crude protein, ash, crude fat, vitamin C and mineral content also suggested the possibility of incorporating it as a feed supplement for animals [11]. The highest vitamin B_2, Vitamin B_3, Vitamin C and caffeine contents were obtained in the two-month cured nuts. These vitamins are very important in the metabolic processes that did occur in the human body. Most especially, the vitamin C has been reported to be a very good antioxidant agent in the fight against free radicals-generated diseases [11].

4. CONCLUSION

Kolanuts can be cured by wrapping them in fresh banana leaves over a long period of time with no changes in most quality parameters required for consumption or industrial processing. However, from the results of nutrient, caffeine, gross energy, vitamins and mineral content presented in this study, it could be concluded that the two month cured nuts has the highest nutrient except for its lower copper and zinc contents. On the other hand, the fresh nuts are the least nutritious of these samples having the least quantity of all nutrients except its highest copper and zinc. Therefore, it is further concluded that the storage process has no negative effect on the nutrient contents of *Cola nitida.*

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

AVAILABILITY OF DATA AND MATERIALS

The data presented in the study are included in the article and additional material.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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