European Journal of Nutrition & Food Safety

12(11): 13-19, 2020; Article no.EJNFS.62576
ISSN: 2347-5641

Evaluation of Nutrient and Phytochemical Composition of *Cola lepidota* Fruits (K. Schum): An Underutilized Fruit

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Authors' contributions

This work was carried out in collaboration among all authors. Authors GIO and COA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CFE and OAO managed the experimental work, analyses and literature searches of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i1130313
Editor(s):
(1) Dr. Raffaella Preti, Sapienza University of Rome, Italy.
Reviewers:
(1) Heena Sharma, ICAR-National Dairy Research Institute, India.
(2) Aparecida Leonir da Silva, Universidade de São Paulo (USP), Brasil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/62576

Original Research Article

Received 29 August 2020
Accepted 02 November 2020
Published 02 December 2020

ABSTRACT

This study examined the nutrient and phytochemical composition of *Cola lepidota* fruits commonly known as Monkey Kola. The pulps were extracted, grated and dried. Dried pulps were milled into flour and packaged in properly labeled air-tight polyethene sachets. The nutrient composition was determined using standard AOAC methods while the phytochemical composition was determined using the gravimetric and spectrophotometric methods. Findings from the results revealed that 100 g portion of fresh *Cola lepidota* was high in moisture content (88.9%), moderate in carbohydrate content. The most abundant mineral was calcium (182.5 mg/100 g), followed by magnesium (87.5 mg/100 g), potassium (68.1 mg/100 g) and phosphorous (34.4 mg/100 g). *Cola lepidota* has substantial amount of vitamin A (25.63 mg/100 g) and vitamin C (12.98 mg/100 g). The phytochemical compositions found in the fruit were quite high, the most abundant were flavonoid

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(420.7 mg/100 g) and saponin (42.4 mg/100 g). These findings indicate rich nutritional and potential health benefits of this underutilized fruit. Thus, the information obtained from the study will contribute in widening the scope of the knowledge and encourage conservation and domestication preservation of this species.

Keywords: Cola lepidota; nutritional composition; phytochemical; underutilized species.

1. INTRODUCTION

Tropical African sub-regions are home to many underutilized valuable fruit-tree species whose potentials have not been fully realized [1]. These trees are primary sources of medicines that possess therapeutic potentials Ene-Obong et al. [2] and generates tangible income for the vulnerable groups especially women and children. Currently, there is a global interest on increased food production with emphasis on provision of nutritional food for the increasing world population [3] following the fact that these fruits and seeds are important components of a balanced diet, rich in natural sources of food nutrient needed by both humans and animals.

One of the enlisted underutilized fruit trees is the *Cola lepidota* commonly known as monkey kola. Monkey kola is a popular nomenclature for the lesser known members of the *Cola* species that yield edible tasty fruits. They are a close relative to the familiar West African kola nuts (*C. nitida* and *C. acuminata*), cultivated for their masticatory and stimulating nuts [4]. *Cola lepidota* is a tropical edible fruit, a member of the family of *Sterculiaceae* and belongs to a group called drupes [5] with three varieties; Yellow (*Cola lepidota*), White (*Cola parchycarpa*) and Red (*Cola laterita*) [6]. *Cola lepidota* is geographically distributed mainly in Africa (Cameroon, Gabon and Nigeria) and some parts of Brazil and Jamaica. The pod of *Cola lepidota* is yellowish and roundish and is also called Yellow Monkey Kola, while the white variety which is *Cola parchycarpa* has more cylindrical shape and is also called White Monkey Kola. The tree produces fruit between the months of June to November [7] and the fruit tree is identified by various local names in South Eastern Nigeria such as “achicha” or “ochiricha” in igbo and ndiyah in Efik [2]. In Nigeria, Monkey kola is mostly consumed fresh and like most fruits and vegetables, it has a very short life span probably due to its high moisture content Ene-Obong et al. [2]. *Cola lepidota* is of great importance to the vulnerable groups, the fruit is a good source of protein, fat, carbohydrate and minerals [8] and constitutes one of the best tools for preventing diseases caused by lack or insufficient supply of vitamins in diet [9]. Nutritionally, the fruits are believed to contain beta carotene which acts as antioxidant [10]. Also, recent findings have revealed that fruits contain bioactive compounds such as polyphenols, alkaloids, saponins and anthraquinones etc. which have some medicinal potential [11].

In the light of the imminent importance of *Cola lepidota,* the fruit tree is still dominant in the wild, this may have contributed to the low consumption of the fruits and paucity of information of the health benefits. Reported that it is common knowledge that in Nigeria, a number of indigenous trees have been underutilized, abandoned and are becoming extinct or threatened. Hence, the need arises to study this underutilized forest species that is mostly found in the wild. The information obtained on the nutritional and medicinal benefits of this species will create an awareness and further contribute to the knowledge bank of this species, as this will lead to conservation, domestication and improvement of this species especially in the urban areas. Following the growing interest of wild fruits due to their medicinal properties, nutritional value, vitamin and mineral contents [12]. Thus, this research study aims at determining the nutritional and phytochemical composition of *Cola lepidota* as this will promote the cultivation and consumption of this underutilized species.

2. MATERIALS AND METHODS

2.1 Sample Collection

Matured fruits of *Cola lepidota* were sourced and purchased from a local market called Ahiaeke market in Ikwuano Local Government Area in Umuahia, Abia State and were identified by a taxonomist, Mr. Ibe Ndukwe in the Forestry Department of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

2.2 Preparation of the Fruit for Chemical Analysis

Inspection was carried out on the purchased samples, to select only physical healthy fruits

with no physical injury. The pods of *Cola lepidota* were cut open exposing the fruit pulp which was further cut longitudinally with the aid of a sterile scalpel blade to separate the seeds from the tasty edible pulp. Thereafter, the membranous layer separating the pulp from the seed was scrapped off. After which, the arils were grated with a kitchen grater. Samples were used immediately for moisture analysis while the rest were sun-dried and milled into fine powder and packaged in properly labeled air-tight polyethene sachets for further chemical analysis.

2.3 Experimental Design

The samples were purchased from six randomly selected vendors in the market and pooled to obtain sixty fruits for the analysis. The fruits were sorted by hand to remove fruits damaged by either physical injury or infestation of mold growth. The criteria for selecting healthy fruits include; the fruit colour, firmness, size, absence of disease and physical injury. Thereafter, the fruits were taken to the laboratory for chemical investigation on selected ripe fruits. The samples were analyzed at Emery Laboratory, located at Umuahia, Abia State, Nigeria.

2.4 Chemical Analysis

The proximate composition of the samples was determined using standard AOAC [13] methods. The crude protein content was determined by micro-Kjeldahl method while crude fat content was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600°C in a muffle furnace. The carbohydrate content was calculated by difference as the nitrogen free extractive (NFE), a method separately described by James [14].

The phytochemical composition of the samples was determined as follows; Phosphorus was determined by the molybdo vanadate colorimetric method [14] while sodium and potassium were determined using Flame photometer which was set out according to the manufacturer instruction. Also, calcium and magnesium were determined by complexiometric titration. The versanate EDTA titrimetric method of AOAC [13] was employed.

The Thiamine (vit B_1), Riboflavine (vit B_2), Niacin Content, V9itamin A, Vitamin C content in each sample were determined using the method by Kimura M and Rodriguez-Amaya D. [15].

The mineral composition of the fruits were determined as follows; Saponin was determined by the double solvent extraction gravimetric method [16], flavonoid was determined using the method described by Harborne [16] while Tanin and Phenol were determined using methods described by Folin Denis colometric and Folin – Ciosptean spectrophotometer [13] respectively.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of *C. lepidota*

The proximate analysis of *C. lepidota* fruit pulp is depicted in Table 1. Moisture content was highest in the fruit (88.9%), followed by carbohydrate (6.6%), crude protein (2.5%) and ash content (1.1%). These values indicate the presence of some nutritionally important elements. The values obtained from the study were similar with that of Ogbu et al. [1], who reported that *C. lepidota* waxy aril contain moisture (82.6 g/100 g), fibre ash (1.58 g/100 g), carbohydrate (25.8 g/100 g) and crude protein (1.75 g/100 g). Also, a similar result was reported by Udouroso and Essien [17]. The high moisture content as observed from the study could be attribute to an array of factors such as, time of harvesting, maturation period and some other environmental conditions like humidity, temperature during the growing phase of the species and storage conditions [18].

However, the moisture content found in *Cola lepidota* was slightly higher than some fruits. According to Akubor and Egbekum, [19], most fruits such as ripe pawpaw, pineapple and soursop had moisture content of 84%, 82%, 82% respectively. This high moisture content found in fruits could be attributed to the fruit state of freshness and maturity [5]. Moisture content of fruit is a function of its quality which determines its freshness at harvest or storage duration before analysis [20] and also a function of its shelf-life stability.

Crude protein, carbohydrate and ash values reported in the study had a lower proximate content. A similar scenario was observed in Okudu et al. [21]. The values were also similar in other fruits like orange and watermelon (0.78% and 0.15%) respectively [22], 0.52% reported for African bush mango [23] and 0.9% reported for pineapple and soursop juices [24]. The value of protein as observed in this study can be said to complement other sources of protein. Low

protein and fat make the fruit suitable for patients with some physiological conditions [2].

The carbohydrate contents observed in *Cola lepidota* was low (6.6%). Generally, fruits are low in carbohydrate. Okudu, et al. [21], reported a low carbohydrate content in *Cola parchycarpa* (4.9 g/100 g) and *C. lepidota* (3.8 g/100 g). However, Udouroso and Essien, [17], reported a high value of carbohydrate value of 84.33%.

Table 1. Proximate composition of *C. lepidota* per 100 g edible portion

Nutrient	Composition (%)
Crude protein	2.5 ± 0.00
Crude fat	0.5 ± 0.07
Crude fiber	0.6 ± 0.14
Ash	1.1 ± 0.14
Moisture	88.9 ± 0.28
Carbohydrate	6.6 ± 0.14

Values are Mean ± S.D (Standard Deviation); n = 60

3.2 Mineral Composition of *Cola lepidota*

The mineral elements content of *C. lepidota* is presented in Table 2. Analysis revealed higher levels of calcium (182.5 mg/100 g), magnesium (87.5 mg/100 g), potassium (68.1 mg/100 g) and phosphorus (34.1 mg/100 g) in the fruit. The relative high concentration of calcium observed in the fruit could be attributed to the firm-nature of the fruits [25], cell wall stability and membrane integrity [26]. This is an additional advantage to the fruit as calcium is known to play an essential role in health of bone and teeth as well as regulating blood pressure. In a similar study, Eneobong et al. [2] also indicated that calcium and magnesium were the most abundant minerals in the fruit pulp of both *C. parchycarpa* and *C. lepidota*. This result reported in this study was also corroborated by Osabor et al. [8] who reported high amount of some essential minerals in the endocarp of *C. lepidota.*

Potassium has been shown to be essential for the normal functioning of the nerves and muscles in maintaining the acid-base of the body [27,2]. Magnesium on the other hand plays a role in the active transport of calcium and potassium ions across cell membranes, a process that is important to nerve impulse conduction, muscle contraction and normal heart rhythm [28].

However, the low amount of sodium in *Cola lepidota* makes it advisable for consumption in other to prevent high blood pressure and serious build-up of fluid in people with congestive heart failure, cirrhosis of the liver or kidney disease [29].

Table 2. Mineral composition of *Cola lepidota* per 100 g edible portion

Nutrient	Composition (mg/100 g)
Calcium (Ca)	182.5 ± 0.0
Magnesium (Mg)	87.5 ± 0.0
Sodium (Na)	5.4 ± 0.21
Potassium (K)	68.1 ± 0.0
Phosphorus(P)	34.4 ± 0.25

Values are mean ± S.D (Standard Deviation); n = 60

3.3 Vitamin Composition of *C. lepidota*

Result from the vitamin analysis depicted in Table 3 showed a high level of Vitamin A (25.63 mg/100 g) and Vitamin C (12.98 mg/100 g) in fruits of *Cola lepidota.* Thiamine (B_1), Riboflavin (B_2) and Niacin (B_3) were found in trace amount (0.08, 0.02 and 0.23 mg/100 g respectively). The values obtained in this study was higher than those of Udouroso and Essien, [17] who reported that *C. lepidota* contained high amount of vitamin B_1 (0.249 mg/100 g), B_2 (0.125 mg/100 g), B_3 (0.940 mg/100 g) and Vitamin C (6.497 mg/100 g). Oranusi et al. [30] also reported that the vitamin C content was 14.39 mg/100 while Ogbu and Umeokechukwu [1] reported the vitamin C content was 13.47 mg/100 g for *Cola lepidota*.

Vitamin C content found in moderate amount in *Cola lepidota* fruit, can be said to be a suitable source of antioxidant [10]. It is a water-soluble vitamin implicated in most of life processes but principally function as an antioxidant [10]. The presence of this vitamin in a fruit will further increase the absorption of iron in humans [2] and enhances the conversion of plant iron into absorbable form. Also, the high amount of vitamin A in Monkey Kola makes it beneficial to human vision. The reason being that Vitamin A is an essential component of rhodopsin, a protein that absorbs light in the retina receptors and supports the normal differentiation and functioning of the conjunctival membranes and cornea [31,32]. Also, Okudu et al. [21] observed a relative narrow spectrum of vitamins profile of juice and jam developed from *C. lepidota* and *C. parchycarpa* fruit pulps, however, vitamins are relatively labile and can be destroyed during processing and storage of food [33]. The author further buttressed that vitamins are a broad group of organic compounds that are minor, but significant components of food required for

normal growth, self-maintenance, and functioning of human and animal systems. They play diverse specific and indispensable functions in metabolism, and their deficiency produces specific diseases [33].

Table 3. Vitamin composition of *C. lepidota* per 100 g edible portion

Nutrient	Composition(mg/100 g)
Thiamine(B_1)	0.08 ± 0.00
Riboflavin(B_2)	0.02 ± 0.0021
Niacin(B_3)	0.23 ± 0.041
Vitamin A	25.63 ± 0.25
Vitamin C	12.98 ± 00.32

Values are Mean ± S.D (Standard Deviation); n = 60

Table 4. Phytochemical composition of *C. lepidota* per 100 g edible portion

Phytochemical	Composition(mg/100 g)
Tannin	18.25 ± 0.21
Flavonoid	420.7 ± 0.00
Saponin	42.4 ± 0.00
Phenol	2.45 ± 0.35

Values are Mean ± S.D (Standard Deviation); n = 60

3.4 Phytochemical Composition of *C. lepidota*

Phytochemical analysis revealed the presence of tannins (18.25 mg/100 g), flavonoid (420.7 mg/100 g), saponins 42.4 mg/100 g) and phenol (2.45 mg/100 g) in fruits of *Cola lepidota* (Table 4). This trend was also confirmed by Okudu et al. [34], who reported the presence of these phytochemicals - flavonoids, saponins, phenols and tannins. Also, Oranusi, et al. [30] and Ene-Obong et al. [34] corroborated the result from this study. The authors reported that flavonoid and β-carotene are the most abundant phytochemicals in *Cola lepidota* fruits.

Flavonoid and Phenols are known to be strong antioxidants, they possess anti-microbial, anti-inflammatory, anti-allergic, anti-mutagenic and anti-cancer activity and more so, protects against heart diseases [35,36,37] and cardio protective activity [38]. Furthermore, tannins suppress bacterial cell proliferation by blocking essential enzymes of microbial metabolism such as proteolytic enzymes [39] while the presence of saponin in the fruit makes the fruit recommendable for the lowering of cholesterol level and reduction in heart disease [40]. According to Oyinlade, [41], saponins exhibit antioxidant and anti-inflammatory activity and are used in the management of hypercholesterolemia and hyperglycemia.

4. CONCLUSION

Africa especially West and central Africa are known for its rich diversity in species. Most of these trees are indigenous fruit trees which are either disappearing at an alarming rate or going extinct, reason being that the rural-poor harvest indigenous fruit trees from the wild without conscious re-planting of these trees. Oftentimes, the trees could be termed underutilized due to lack of relevant information or proper documentation on the development of such species. To this end, this study has presented the nutrient and phytochemical compositions of *C. lepidota* fruit. Result from the study has shown that the *C. lepidota* fruit contain substantial amount of essential nutrients, minerals, vitamin C and phytochemicals, this makes the fruit suitable for human consumption. However, it was imperative to fully exploit this fruit due to its nutritional and health benefits of *Cola lepidota*. Although, the need arises to intensify scientific research on this underutilized indigenous fruit tree as this would serve as a necessary step towards its conservation, domestication and tree improvement of the species.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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