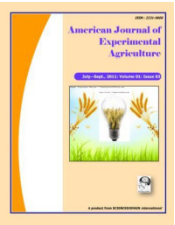

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Biochemical and Phytochemical Properties of *Cola acuminata* Varieties

O. A. Abiodun[1*], A. M. Oyekanmi[2] and O. J. Oluoti[1]

[1]Department of Food Science and Technology, Osun State Polytechnic, Iree, Nigeria.
[2]Department of Applied Science, Osun State Polytechnic, Iree, Nigeria.

Authors' contributions

Author OAA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AMO and OJO managed the analyses of the study. Author OAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of this work was to determine the biochemical and phytochemical properties of *Cola acuminata* varieties.
Place and Duration of Study: Department of Food Science and Technology, Osun State Polytechnic, Iree, Nigeria, between August 2012 to June 2013.
Methodology: The kolanuts (white and red varieties of *Cola acuminata*) were oven dried at 80ºC for 16h and pulverized into powder. Proximate, mineral and phytochemical analyses were analyzed using standard methods.
Results: The results showed higher dry matter (91.88%) in the white variety, ash (4.71%) and fat (11.80%) contents were higher in the red varieties. White variety had higher crude fibre (10.08%), protein (10.92%) and carbohydrate (55.65%), sugar (2.29%) and starch (10.80%) contents. Carotenoid contents of red varieties (25.90mg/100g) were higher than that of white variety. The red variety had higher calcium (734.89mg/kg), magnesium (486.93mg/kg) and potassium (360.68 mg/kg) contents while the white variety had higher values in sodium (78.74mg/kg) and phosphorus (112.20mg/kg) contents. Red variety of *Cola acuminata* had higher phytate (10.67mg/100g), phenol (33.50mg/100g) and flavonoid (12.13mg/100g) contents while the white variety had higher values in alkaloid (8.21mg/100g) and tannin (8.13mg/100g) contents.
Conclusion: The nutrients in *Cola acuminata* varieties are comparable to other nuts with high nutritional values. Apart from the potentials in pharmaceutical company, it could be explored in food industry for wine and juice production.

**Corresponding author: Email: funmiabiodun2003@yahoo.com;*

Keywords: Anti-nutrient; chemical composition; Cola acuminata; red variety; white variety.

1. INTRODUCTION

Kola nut belongs to the plant family S*terculiaceae*, having about 125 species of trees native to the tropical rainforests of Africa. Kola is the second most important indigenous cash crop in Nigeria [1]. The cultivation of kola in Nigeria is ecologically limited to the rain forest zones of the South and riverine areas of the Savannah region [2]. Of these species, the most common in Nigeria are C*ola nitida* (Gbanja) with two phenotypic varieties; the white and red cultivars, C*ola acuminata* (Abata) and *Garcina cola* (Orogbo) and *Buchholzia coriacea* popularly known as wonderful kola [2]. Kola is an important economic cash crop to a significant proportion of Nigerian population who are involved in kola farming, trading and industrial utilization [3]. Out of the two major kolanut species cultivated in Nigeria, C*ola nitida* is being traded internationally, while, the consumption of *Cola acuminata* is confined to Southern Nigeria [4]. *C. acuminata* is frequently used for social and religious ceremonies in Southern and Middle-belt Nigeria. It is characterized by four to six cotyledons and mainly used to fulfill traditional roles [5].

Kolanut has a wide application in the food and pharmaceutical industrials where it is used as sources of caffeine in foods and pharmaceutical products [6]. The active principles caffeine, theobromine and kolatin prevent sleep, thirst and hunger and also acts as an anti-depressant [3,7]. Kolanut could be utilized in the producing countries to produce value added products such as the kola drink and thereby create and increase the income of farmers and industrialists in the country [7]. It is also used in the manufacture of dyes and cola group of beverage drinks [8].

Various researchers have studied the nutritive and medicinal values of kolanut [9-12]. Kanoma et al. [13] observed the antifungal activities of aqueous and methanol nut extracts of *C. nitida* and *C. acuminata* against phytopathogenic fungi. Aikpokpodion et al. [14] studied the pesticide residue in kolanut while Umoren et al. [15] studied the effects of chronic consumption ofkola nut (*Cola nitida*) and caffeine diets on exploration, anxiety and fear in Swiss white mice. *Cola nitida* had been used for kola drink [7] and other products such as wine, soap and dye [1,16] but work on *Cola acuminata* are limited due to believe that they are for social and traditional rite. This work aimed at comparing the chemical and anti-nutritional properties of two varieties of *Cola acuminata.* This would provide nutritive and medicinal information of the kola for food and pharmaceutical industries.

2. MATERIALS AND METHODS

2.1 Materials

Cola acuminata varieties (red and white) were obtained in February at Oja-Oba, Osogbo, Osun State, Nigeria in year 2012.

2.2 Methods

Dirt's and other extraneous materials were removed from the nuts with a stainless steel knife and the nuts oven dried at 80ºC for 16h [3]. They were pulverized with a ceramic mortar and pestle to powder and the powder used for subsequent analysis.

2.2.1 Biochemical analyses

Dry matter in *Cola acuminata* was calculated by drying 100g of the Cola varieties and 40ºC till a constant weight was obtained and the value was expressed in percentage [17] Proximate composition (Crude protein, fat, ash and crude fibre contents) analyses was done with AOAC methods 920.87, 920.39, 923.03 and 962.09E respectively [18]. A modified method of Eric [19] was used for determining the sugar content while starch was determined by the titrimetric method of Moorthy and Padmaja [20]. Total carotenoids ($mg100g^{-1}$) were determined by a modified method of Ahmed and Beigh [21] using acetone and petroleum ether as extracting solvents and measuring the absorbance at 450nm. Mineral contents were done with the methods of Novozamsky et al. [22]

2.2.2 Phytochemical analyses

The phytate contents of *Cola acuminata* varieties were determined using the method of Dairo [23], alkaloid and tannin were quantified using the method of Alexis and Georges [24] and Obadoni and Ochuko [25] were used for phenol determination. Flavonoid content was determined using Boham and Kocipai [26]

2.3 Statistical Analysis

The analyses were carried out in triplicate. The mean and standard deviation of the data obtained were calculated using SPSS (17.0).

3. RESULTS AND DISCUSSION

Table 1 showed the chemical composition of *Cola acumulata* varieties. Dry matter content of white variety was higher (91.88%) than the red variety (88.69%). High dry matter content (98.70 %) was reported for *Buchholzia coriacea* seeds [11]. Dry matter content is important since it affects the mouth feel and the texture of the kolanut. Higher dry matter observed signified low moisture contents in the powder of *Cola acumulata* varieties leading to improved shelf life of the product.

White variety of *Cola acuminata* had higher protein (10.92%) content than red variety. Atanda et al. [3] reported higher protein contents of 13.38% for *Cola acuminata* powder while Ajai et al. [27] reported lower protein content (8.65%) for *Cola acuminata*. Protein values observed for fresh *Cola nitida* were 2.63% by Odebunmi et al. [9] while Jayeola [7] reported 8.90% protein content. Protein contents may depend on factors such as species, varieties, location and planting conditions. Protein contents of *Cola acuminata* varieties were higher than bitter kola (G*arcinia kola*) (2.48-1.86%) as reported by Odebunmi et al. [9] and Adesuyi et al. [28].

Fat and ash contents ranged from 11.56 to11.80% and 3.67 to 4.71% respectively with higher values in the red variety. There were slight differences in the fat and ash contents of the two varieties. Fat contents of *Cola acuminata* powder were high when compared to *Buchholzia coriacea* seeds (2.30%) [11]. Fat contents of 10.80% and 11.90% were observed for *Cola acumulata* and *Cola nitida* respectively [3]. High fat content in the kola powder may lead to susceptibility to rancidity.

Higher crude fibre (10.08%) and carbohydrate (55.65%) contents were observed in the white variety of *Cola acumulata*. Atanda et al. [3] reported crude fibre of 9.68% for *Cola acumulata* and 10.70% for *Cola nitida*. The value obtained for white variety was higher than the value (7.3%) reported for *Cola nitida* [7]. Crude fibre content of 2.19% was observed in *Buchholzia coriacea* seeds [11]. Ajai et al. [27] reported higher carbohydrate content (64.05%) for *Cola acuminata.* Carbohydrate contents of *Cola acuminata* varieties were slightly higher than *C. millenii* (51.54%) as reported by Ajayi and Ojelere [29]. Carbohydrates are common components of foods, both as natural components and as added ingredients. Their use is large in terms of both the quantities consumed and the variety of products in which they are found [30].*Cola acuminata* varieties are good source of energy to the body.

White variety of *Cola acuminata* had higher sugar (2.29%) and starch (10.80%) contents than the red variety. The sugar contents of *Cola acuminata* were higher than *Buchholzia coriacea* (1.14-1.17%) [11]. *Cola acumulata* contained appreciable amount of starch as storage reserves. Starch is the predominant food reserve substance in plants and provides 70–80% of the calories consumed by humans worldwide [30]. Starch is an important ingredient in various food systems as thickening, gelling and binding agents [31-32].*Cola acumulata* varieties cannot serve as a source of starch for industrial use due to the low starch contents when compared to other crops like cereals and roots and tubers.

Carotenoid (25.90mg/100g) contents of red variety were higher than white variety. Carotenoids act as a powerful antioxidant that neutralizes free radicals and stimulates the genes that prevents cells from becoming cancerous [33]. They serve as precursors to vitamin a (provitamin A). Rahmathullah et al.. [34] and Chakravarty [35] reported that consumption of carotene-rich food is a sustainable approach to combat vitamin A deficiency. Processing or direct consumption of *Cola acumulata* varieties could alleviate the problem of vitamin A deficiency in our society.

Table 1. Chemical composition (dry basis) of *Cola acuminata* powder varieties

Parameter	White	Red
Dry matter (%)	91.88±0.21	88.69±0.15
Ash content (%)	3.67±0.10	4.71±0.08
Fat (%)	11.56±0.11	11.80±0.10
Crude fiber (%)	10.08±0.36	9.42±0.24
Crude protein (%)	10.92±0.82	9.83±0.53
Carbohydrate (%)	55.65±0.30	52.93±0.27
Sugar (%)	2.29±0.69	2.20±0.44
Starch (%)	10.80±0.17	9.51±0.20
Carotenoid (mg/100g)	22.12±0.23	25.90±0.16

Mean ± standard deviation

Mineral composition of *Cola acuminata* varieties are shown in Table 2. Red variety had higher potassium (360.68mk/kg), magnesium (486.93mg/kg) and calcium (734.89mg/kg) while the white variety had higher values in sodium (78.74mg/kg) and phosphorus (112.20mg/kg). Phosphorus content (180mg/kg) was reported by Atanda et al. [3] for *Cola acuminata*and higher sodium content was also reported. Potassium, magnesium and calcium were also the predominant mineral contents in *Cola nitida* reported by Odebunmi et al. [9]. Ajai et al. [27] recorded minerals concentration of 0.60, 0.45, 0.17, 0.09 and 0.25 mg/g for calcium, potassium, iron, sodium and magnesium respectively for *Cola acuminata*. Variations in the mineral content values may be due to some factors such as soil type,

location, species and cultural practices adopted during planting. *Cola acuminata*serves as source of essential mineral contents that are useful for bone formation, aid digestion and maintain body processes.

Table 2. Mineral composition of *Cola acuminata* varieties

Parameter	White	Red
Na (mg/kg)	78.74±0.10	63.12±0.14
K (mg/kg)	324.80±0.32	360.68±0.57
Mg (mg/kg)	236.22±0.09	486.93±0.06
Ca (mg/kg)	420.76±0.12	734.89±0.10
P (mg/kg)	112.20±0.11	93.78±0.09

Mean ± standard deviation

Phytochemical analyses of Cola acuminata are presented in Table 3. Red variety contained higher phytate (10.67mg/100g), phenol (33.50mg/100g) and flavonoids (12.13mg/100g) contents. White variety had higher tannin (8.13mg/100g) and alkaloid (8.21mg/100g) contents. Flavonoids, phenolic acids and tannins belong to polyphenol group with anti-oxidative properties. Flavonoids are potent water soluble antioxidants and free radical scavengers which prevent oxidative cell damage, have strong anticancer activity and protect against the different levels of carcinogenesis [12,36]. They are non-toxic and are found in the colouring of plants thus making kola nut a potential source of food colorant [3]. In food, polyphenols may contribute to the bitterness, astringency, colour, flavour, odour and oxidative stability [37-38].Tannins bind to both proteins and carbohydrates and their presence can cause browning or other pigmentation problems in both fresh foods and processed products [12].The presence of tannin in the plants implies they may have astringent properties and in addition, could quicken the healing of wounds and burns [12,39]. Alkaloids are the most efficient therapeutically significant plant substances. Pure isolated alkaloids and their synthetic derivatives are used as basic medicinal agents because of their analgesic, antispasmodic and anti-bacterial properties [12]. The alkaloid compounds found in kola nuts can therefore be useful in pharmaceutical preparations [3,40]. Phytate forms complexes with dietary minerals, especially iron and zinc, and causes mineral-related deficiency in humans. Apart from this, it's consumption provides protection against a variety of cancers mediated through anti-oxidation properties, interruption of cellular signal transduction, cell cycle inhibition and enhancement of natural killer cells activity [41]. The bioactive compounds in *Cola acumulata* are comparable to *Cola nitida*, *Garcinia cola* and *Buchiacea* [11]. Therefore, *Cola acumulata* could be used in pharmaceutical and food industry.

Table 3. Phytochemical analysis of *Cola acuminata* varieties

Parameter	White	Red
Phytate (mg/100g)	6.52±0.23	10.67±0.19
Tannin (mg/100g)	8.13±0.07	2.04±0.04
Alkaloid (mg/100g)	8.21±0.10	6.90±0.09
Phenol (mg/100g)	15.60±0.28	33.50±0.16
Flavonoids (mg/100g)	6.51±0.09	12.13±0.10

Mean ± standard deviation

4. CONCLUSION

Cola acuminata varieties (red and white) contained essential nutrients needed for growth and development. The chemical properties of the kolanut compared with other crops and

the phytochemical properties indicated their importance in pharmaceutical industries. Therefore, its uses in food industry could improve the utilization of the kolanut apart from using it in social functions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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