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Comparative Proximate, Vitamins, Minerals and Phytochemical Analysis of *Cola rostrata* K. Schum. and *Cola parchycarpa* K. Schum.

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ABSTRACT: *Cola rostrata* and *Cola parchycarpa* are under-utilized indigenous kola plants, known as achicha by the Igbo natives in Nigeria, whose fruit pulps are edible and tasty. The proximate, vitamins, minerals and phytochemicals constituent of the fruit epicarp, fruit pulp and seed of *C. rostrata* and *C. parchycarpa* were evaluated using standard analytical laboratory procedures. The results revealed that *C. rostrata* and *C. parchycarpa* fruit pulps contained high moisture contents (56.56 % and 58.83 %) and carbohydrates (31.30 % and 55.39 %) respectively. They also contained vitamins and minerals that are required for nutrition in humans and animals. However, *C. rostrata* fruit pulp had higher concentrations of magnesium (80.36 mg/100g), calcium (170.31 mg/100g), vitamin A (54.53 mg/100g), vitamin C (21.41 mg/100g) and vitamin E (4.25 mg/100g), while *C. parchycarpa* had higher concentrations of all the phytochemicals screened. These phytochemicals, if explored further, can be implored in the treatment of certain ailments. The fruit pulp can be recommended for individuals who suffer from calcium deficiency while the seed and fruit epicarp could be used in the formulation and fortification of animal feeds due to the substantial nutrient deposits in them as revealed by this study.

Keywords: *Cola rostrata*, *Cola parchycarpa*, Vitamins, Minerals, Phytochemicals

Introduction

Cola rostrata K. Schum. and *Cola parchycarpa* K. Schum. belong to the family Malvaceae, subfamily Sterculioideae and are commonly called monkey kola (Keay, 1989). Monkey kola is a common name given to a number of minor relatives of the *Cola* species that produce edible tasty fruits. The fruit pulp or aril, which is the edible part of the fruit, varies in colour, from yellow in *C. rostrata* to white in *C. parchycarpa*. The seeds of monkey kola species are not edible unlike the seeds of *Cola nitida* and *Cola acuminata* which are known for their masticatory and stimulating nuts (Bosch *et al*., 2002).

Cola parchycarpa is a cauliflorous tree with leaflets oblanceolate to obovate, always petiolulate, not lobed and subglabrous beneath. Fruiting carpels shortly stipulate, ellipsoid or oblong, stout and glabrous (Hutchinson and Dalziel, 1972). *Cola rostrata* leaflets are oblanceolate to obovate, not lobed, very abruptly long caudate acuminate at apex. Fruiting carpels brown irregular conical warts, ellipsoid to subglobose (Hutchinson and Dalziel, 1972). Essien *et al*. (2015) and Udousoro and Essien (2017) studied the chemical composition of two monkey kola species (*Cola rostrata* and *Cola lepidota*).

Tropical African sub-regions are home to many plant species whose potentials have not been fully realized (Ogbu and Umeokechukwu, 2014). When scientific and institutional attention is given to African fruits studies, they are capable of contributing immensely to the nutrition, health and economic development of several countries in the world (Akinnifesi *et al.*, 2007). In Africa, fruit trees constitute one of the best tools for preventing diseases caused by lack or insufficient supply of vitamins in diet (Lovett *et al.*, 2006). Fruit, also

used as food, contains a variety of organic compounds, which at certain critical levels have anti-nutritional components such as oxalate, phytic acid and hydrocyanic acid (Omorayi and Dilworth, 2007). Hence, the need to investigate these two underutilized *Cola* species whose fruit pulp serve as food for their proximate, vitamins, minerals and phytochemical constituents.

Materials and methods

Sample collection and preparation: The fruits of *C. rostrata and C. parchycarpa* were collected in a homestead from Amaba Amaokwe Item in Bende Local Government Area of Abia State, Nigeria. The seed, fruit pulp and fruit epicarp of the fruit were separated (Plate 1), chopped into small pieces, oven dried at 40 ºC. The dried samples were milled into powder with the aid of a blender, and stored in desiccators until required for analysis.

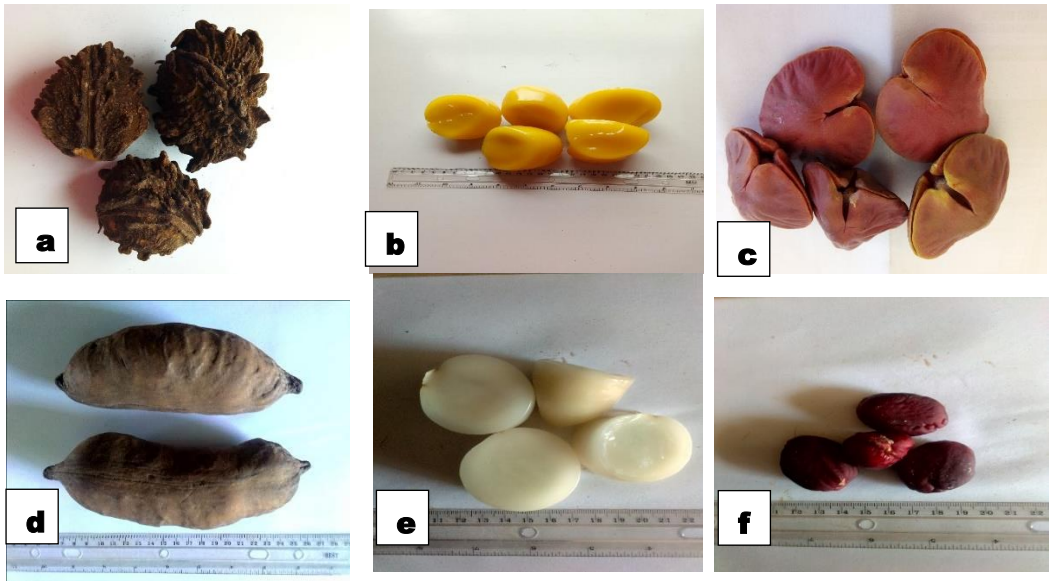

Plate 1: Fruits of *Cola rostrata* and *Cola parchycarpa* (a) *Cola rostrata* fruit epicarp (b) *Cola rostrata* fruit pulp (c) *Cola rostrata* seed (d) *Cola parchycarpa* fruit epicarp (e) *Cola parchycarpa* fruit pulp (f) *Cola parchycarpa* seed.

Proximate analysis: The moisture content, ash, crude protein, crude fibre and fat of the samples were determined using methods of AOAC (2000, while carbohydrate content was calculated by difference (Pearson, 1976). All determinations were done in duplicates and reported in percentage.
Vitamin analysis: The spectrophotometric methods by Onwuka (2005) and Okwu (2004) were employed in the determination of vitamin contents. The sample (0.1 g) was extracted using ethanol and concentrated to 1.0 ml for chromatographic analysis.
Mineral element analysis: Potassium and sodium were determined using flame photometer, while calcium, magnesium, iron, and zinc were determined using atomic absorption spectrophotometer as described in the methods of AOAC (2000). Phosphorous was determined by Vanado molybdate colorimetric method as described by James (1996). All determinations were done in duplicates and reported in mg/100g.
Phytochemical analysis: Flavonoids, tannins, phenol, hydrogen cyanide (HCN), alkaloids, phytate and saponins were screened by the methods of Harbone (1991) and Kotoky *et al*. (2005).
Statistical analysis: All data generated were analyzed using descriptive statistics and values were reported as mean ± standard deviation. Statistical Analysis System (SAS) software version 9.4 was employed.

Results

Cola parchycarpa had higher quantities of all the proximate parameters (moisture content, ash, crude protein, crude fibre and carbohydrate), except for the fat content which was higher in *Cola rostrata* (Table 1). The fruit pulp of each of the *Cola* species had the highest moisture content and the lowest carbohydrate content when compared to the fruit epicarp and seed of the *Cola* species.

Table 1: Proximate composition of *Cola rostrata* and *C. parchycarpa* (%)

Parameter	*Cola rostrata*			*Cola parchycarpa*		
	Fruit epicarp	**Fruit pulp**	**Seed**	**Fruit epicarp**	**Fruit pulp**	**Seed**
Moisture Content	11.8±0.60	56.56±0.23	15.79±0.01	12.73 ± 0.04	58.83 ± 0.99	18.83 ± 0.08
Ash	7.14±0.03	3.25±0.01	3.88 ± 0.03	6.86 ± 0.06	3.87 ± 0.04	4.73 ± 0.02
Crude Protein	7.14±0.03	4.84±0.02	7.51±0.13	8.43 ± 0.04	5.88 ± 0.06	8.15 ± 0.02
Crude Fibre	4.91±0.01	2.44±0.02	2.84 ±0.03	5.66 ± 0.06	3.01 ± 0.16	3.25 ± 0.01
Fat	0.61±0.01	1.62±0.00	0.81±0.01	0.47 ± 0.01	1.47 ± 0.01	0.47 ± 0.01
Carbohydrate	69.52±0.08	31.30±0.24	69.17±0.16	108.59 ± 0.04	55.39 ± 0.04	108.59 ± 0.04

Values show means of duplicate analysis ± standard deviation

In comparison of the mineral composition of both *Cola* species, *Cola rostrata* was richer in magnesium, zinc and calcium contents while *C. parchycarpa* was richer in sodium and potassium contents (Table 2). However, the seeds of *C. rostrata* and *C. parchycarpa* had higher levels of all the minerals tested when compared to their fruit epicarp and fruit pulp.

Table 2: Mineral composition of *Cola rostrata* and *C. parchycarpa* (mg/100g)

Minerals	*Cola rostrata*			*Cola parchycarpa*		
	Fruit epicarp	**Fruit pulp**	**Seed**	**Fruit epicarp**	**Fruit pulp**	**Seed**
Mg	46.71 ± 0.01	80.36 ± 0.06	95.27 ± 0.04	48.52 ± 0.31	78.51 ± 2.16	82.58 ± 0.03
Na	24.77 ± 0.10	42.71 ± 0.01	56.36 ± 0.08	26.36 ± 0.09	45.32 ± 0.03	58.51 ± 0.16
K	52.66 ± 0.05	82.70 ± 0.00	125.22 ± 0.54	54.72 ± 0.17	83.67 ± 0.10	128.61 ± 0.01
Zn	1.08 ± 0.00	1.41 ± 0.01	1.84 ± 0.00	0.85 ± 0.01	1.25 ± 0.02	1.67 ± 0.02
Fe	0.94 ± 0.02	2.51 ± 0.01	3.63 ± 0.02	0.94 ± 0.03	2.66 ± 0.06	3.82 ± 0.03
P	22.75 ± 0.07	36.79 ± 0.01	48.31 ± 0.16	20.81 ± 0.04	35.60 ± 0.31	49.18 ± 0.59
Ca	48.78 ± 0.03	170.31 ± 0.16	220.67 ± 0.05	45.80 ± 0.00	163.82 ± 0.03	216.57 ± 0.38

Values show means of duplicate analysis ± standard deviation

Cola rostrata fruit epicarp, fruit pulp and seed had higher vitamins A, C, and E content when compared to *Cola parchycarpa* (Table 3). The fruit pulp of *C. rostrata* and the fruit pulp of *C. parchycarpa* contained higher amount of vitamins compared to their seed and fruit epicarp.

Table 3: Vitamins composition of *Cola rostrata* and *C. parchycarpa* (mg/100g)

Vitamin	*Cola rostrata*			*Cola parchycarpa*		
	Fruit epicarp	**Fruit pulp**	**Seed**	**Fruit epicarp**	**Fruit pulp**	**Seed**
A	2.77 ± 0.01	54.53 ± 0.33	3.28 ± 0.00	2.87 ± 0.04	48.66 ± 0.08	3.47 ± 0.02
B1	0.04 ± 0.00	0.07 ± 0.00	0.04 ± 0.00	0.03 ± 0.00	0.07 ± 0.00	0.05 ± 0.00
B2	0.02 ± 0.00	0.04 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.02 ± 0.00
B3	0.20 ± 0.00	0.35 ± 0.00	0.25 ± 0.01	0.18 ± 0.00	0.31 ± 0.01	0.21 ± 0.01
C	4.76 ± 0.06	21.41 ± 0.01	6.41 ± 0.01	3.87 ± 0.04	16.79 ± 0.01	5.79 ± 0.01
E	1.71 ± 0.01	4.25 ± 0.07	2.89 ± 0.05	1.67 ± 0.02	3.16 ± 0.00	2.79 ± 0.01

Values show means of duplicate analysis ± standard deviation

The quantity of phytochemicals present in *Cola parchycarpa* was higher than that present in *Cola rostrata* (Table 4). In both *Cola* species, the edible fruit pulp had the least quantity of phytochemical deposit and the phytochemical constituents are below permissible toxic levels.

Table 4: Phytochemical composition of *Cola rostrata* and *C. parchycarpa* (mg/100g)

Parameter	*Cola rostrata*			*Cola parchycarpa*		
	Fruit epicarp	**Fruit pulp**	**Seed**	**Fruit epicarp**	**Fruit pulp**	**Seed**
Flavonoids	0.75 ± 0.01	0.42 ± 0.01	0.61 ± 0.01	0.81 ± 0.00	0.48 ± 0.01	0.64 ± 0.01
Tannins	1.04 ± 0.00	0.52 ± 0.00	0.76 ± 0.00	1.06 ± 0.01	0.57 ± 0.01	0.77 ± 0.01
Phenols	0.32 ± 0.03	0.14 ± 0.00	0.17 ± 0.01	0.33 ± 0.01	0.63 ± 0.71	0.67 ± 0.73
Hydrogen cyanide	0.87 ± 0.01	0.60 ± 0.00	1.03 ± 0.01	0.93 ± 0.01	0.64 ± 0.01	1.05 ± 0.04
Alkaloids	1.47 ± 0.01	0.42 ± 0.00	1.25 ± 0.01	1.49 ± 0.01	0.45 ± 0.00	1.27 ± 0.02
Phytates	1.13 ± 0.01	0.37 ± 0.02	0.96 ± 0.01	1.24 ± 0.03	0.39 ± 0.01	1.05 ± 0.02
Saponins	0.55 ± 0.01	0.25 ± 0.00	0.42 ± 0.00	1.06 ± 0.65	0.28 ± 0.00	0.46 ± 0.01

Values show means of duplicate analysis ± standard deviation

Discussion

High moisture contents of *Cola rostrata* and *Cola parchycarpa* (Table 1) indicate that they are susceptible to microbial attack and may also have short shelf life. The high moisture content of *C. parchycarpa* agrees with the report of Udousoro *et al.* (2017), Okudu *et al.* (2015) and Odion *et al.* (2013) and this high moisture content may be responsible for the fast spoilage of the fruit in storage. According to Odion (2013), moisture content and total ash value of *C. rostrata* root bark were 10.23±0.55 and 13.39±0.05 respectively. They also concluded that the crude extract of *C. rostrata* administered orally is relatively safe. The ash contents of the fruit epicarps of both *Cola* species were higher than their fruit pulps and seeds. Oyeyede (2005) postulated that high ash levels of the exocarp indicates that mineral elements are likely to be concentrated in the exocarp than in the endocarp. The fruit pulp of these *Cola* species was observed to be very low in crude protein, crude fibre, and carbohydrate. Protein are essential components of the diet needed for survival and the supply of adequate amounts of required amino acids (Pugalenthi *et al.*, 2004). Christopher and Okon (2016) observed and postulated that *C. rostrata* is a poor supplier of protein. The low crude fibre value of *C. rostrata* can be beneficial to health and can be used in diets designed for weight reduction (Okudu *et al*., 2015). Fibre in nutrition expands the internal walls of the colon, eases the passage of waste products and acts as anti-constipation agent. Low fibre intake is recommended for infants and pre-school children as high intake is implicated in the irritation of gut mucosa and gut perturbation (Eromosele and Eromosele, 1991; Bello *et al.*, 2008). The relative high amount of carbohydrates in the white fruit pulp of *C. parchycarpa* may be due to the sugary taste it has when compared with the yellow fruit pulp of *C. rostrata*.

Cola rostrata was richer in magnesium, zinc and calcium contents compared to *C. parchycarpa* (Table 2). Osabor *et al.* (2015) also reported that calcium was the most predominant element in the endocarp of *Cola lepidota* and that mineral elements are needed in the body for proper functioning. Calcium plays fundamental roles in most reactions involving phosphate transfer, believed to be essential in the structural suability of nucleic acid and intestinal absorption (Appel, 1999). Magnesium was reported as an activator of many enzymes systems and maintains the electrical potential in nerves while zinc is needed for catalysis, stabilization of cell membranes and regulation of gene expression (Black, 2003). In a similar studies conducted by Udousoro and Essien (2017), it was also reported that higher levels of Na, Ca, Mg, Zn, Cu and Mn in the fruit epicarp; iron and potassium in aril and seed respectively. *C. parchycarpa* was richer in sodium and potassium contents. According to Ene-Obong *et al.* (2014), the most abundant minerals for *C. parchycarpa* are calcuim and B-carotene while most abundant for *C. lepitoda* is potassium. Arinanthan *et al.* (2005) reported that high concentration of potassium is beneficial to people taking diuretic to control high blood pressure. Wild fruits are generally good sources of calcium, magnesium and potassium (Lockett *et al* 2000; Nnam and Obiakor, 2003). These *Cola* species have shown to be natural sources of antioxidants.

The yellow fruit pulp of *C. rostrata* and the white fruit pulp of *C. parchycarpa* contained higher amount of vitamins compared to their seed and fruit epicarp (Table 3). These vitamins are significant component of food required for normal growth, self-maintenance and functioning of human systems. Udousoro and Essien (2017) observed that the white aril of *C. parchycarpa* contained higher amount of vitamins compared to the seed and fruit pericarp. It was observed from this study that *C. rostrata* and *C. parchycarpa* had very low quantities of vitamins B1, B2 and B3 but contained high deposits of vitamins A, C, and E especially in the fruit pulp. The yellow colour of the fruit pulp of *C. rostrata* may explain the reason for the high value of vitamin A (54.53 ± 0.33) in the fruit. However, it is generally accepted that the concentration of vitamin C in the indigenous wild fruits is higher than that in exotic fruits (Wehmeyer, 1966).

The fruit pulp, fruit epicarp and seed of *Cola pachycarpa*, is richer in flavonoids, tannins, and phenol when compared to *Cola rostrata* (Table 4). This result agrees with the observation of Odion *et al.* (2013). Phenols and flavonoids are grouped among phytochemicals with health benefit (Heim and Keil, 2004 and Mallavadhani *et al.*, 2006). Okudu *et al.* (2015) also observed the presence of flavonoids, tannins and phenol in *Cola rostrata* root bark but Odion *et al.* (2013) reported the absence of alkaloids in *C. rostrata* root bark. Flavonoids are known to have different pharmacological activities but most importantly, its antioxidant activities have been exploited because of its ability to donate protons (Alan and Miller, 1996). Tannins are reported to have astringent property this has been taken advantage of in the treatment of wounds (Halken and Host, 2001). Phenols are complex of oil which is used in the treatment of wild range of ailments which includes malaria (Evans, 2002). According to Essien *et al.* (2015), the fruit pulp of *C. rostrata* contained the highest amount of flavonoids (60.5 µgQE/g) when compared to its seed but in this study flavonoids was higher in the seed (0.61 ± 0.01) of *C. rostrata* than its fruit pulp (0.42 ± 0.01).

Conclusion

Cola parchycarpa and *Cola rostrata* contains appreciable amount of nutrients, while the phytochemical constituents are below permissible toxic levels and indicate probable lack of interference with the availability of mineral elements. *C. pachycarpa* however, had higher crude protein, moisture content, crude fibre and carbohydrate. *Cola rostrata* was very rich in Ca, Mg, vitamin C, B_1 and E. The seed and fruit epicarp of *C. rostrata* and *C. parchycarpa* could be used in the formulation or fortification of animal feeds due to substantial nutrient deposit in them, while the fruit pulp can be recommended for individuals who suffer from calcium deficiency. Since these *Cola* species have shown to be natural sources of antioxidants, there is need for the elucidation of their potential biological activity.

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