Evaluation of the Nutrients and Phytochemical Composition of Two Varieties of Monkey Kola Membrane

(Cola parchycarpa and Cola lepidota)

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Monkey kola is a common name given to some edible wild relatives of West African kolanut, viz Cola lateritia K. Schum, C. lepidota K. Schum and C. parchycarpa K. Schum. The yellow and white varieties of monkey kola were collected from the major markets in Calabar (in the South-south zone) and Umuahia (in the South - east zone) Nigeria. C. parchycarpa membrane had significantly (p<0.05) higher crude protein (15.25-21.6 g/100g), crude fat (0.94-2.66 g/100g), Ca (186 mg/100g), Mg (48.65-79 mg/100 g) and P (30.15-32.65 mg/100g), Zn (9.15-10.68 mg/100g), Cu (4.77-7.82mg/100g) while C.lepidota membrane (mg/100g) had significantly (p<0.05) higher K(127-140.9),Na (32.65-41.75), Fe (8.60-13.49). β-carotene and vitamin C (928.5 -1003 mcg/100g ; 15.4- 19.5 mg/100g respectively) were found in significant amount in C. parchycarpa membrane than in C.lepidota membrane (444-462.5 mcg/100g; 9.45-9.75 mg/100g). The B-vitamins, particularly riboflavin and niacin were found in significant amount in monkey kola membrane. Both varieties of monkey kola had substantial amounts of phytochemicals (particularly alkaloids, phenols, flavonoids and saponins). The high phytochemical values obtained in monkey kola seed makes it an important seed that need to be fully exploited.

Key words: Cola parchycarpa, Cola lepidota, membrane, Varietal difference, β-carotene, bioactive compounds

INTRODUCTION

Tropical African sub-regions are home to many valuable fruit species whose potentials have not been fully realized. A good number of these fruit species are not yet domesticated; and records show that plant foods represents the largest segment of dietary diversity that offers useful perspectives on a number of issues of contemporary scientific and public health importance including, micronutrient deficiency and bioavailability, nutrition and disease, medicinal and functional activities (Kant et al., 1995; Popkin, 2002; Johns, 2003). Fruits as members of plant foods are generally known for their rich micro-nutrient constituents, low caloric and protective effects (Shiundu, 2002; Sachdeva et al., 2013). The protective effect is mediated probably through the action of antioxidants and micronutrients (WHO, 2003). The fiber content of fruit is reported to have beneficial effects...
on blood cholesterol and also aid in the prevention of large bowel diseases (Williams et al., 2009). It has been shown that population that consume diets rich in fruits usually have significantly lower rates of certain types of cancer (Voorrips et al., 2000). Fruits are also low in calorie which can help lower one’s calories intake as part of a weight loss diet (Ene-Obong et al., 2014).

Monkey kola is a common name given to a number of minor relatives of the *Cola* spp. that produce edible tasty fruits. Native people of southern Nigeria and the Cameron relish the fruits, as well as some wild primate animals especially monkeys, baboons and other species. They belonged to the same botanical family Malvaceae and sub-family Sterculioideae with the popular West African plantation kola nuts (*Cola nitida*), grown for their masticatory and stimulating nuts (Keay, 1989; Bosch et al., 2002; APG, 2009). Among the species commonly referred to by this name (Monkey kola) are the *Cola pachycarpa*, *C. lepidota* and *C. lateritia* (Meregini, 2005). The pod of the yellow variety is roundish, while the white variety has more cylindrical shape. Monkey kola is identified by various local names in Southern Nigeria (“achicha” or “ohiricha” in Igbo and “ndiyah” in Efik) (Ogbu et al., 2007). Monkey kola is cultivated throughout the tropical regions of the world; it is commonly found in Southern Nigeria between the months of June to Nov. (Ogbu et al., 2007). Monkey kola has nutritional and medicinal values (Pamplona-Roger, 2008; Singh et al., 2010). Record shows that the yellow variety pulp is a good source of crude protein, crude fiber, crude fat, Ca, Mg, Zn, Cu, β-carotene and niacin while, *C. lepidota* (the white variety) pulp is a good source of ash, starch, carbohydrate, K, P, and Se contents (Ene-Obong et al., 2014). Like most consumed fruits in Nigeria only the pulp of the fruit is usually consumed. The membrane and seeds are normally discarded as waste. Membrane consumption of monkey kola along with the pulp or incorporating it into food may increase intake particularly those of micronutrients. This study was therefore designed to evaluate the chemical composition of two varieties of monkey kola seeds (*Cola pachycarpa* and *Cola lepidota*).

MATERIALS AND METHODS

Source of materials and identification

The two varieties monkey kola (*Cola pachycarpa* and *Cola lepidota*) were identified botanically in the Department of Forestry, Michael Okpara University of Agriculture, Umudike, Abia State. Nigeria. The yellow and white varieties were collected from the major markets in Calabar (in the South-South zone) and Umuahia (in the South - East zone) Nigeria purchased from at least 5 randomly selected vendors in the various markets and pooled to obtain the samples for the study (Figure 1).

![Figure 1: Title](Image 320x621 to 448x716)

Monkey kola membrane preparation for chemical analysis

The fruits were inspected and sorted. Fruits that were firm, matured and free from insect damage or mechanical injuries were selected. The outer covering of the fruits were cut open using a knife and stripped/peeled off manually. The pulps (edible part) were carefully cut longitudinally and then separated from the seed. The membranous layer separating the pulp from the seed was scraped off using a knife. Samples were dried for 72h using locally constructed solar dryer. Milling the dried seeds into flour was done using attrition milling machine (Thomas Wiley Model ED-5 USA) to 5mm sieve size. The milled samples were collected in air-tight polythene for chemical analysis.

Proximate analysis

The proximate composition of the samples was determined by AOAC (2006). Moisture content of the samples was carried out by oven drying at 105°C to constant weights. Crude protein was determined using micro-kjeldahl method. Crude fat was determined by Soxhlet extraction method using petroleum ether. Ash was determined by furnace incineration method. Crude fiber was determined by digesting the sample in a reagent mixture (Trichloroacetic acid, acetic acid, nitric acid and distilled water), boiling, refluxing, drying and ashing. Carbohydrate was obtained by difference, while gross energy (KJ and Kcal per 100g) was calculated based on the formula by Eknayake et al. (1999). Gross energy (Kcal per 100g dry matter) = (crude protein x 16.7) + (crude lipid x 37.7) + (crude carbohydrate x 16.7) for proteins, carbohydrates and lipids respectively.

Determination of minerals

The minerals were determined using wet acid digestion method for multiple nutrient determinations as described by AOAC (2006). K and Na were determined by Flame photometer (Jenway Digiter, Model PFP7, USA). Ca and
Mg were determined by EDTA Versarale Complexiometric titration method. P was determined by the phosphovanado-molydate yellow method (AOAC, 2006). The Fe was determined by Atomic Absorption Spectrophotometer (Model 3030 Perkin Elmer, Norwalk USA).

**Determination of vitamins**

Vitamins A, thiamin, niacin, riboflavin, vitamin E and folic acid were determined by using spectrophotometric method. Ascorbic acid by dye solution of 2, 6-dichloroindophenol (DCIP) titration method was determined according to the Association of Official Analytical Chemist Methods (AOAC, 2006).

**Determination of anti-nutrients**

Gravimetric method (Harborne, 1973) was used to determine alkaloids and flavonoids. Tannin content of the samples was determined spectrophotometrically as described by Kirk and Sawyer (1991). Saponins were determined by comparing the absorbance of the extract of the samples with the standard at 380nm (Makkar and Becker, 1996). Oxalate was determined spectrophotometrically at 420 nm as described by AOAC, (2006). Phytate was determined by titration with ferric chloride solution using the method described by Makkar and Becker (1996).

**Statistical analysis**

The obtained results from the various analyses were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS version 16.0). (SPSS Inc., Chicago IL, USA).

**RESULTS**


Energy and proximate composition of 2 varieties monkey kola membrane (C.parchycarpa and C.lepidota) are presented in (Table 1). Moisture (%) ranged between 4.76-6.62 for Cola parchycarpa membrane and 3.73 - 5.92 for Cola lepidota membrane. Crude protein (15.25-21.6%), crude fat (0.69-2.66%), fiber (5.86-6.15%), and ash (9.10 -12.02%) obtained in C.parchycarpa membrane were significantly higher than crude protein (7.64-14.20%), crude fat (0.69-0.74%), crude fiber (1.84 -2.65%), and ash (6.19-7.54%) obtained in Cola lepidota membrane. Carbohydrate and energy calculated for C.lepidota membrane (72.49-76.37% vs 342-353 kcal respectively) were higher than those of C. parchycarpa membrane (54.16-60.88% vs 312 -326kcal respectively).


The mineral composition (mg/100g) of the 2 varieties of monkey kola membrane (C. parchycarpa and C.lepidota) is presented in (Table 2). Ca (186) obtained for C. parchycarpa membrane irrespective of location was significantly (p<0.05) higher than that of C. lepidota membrane (122 - 130). Mg ranged between 48.2-79 mg/100g. C.parchycarpa membrane South-East having the highest (79). K (127-140.9) was significantly (p<0.05) higher in C.lepidota membrane than in C.parchycarpa membrane (50-68.75). Na and P were generally low in all the samples. Na ranged between 25-41.75 mg/100g while, P (25-32.65). Micro-mineral (mg/100g) results in (Table 2) showed that C.parchycapa membrane had higher Zn (9.15-10.65) and Cu (1.47-2.16) than C. lepidota membrane (1.13-3.14 vs 1.47-7.82 respectively). Fe varied between 9.65- 10.68 for C.parchycarpa membrane and 8.60-13.49 for C.lepidota membrane, with C. lepidota membrane South-East having the highest Fe value. C.lepidota membrane was a better source of Se (0.15-0.17) than C.parchycarpa membrane (0.01-0.02).

Vitamin compositions of 2 varieties monkey kola membrane (C.parchycarpa and C.lepidota)

The vitamin composition of the yellow and white varieties of monkey kola is presented on (Table 3). β-carotene obtained in C. parchycarpa membrane (928.5-1003 mcg/100g) was higher than 444-462 mcg/100g obtained in C.lepidota membrane. Also vitamin C (mg/100g) obtained in C. parchycarpa membrane (15.4-19.5) was significantly higher than that of C.lepidota membrane (9.45-9.75mg/100g). The B-vitamins (mg/100g), riboflavine (0.88-1.42), niacin (2.84-3.84), and thiamin (0.91-1.69) obtained in C. lepidota membrane were significantly higher than those obtained in C. parchycarpa membrane (0.42 -0.52, 2.23-3.04 and 0.59-0.72 respectively).

Phytochemical compositions of 2 varieties monkey kola membrane (C.parchycarpa and C.lepidota)

The phytochemical composition of monkey kola (C.parchycarpa and C.lepidota) membrane is shown in (Table 4). Flavonoid (mg/100g) ranged between 33-44 in C.parchycarpa membrane, while in C. lepidota membrane it ranged between 24.78-31.21.Obtained alkaloids in C.parchycarpa membrane (646-784 mg/100g) was higher than the value (288-346 mg/100g) obtained for C. lepidota membrane. Saponins and
Table 1. Energy and proximate composition of 2 varieties of monkey kola (C. parchycarpa and C. lepidota) membrane.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>CPSEM</th>
<th>CPSSM</th>
<th>CLSEM</th>
<th>CLSSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>6.62± 0.67</td>
<td>4.76±0.14</td>
<td>5.92±1.21</td>
<td>3.73±0.83</td>
</tr>
<tr>
<td>Crude protein %</td>
<td>21.6±0.04</td>
<td>15.25±0.07</td>
<td>7.64±0.62</td>
<td>14.20±1.26</td>
</tr>
<tr>
<td>Crude fat %</td>
<td>2.66±0.53</td>
<td>0.94±0.42</td>
<td>0.69±0.12</td>
<td>0.74±0.14</td>
</tr>
<tr>
<td>Crude fiber %</td>
<td>5.86±0.59</td>
<td>6.15±0.49</td>
<td>1.84±0.62</td>
<td>2.65±0.55</td>
</tr>
<tr>
<td>Ash %</td>
<td>9.10±0.84</td>
<td>12.02±0.87</td>
<td>7.54±2.17</td>
<td>6.19±0.12</td>
</tr>
<tr>
<td>Carbohydrate* %</td>
<td>54.16</td>
<td>60.88</td>
<td>76.37</td>
<td>72.49</td>
</tr>
<tr>
<td>Energy (kcal/KJ/100g)</td>
<td>326/1386</td>
<td>312/1328</td>
<td>342/1453</td>
<td>353/1501</td>
</tr>
</tbody>
</table>

Values of means ± standard deviation of double determinations. * calculated by difference; CPSEM- C. parchycarpa South-east membrane; CPSSM- C. parchycarpa South-south membrane; C. lepidota South-east membrane; C. lepidota South-south membrane.

Table 2. Mineral composition of 2 varieties of monkey kola (C. parchycarpa and C. lepidota) membrane (mg/100g).

<table>
<thead>
<tr>
<th>Element</th>
<th>CPSEM</th>
<th>CPSSM</th>
<th>CLSEM</th>
<th>CLSSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>186±7.07</td>
<td>186±2.12</td>
<td>130±0.49</td>
<td>122±2.33</td>
</tr>
<tr>
<td>Magnesium</td>
<td>79±8.55</td>
<td>48.65±8.55</td>
<td>48.20±0.56</td>
<td>48.2±0.56</td>
</tr>
<tr>
<td>Potassium</td>
<td>68.75±1.76</td>
<td>50±3.53</td>
<td>140.9±1.40</td>
<td>127±4.24</td>
</tr>
<tr>
<td>Sodium</td>
<td>33.75±5.30</td>
<td>25±3.53</td>
<td>41.75±0.53</td>
<td>32.65±0.53</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>30.15±1.90</td>
<td>32.65±0.56</td>
<td>25.25±0.21</td>
<td>27.35±0.91</td>
</tr>
<tr>
<td>Zinc</td>
<td>10.68±0.51</td>
<td>9.15±0.42</td>
<td>1.13±0.09</td>
<td>3.14±0.14</td>
</tr>
<tr>
<td>Copper</td>
<td>7.62±0.14</td>
<td>4.77±0.14</td>
<td>2.16±0.04</td>
<td>1.47±0.01</td>
</tr>
<tr>
<td>Iron</td>
<td>10.68±0.51</td>
<td>9.65±0.42</td>
<td>13.49±0.01</td>
<td>8.60±0.09</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.02±0.00</td>
<td>0.01±0.00</td>
<td>0.17±0.01</td>
<td>0.15±0.00</td>
</tr>
</tbody>
</table>

Values of means ± standard deviation of double determinations. * calculated by difference; CPSEM- C. parchycarpa South-east membrane; CPSSM- C. parchycarpa South-south membrane; C. lepidota South-east membrane; C. lepidota South-south membrane.

Table 3. Vitamin composition of 2 varieties of monkey kola (C. parchycarpa and C. lepidota) membrane.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>CPSEM</th>
<th>CPSSM</th>
<th>CLSEM</th>
<th>CLSSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-carotene (mcg/100g)</td>
<td>926.5±1.12</td>
<td>1003±2.17</td>
<td>444±2.89</td>
<td>462.5±3.53</td>
</tr>
<tr>
<td>Vitamin C (mg/100g)</td>
<td>19.5±3.53</td>
<td>15.4±3.11</td>
<td>9.75±0.77</td>
<td>9.45±0.49</td>
</tr>
<tr>
<td>Riboflavin (mg/100g)</td>
<td>0.42±0.02</td>
<td>0.52±0.42</td>
<td>0.88±0.02</td>
<td>1.42±0.11</td>
</tr>
<tr>
<td>Niacin (mg/100g)</td>
<td>2.23±0.00</td>
<td>3.04±0.00</td>
<td>3.84±0.22</td>
<td>2.84±0.06</td>
</tr>
<tr>
<td>Thiamin (mg/100g)</td>
<td>0.59±0.09</td>
<td>0.72±0.00</td>
<td>0.91±0.55</td>
<td>1.69±0.12</td>
</tr>
</tbody>
</table>

Values of means ± standard deviation of double determinations. * calculated by difference; CPSEM- C. parchycarpa South-east membrane; CPSSM- C. parchycarpa South-south membrane; C. lepidota South-east membrane; C. lepidota South-south membrane.

phenols 9 mg/100g) obtained for C. parchycarpa membrane South-South (20.5;30 respectively) were comparable to those of C. lepidota membrane irrespective of location (20.50-27; 30.5-43 respectively). Obtained tannin obtained for C. lepidota membrane (23-28.05 mg/100g) was significantly (p<0.05) higher than tannin in C. parchycarpa membrane (17.5-23 mg/100g).

DISCUSSION

Energy and proximate composition of 2 varieties monkey kola membrane (C. parchycarpa and C. lepidota)

The results showed that obtained moisture in all the samples irrespective of location were below 10%; this implies that monkey kola membrane might have long shelf-life because it has been shown that moisture of less than 10% in foods retards the proliferation of microorganisms (Makkar et al., 1998). Monkey kola membrane is a good source of plant protein, of note is that of C. parchycarpa membrane (South-East) which had protein that was many fold higher than the values reported for most fruits (Stadlmayr et al., 2012). Low crude fat obtained in monkey kola membrane makes it an important ingredient that can be incorporated in weight reducing diet regime (Ene-Obong et al., 2014). Fiber and ash obtained for C. parchycarpa membrane were observed to be significantly higher than those of C. lepidota membrane irrespective of location.
Mineral compositions of 2 varieties monkey kola membrane (C. parchycarpa and C. lepidota)

Monkey kola membrane just like the pulp (Ene-Obong et al., 2014) is a good source of mineral. C. parchycarpa membrane was a better source of Ca, Mg, P, Zn and Cu while C. lepidota membrane was a better source of K, Na, Fe, and Se. C value of monkey kola was higher than those of C. parchycarpa membrane. The high fiber and low carbohydrate obtained in monkey kola can play significant role in diet of diabetic and hypertensive patients (Ene-Obong et al., 2014).

Vitamin profiles of 2 varieties monkey kola membrane (C. parchycarpa and C. lepidota membrane)

Monkey kola membrane, particularly the yellow variety is a good source of β-carotene (Ene-Obong et al., 2014). Its β-carotene value fell within values reported for baobab leaves (1500-1620 mcg/100g) (Stadlmayr et al., 2012). The high β-carotene in C. parchycarpa membrane can be attributable to its orange-yellow color (Sharma et al., 2011). β-carotene is a good antioxidant also known as a precursor of vitamin A (Ene Obong et al., 2014). Vitamin C was found in moderate amount in monkey kola. Apart from acting an anti-oxidant consumption of Vitamin C alongside other nutrients enhances the conversion of plant iron into absorbable form. B-vitamins particularly the niacin, was found in significant amount. Niacin is important in energy metabolism and synthesis of body fat; also it is involved in the maintenance of normal nervous system function (Brown, 2011).

Phytochemical compositions of 2 varieties monkey kola membrane (C. parchycarpa and C. lepidota)

Phytochemicals are plant chemicals associated with some health benefits; many of the phytochemical that impact health benefits are pigments that act as antioxidants in the human body (Brown, 2011). Phenols and flavonoids are grouped among phytochemicals with health benefit (Tanaka et al., 1998; Heim et al., 2004; Mallavadhani et al., 2006). The study showed that monkey kola had appreciable amount of phenol and flavonoids. Flavonoids are known to perform several functions in the body; they have cardio-activity through inhibition of peroxidation, they have been shown to be effective anti-cancer agents (Erdman et al., 2007). Though obtained alkaloid was relatively high, processing however has been shown to reduce its amount in food.

Conclusion

The study has shown that the membranes of the 2 varieties of monkey kola rich in essential nutrients and phytochemicals. The white variety will make contribute to K, Fe, niacin and thiamin intake, while the yellow variety will make substantial contribution to fiber, Ca, Zn, Cu, β-carotene and vitamin C. this study has shown that fruit waste can make important contribution to intake if fully exploited.

Authors’ declaration

We declare that this study is an original research by our research team and we agree to publish it in the journal.
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