CPQ Nutrition (2018) 1:1
Research Article

Nutrient Potentials and Phytochemical Compositions of Two Varieties of Monkey Kola (*Cola Parchycarpa*, *Cola Lepidota*) Seed Flour

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Received: 27 April 2018

Published: 14 May 2018

Keywords*: Monkey Kola Seed; Varietal Difference; Phytochemical; ß-Carotene*

Abstract

The yellow *(C. lepidota)* and white *(C. parchycarpa)* monkey kola varieties were collected from the major markets in Calabar (South-south) and Umuahia (South - east) Nigeria. The pulps (edible part) were carefully cut longitudinally and then separated from the seed. The seeds were grated with a kitchen grater. Samples were dried for three days using locally constructed solar dryer. Milling the dried seeds into flour was done using attrition milling machine. The proximate compositions of the sample were determined using AOAC methods. Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC. The ß – carotene, riboflavin, niacin and thiamin values of the products were determined using spectrophotometry method, while ascorbic acid was determined using titration method. All tests were carried out in duplicates and the data generated were analysed using standard methods. Crude protein (6.3 - 9.0g/100g), crude fat (4.4 - 4.8g/100g), Ca (228 - 373mg/100g), K (105.6 - 121.5mg/100g) and Mn (238 - 349mg/100g) while ash (4.2 - 6.6g/100g), Mg (39.5 - 54.7mg/100g), Fe (29.1 - 38.4mg/100g) and ß – carotene (15,729 - 39,405mcg/100g) of *C. parchycarpa* seed were significantly ($p<0.05$) higher than that of *C. lepidota* seed.

Both seeds had substantial amounts of phytochemicals (particularly flavonoid, alkaloid and saponin). The high phytochemical values obtained in monkey kola seed makes it an important seed that need to be fully exploited.

Introduction

Fruits and vegetables are an important component of a healthy diet. Their inclusion in the daily diet not only serve as cheap source(s) of vitamins and minerals but a means of reducing risk for some forms of cancer, heart disease, stroke, and other chronic diseases [1-3]. In Nigeria a variety of fruits and vegetables are consumed on a daily basis, but most often only the fleshy pulp of these fruits are consumed leaving the seed and the rind. Studies carried out on some seeds showed that they are rich sources of vitamins, fibres, minerals and other essential nutrients activity than the pulp fractions [4,5]. The present uncertainty in the world food supply and the expected increase in demand have warranted the search for alternative sources of food which will be readily available for all and sundry by the government planners and scientists.

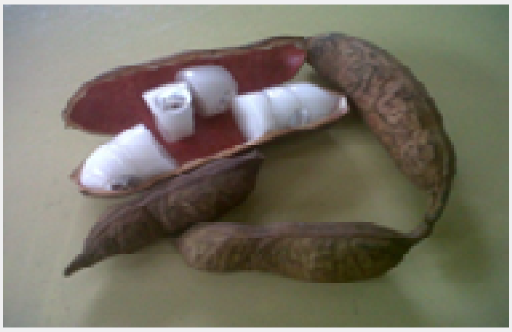
Monkey kola is grouped among the wild fruits in Nigeria. It is a member of the family of *sterculiaceae* and belongs to a group called drupes [6]. It is made up of three varieties: red (*Cola latertia*), yellow (*Cola parchycarpa*) and white (*Cola lepidota*) [7]. The pod of the yellow variety is roundish, 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). Monkey kola is cultivated throughout the tropical regions of the world; it is commonly found in Southern Nigeria between the months of June to November [8].

Contributions of monkey kola to intake particularly among the rural populace and the urban poor have been documented [6,7]; like most fruits only the pulp of monkey kola is utilized as food while the seeds are discarded as waste. Knowing the chemical composition of monkey kola seed may warrant its utility as an alternative source of food or animal feed. This work was therefore designed to evaluate the chemical composition of two varieties of monkey kola seeds (*Cola parchycarpa, Cola lepidota*).

Materials and Methods

Source of Materials and Identification

The two varieties monkey kola; yellow *(Cola parchycarpa)* and white *(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 (South-south) and Umuahia (South - east) zones of Nigeria. Samples were purchased from at least five randomly selected vendors in the various markets and pooled to obtain the samples for the study.



C.lepidota(white specie)

C.parchycarpa (yellow specie)

Preparation of Monkey Kola Pulp 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 kitchen knife and stripped/peeled off manually. The pulps (edible part) were carefully cut longitudinally and then separated from the seed. The seeds were grated with a kitchen grater. Samples were dried for three days using locally constructed solar dryer. Milling the dried seeds into flour was done using attrition milling machine (Thomas Wiley Model ED-5) to pass through 5mm sieve size. The milled samples were package in air-tight polythene for chemical analysis.

Chemical Analyses

The proximate compositions of the sample were determined using standard AOAC (2006) methods. Moisture content of the seed was determined gravimetrically [9]. The crude protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The 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. Carbohydrate was obtained by difference, while energy was calculated using the Atwater Conversion factors in KJ and Kcal (17KJ/4Kcal, 17KJ/4Kcal, and 37KJ/9Kcal, for protein, carbohydrate and lipid respectively.

Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC (2006) [9]. About 0.2g of the processed sample material was weighed into a 150ml Pyrex conical flask. Five (5.0)ml of the extracting mixture (H_2SO_4 - Sodium Salicylic acid) was added to the sample. The mixture was allowed to stand for 16 hours. The mixture was then placed on a hot plate set at 30°C and allowed to heat for about 2hours. Five (5.0)ml of concentrated perchloric acid was introduced to the sample and heated vigorously until the sample was digested to a clear solution. Twenty (20) milliliters of distilled H_2O was added and heated to mix thoroughly for about a minute. The digest was allowed to cool and was transferred into a 50ml volumetric flask and made up to the mark with distilled water. The digest was used for the determinations of calcium (Ca) and magnesium (Mg) by the ethylamine ditetra acetic acid (EDTA) versanate complexiometric titration method.

Potassium (K) and sodium (Na) were evaluated by flame photometry method and phosphorus (P) by the vanadomolybdate method using the spectrophotometer. The trace metals (zinc, iron, copper, selenium, manganese and iodine) were determined using the atomic absorption spectrophotometer 969 instrument. The appropriate cathode lamp was fixed for each element. The sample was introduced to the atomizer and the value concentration of the element printed out as mgX/liter.

The ß-carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (2006) [9]. Ascorbic acid was determined as described by AOAC (2006) using titration method [9]. Gravimetric method was used to determine alkaloids [10]. Saponin was determined by gravimetric oven drying method as described by the method of AOAC (2006) [9]. Tannin content of the sample was determined using the method of spectrophotometry as described by Kirk and Sawyer (1991) [11]. Phenol was determined by the folin-ciocatean spectrophotometry method (AOAC 2006) [9]. Flavonoid was determined by gravimetric oven drying method as described by Harborne (1973) [10].

Statistical Analysis

All determinations were done in duplicates. The data generated were entered into the computer and analyzed using IBMSPSS (version 20) Means and standard deviations were calculated from the chemical analysis data. Analysis of Variance (ANOVA) was use to separate the means and thelevel of significance was accepted at $p<0.05$.

Results

Energy and Proximate Composition of Monkey Kola (*C. parchycarpa, C. lepidota*) Seed Flour

The energy and proximate composition of monkey kola seed flours are shown on Table 1. The residual moisture obtained for *Cola parchycarpa* seed (11.0-13.1%) was significantly ($p<0.05$) higher than the residual moisture of *Cola lepidota* seed (10.2-10.8%). Crude protein value varied in all the samples. *C.lepidota* seed from Calabar had higher crude protein value (9.0%) compared to the other samples (3.2-5.3%).

Table 1: Energy and proximate composition of two varieties of monkey kola (C. parchycarpa and C. lepidota) seeds

Nutrient	CPSSE	CPSSS	CLSSE	CLSSS
Moisture (%)	$13.1^a \pm 1.34$	$11.0^b \pm 1.48$	$10.2^c \pm 0.00$	$10.8^c \pm 0.86$
Crude protein (%)	$3.2^c \pm 0.06$	$5.6^b \pm 0.06$	$6.3^b \pm 0.18$	$9.0^a \pm 0.86$
Crude fat (%)	$0.66^b \pm 0.11$	$1.1^b \pm 0.14$	$4.8^a \pm 0.06$	$4.4^a \pm 0.60$
Crude fiber (%)	$3.6^a \pm 0.11$	$4.0^a \pm 0.25$	$4.3^a \pm 0.46$	$4.6^a \pm 0.06$
Ash (%)	$4.2^b \pm 0.84$	$6.6^a \pm 0.24$	$4.5^b \pm 0.56$	$3.6^c \pm 0.28$
CHO (%)	75.0	71	70	67
Energy (kcal/KJ)	338/1355	318/1276	347/2104	322/1462

Values are means±standard deviation of duplicate determinations.
CPSES- C. parchycarpa seed South-east, CPSSS- C. parchycarpa seed South-south
CLSSE- C. lepidota seed South-east, CLSSS-C. lepidota seed South-south

Crude lipid obtained for *C. lepidota* seed (4.4 - 4.8%) was significantly (p<0.05) higher than the crude lipid found in *C. parchycarpa* seed (0.66-1.1%) irrespective of location. It was observed that *C. parchycarpa* seed from Calabar had a significantly (p<0.05) higher ash content (6.62%) than the other samples (3.60-4.50%). Energy (KJ) calculated for *C. lepidota* seed (1462-2104KJ) was higher than the energy calculated for *C. parchycarpa* seed (1276-1355KJ) irrespective of location.

Mineral composition of monkey kola (*C. parchycarpa, C. lepidota*) seeds.

The macromineral composition of monkey kola seed on Table 2 revealed that *C. lepidota* seed had significantly (p<0.05) higher calcium (228- 373mg/100g) value than *C. parchycarpa* seed (121-131mg/100g) irrespective of location. *C. pachycarpa* seed from Umuahia had significantly higher magnesium and sodium contents (54.7mg/100g, 47.5mg/100g respectively) than the other samples (14.1-39.5mg/100g, 9.8- 33.05mg/100g respectively). *C. lepidota* seed had significantly (p<0.05) higher (105.6-121mg/100g) potassium value than *C. parchycarpa* (90-92mg/100g) irrespective of location. *C. lepidota* seed from Calabar had higher phosphorus (45.5mg/100g) than the other samples (29.2-36-5mg/100g).

Table 2: Mineral composition of two varieties of monkey kola (C. parchycarpa and C. lepidota) seeds

Nutrient	CPSSE	CPSSS	CLSSE	CLSSS
Ca (mg/100g)	$121^{c}\pm0.00$	$131^{c}\pm1.41$	$373^{a}\pm1.02$	$228^{b}\pm3.88$
Mg (mg/100g)	$54.7^{a}\pm8.62$	$39.5^{b}\pm4.31$	$14.1^{c}\pm2.61$	$25.4^{c}\pm1.62$
Na (mg/100g)	$47.5^{a}\pm3.53$	$21.2^{c}\pm5.30$	$33^{b}\pm0.77$	$9.8^{d}\pm0.24$
K (mg/100g)	$90^{c}\pm3.46$	$92.5^{c}\pm3.53$	$121.5^{a}\pm3.46$	$105.6^{b}\pm7.56$
P (mg/100g)	$34.9^{b}\pm0.14$	$36.5^{b}\pm0.00$	$29.2^{c}\pm0.28$	$45.5^{a}\pm1.27$
Fe (mg/100g)	$29.7^{b}\pm1.49$	$38.4^{a}\pm0.14$	$12.8^{d}\pm1.13$	$20.0^{c}\pm0.67$
Zn (mg/100g)	$17.4^{a}\pm0.88$	$8.4^{b}\pm2.03$	$11^{b}\pm1.03$	$9.4^{c}\pm0.24$
Cu (mg/100g)	$6.4^{a}\pm0.84$	$2.8^{b}\pm0.30$	$6.6^{a}\pm0.38$	$5.21^{a}\pm1.28$
Se (mcg/100g)	Trace	$0.29^{a}\pm0.01$	$0.22^{b}\pm0.01$	$0.14^{c}\pm0.01$
Mn (mg/100g)	$23.9^{c}\pm2.89$	$37.5^{c}\pm3.74$	$349^{a}\pm5.51$	$238^{b}\pm2.48$
I (mg/100g)	0.38±0.05	0.05±0.01	0.26±0.05	0.12±0.10

Values are means±standard deviation of duplicate determinations.
CPSES- *C. parchycarpa* seed South-east
CPSSS- *C. parchycarpa* seed South-south
CLSSE- *C. lepidota* seed South-east
CLSSS- *C. lepidota* seed South-south

The micromineral content on Table 2 shows that *C. parchycarpa* seed had higher iron values (29.7-38.45mg/100g) than *C. lepidota* seed (12.8-20.0mg/100g) irrespective of location. *C. parchycarpa* seed from Calabar however, had a significantly (P<0.05) higher iron content (38.45mg/100g) than the seed from Umuahia (29.7mg/100g). *C. parchycarpa* seed from Umuahia had significantly (p<0.05) higher zinc content

(17.4mg/100g) than the other samples (8.49-11.03mg/100g). Copper obtained in all the samples was generally low. *C. lepidota* seed had significantly (p<0.05) higher manganese (238-349mg/100g) than *C. parchycarpa* seed (23.9-37.5mg/100g) irrespective of location. *C. parchycarpa* seed from Umuahia had significantly (p<0.05) higher iodine content (0.38mg/100g) than the other samples (0.05 - 0.26mg/100g).

Vitamin composition of monkey kola (*C. parchycarpa, C. lepidota*) seed

The vitamin compositions of the seeds are shown on Table 3. The ß - carotene obtained from *C. parchycarpa* (1572.0 -3940.5mcg/100g) was significantly (p<0.05) higher than the ß - carotene content of *C. lepidota* (258.5 - 262.5mcg/100g) irrespective of location. The vitamin C content of *C. lepidota* from Calabar (7.35mg/100g) was significantly (p<0.05) higher than those of the other seeds (3.20 – 6.60mg/100g).

Table 3: Vitamin composition of two varieties of monkey kola seeds

Nutrient	CPSSE	CPSSS	CLSSE	CLSSS
ß-carotene(mcg/100g)	39405[a]±3.20	15720[b]±1.49	262.5[c]±1.76	258.5[c]±9.19
Vitamin C(mg/100g)	6.6[b]±3.11	6.6[b]±	3.2[c]±0.84	7.35[a]±1.48
Riboflavin (mg/100g)	0.27[c]±0.01	0.35[b]±0.01	1.42[a]±0.02	1.44[a]±0.02
Niacin (mg/100g)	2.76[a]±0.04	2.13[a]±0.14	1.92[a]±0.09	2.28[a]±0.02
Thiamin (mg/100g)	0.73[b]±0.06	0.64[b]±0.05	1.40[a]±0.07	0.08[c]±0.00

Values are means±standard deviation of duplicate determinations.
CPSES- *C. parchycarpa* seed South-east
CPSSS- *C. parchycarpa* seed South-south
CLSSE- *C. lepidota* seed South-east
CLSSS- *C. lepidota* seed South-south

The riboflavin obtained for *C. lepidota* (1.42 -1.44mg/100g) was significantly (p<0.05) higher than that of *C. parchycarpa* (0.27- 0.35mg/100g) irrespective of location. There was however no significant (p>0.05) difference in the niacin content of *C. lepidota* seed (1.92 - 2.28mg/100g) and that of *C. parchycarpa* seed (2.13- 2.76mg/100g). The thiamin obtained for *C. lepidota* from Umuahia (1.40mg/100g) was significantly (p<0.05) higher than the thiamin content of all the other samples (0.08- 0.73mg/100g).

Phytochemical composition of monkey kola (C. parchycarpa, C. lepidota) seed

The phytochemical composition of the two varieties of monkey kola (*C. parchycarpa*, *C. lepidota*) seeds is shown on Table 4. The alkaloid and saponin content of *C. parchycarpa* seed (210 - 317mg/100g and 158 - 208mg/100g respectively) were significantly (p<0.05) higher than those of *C. lepidota* seed (195 - 208mg/100g, 56 – 161mg/100g). The flavonoid content of *C. parchycarpa* was 348.5 - 423mg/100g while that of *C. lepidota* was 387 - 417mg/100g. The flavonoid content of *C. parchycarpa* seed from Umuahia (423mg/100g) was similar to that of *C. lepidota* seed from Calabar (417mg/100g).

Table 4: Phytochemical composition of two varieties of monkey kola (C. parchycarpa and C. lepidota) seeds

Nutrient	CPSSE	CPSSS	CLSSE	CLSSS
Alkaloid (mg/100g)	$210^{c}\pm4.80$	$317^{a}\pm1.41$	$280^{b}\pm5.09$	$195^{d}\pm1.27$
Saponin (mg/100g)	$158^{b}\pm7.78$	$236^{a}\pm8.48$	$161^{b}\pm2.82$	$56^{c}\pm1.41$
Flavonoid (mg/100g)	$423^{a}\pm9.89$	$348.5^{c}\pm3.53$	$387^{b}\pm9.89$	$417^{a}\pm8.48$
Tannin (mg/100g)	$12.1^{b}\pm0.78$	$80.5^{a}\pm1.20$	$74.5^{a}\pm2.12$	$76^{a}\pm1.31$
Phenol (mg/100g)	$69.5^{a}\pm3.53$	$68^{a}\pm1.41$	$63.8^{a}\pm3.11$	$79^{a}\pm4.24$

Values are means ±standard deviation of duplicate determinations.
CPSES- *C. parchycarpa* seed South-east
CPSSS- *C. parchycarpa* seed South-south
CLSSE- *C. lepidota* seed South-east
CLSSS- *C. lepidota* seed South-south

The tannin content of *C. lepidota* (74.5 - 76mg/100g) was similar to that of *C. parchycarpa* seed from Calabar (68mg/100g) but significantly ($p<0.05$) higher than the tannin content of *C. parchycarpa* seed from Umuahia (12.1mg/100g). There was no significant difference between the phenol value of *C. parchycarpa* seed (68 - 69.5mg/100g) and that of *C. lepidota* seed (63.8 - 79mg/100g).

Discussion

The study showed that monkey kola seed is a good source of plant protein (particularly *C. lepidota* seed), and crude fiber but a poor source of crude lipid. There is record of work done on monkey kola seed [11], but unfortunately the values obtained in that study cannot be compared with this present study because of the differences in the mode of expression of unit. However, when the values obtained in this study were compared with other works, the crude protein content of monkey kola was lower than that of mango seed (10.06%) but the crude fiber and ash obtained in this study were higher than the crude fiber (2.40%) and ash (2.62%) reported for mango seed [5]. Fiber in diet is associated with health benefits; it aids in weight control and reduces the risk of developing obesity [12]. The crude fat in monkey kola seed (particularly in *C. parchycarpa*) was low. The low fat value obtained in this study was not surprising because seeds are generally poor sources of fat with the exception of oil seeds or groundnuts [13]. Most seeds contain between 1-5% fat; this implies that monkey kola seed fat value conformed to the general seed values. The carbohydrate obtained for the two varieties of monkey kola were not significantly different from each other, but the energy value of *C. lepidota* seed was significantly ($p<0.05$) higher than that of *C. parchycarpa* seed irrespective of location. The higher energy obtained for *C. lepidota* seed is a function of its composition [14].

The most abundant macromineral found in monkey kola seeds were calcium and potassium. The values of calcium and potassium were many folds higher that the values reported for most seeds [15]. These two macronutrients are known for their vital roles in the body [14]; potassium is needed in the body for normal nerve and muscle function and in the maintenance of acid-base of the body [16,17] and calcium is an important constituent of bones and teeth. Other minerals found in considerable quantity include: Mg, Na, Fe, Zn, Se and I for *C. pachycarpa* seed and P, Cu, Mn for C. lepidota seed.

Monkey kola (particularly *C. parchycarpa* variety) is a good source of ß-carotene. The ß-carotene content of *C. parchycarpa* seed was higher than the ß-carotene content of pawpaw (966mcg/100g), mango (708 - 4720mcg/100g) and that of sesame seed (50mcg/100g). Apart from being a pro-vitamin ß-carotene is also linked with antioxidant activities [18]. Monkey kola seed also had substantial quantity of vitamin C and the B-vitamins (thiamin, riboflavin, niacin). The vitamin C content of monkey kola seed was many folds higher than that of most seeds while the B-vitamins were comparable to those most common seeds [15]. Vitamin C plays significant role in the synthesis of several important compounds while the B-vitamins are known are for their role in energy metabolism [19].

Flavonoids, alkaloid and saponin were the major phytochemical found in the seed. Other phytochemicals found in the seed were tannin and phenol. The phytochemical values obtained for monkey kola seed were higher than the values reported for most common seeds [15]. Among the important classes of phytochemicals are the flavonoids and phenol (Cassidy and Dalais, 2003). There is in recent years an increasing evidence also of the health benefits of alkaloid, saponin and tannin [20-23].

Conclusion

The study showed that *C. lepidota* seed had significantly higher crude protein, crude fat, calcium, potassium and manganese while *C. parchycarpa* seed had significantly higher ash, magnesium, iron and ß-carotene. Both seeds had substantial amounts of phytochemicals (particularly flavonoid, alkaloid and saponin). The high phytochemical values obtained in the two varieties of monkey kola seeds calls for the need of the seeds to be fully exploited.

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