Vol.4 (11), pp. 320-325, November 2016
ISSN 2354-4147
International Standard Journal Number (ISJN) e-ISJN: A4372-2604
Article Number: DRJA87512903

Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/aboutjournal/drjafs

Research Paper

Evaluation of the Nutrients and Phytochemical Composition of Two Varieties of Monkey Kola Membrane (*Cola parchycarpa* and *Cola lepidota*)

***[1]Okudu H. O., [2]Ene-Obong H. N., [1]Asumugha V. U. and [1]Umoh E. J.**

[1]Department of Human Nutrition and Dietetics Michael Okpara University of Agriculture Umudike, Abia State, Nigeria.
[2]Department of Biochemistry (Nutrition and Dietetics Unit). Faculty of Basic Medical Science. University of Calabar, Calabar. Cross River State, Nigeria.
*Corresponding author E-mail: helenokudu@yahoo.com.

Received 16 September 2016; Accepted 5 October, 2016

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. pachycarpa* 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/100g) 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 pacycarpa, 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 parchycarpa* and *Cola lepidota*).

MATERIALS AND METHODS

Source of materials and identification

The two varieties monkey kola (*Cola parchycarpa* 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).

C.lepidota (white specie)

C.parchycarpa (yellow specie)

Figure 1: Title

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^{0}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*).

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).

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

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. parhycarpa* 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), riboflavin (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.

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

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).

Element	CPSEM	CPSSM	CLSEM	CLSSM
Calcium	186± 7.07	186 ±2.12	130 ±0.49	122 ±2.33
Magnesium	79 ±8.55	48.65± 8.55	48.20± 0.56	48.2 ±0.56
Potassium	68.75± 1.76	50±3.53	140.9 ±1.40	127 ±4.24
Sodium	33.75 ±5.30	25 ±3.53	41.75 ±0.35	32.65 ±0.21
Phosphorus	30.15 1.90	32.65 ±5.86	25.25 ±0.21	27.35 ±0.91
Zinc	10.68 ±0.51	9.15 ±0.42	1.13± 0.09	3.14 ±0.14
Copper	7.82 ±0.14	4.77 ±0.14	2.16± 0.04	1.47 ±0.01
Iron	10.68 ±0.51	9.65 ±0.42	13.49± 0.01	8.60 ±0.09
Selenium	0.02± 0.00	0.01± 0.00	0.17 ±0.01	0.15± 0.00

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.

Nutrient	CPSEM	CPSSM	CLSEM	CLSSM
β-carotene (mcg/100g)	928.5± 1.12	1003 ±2.17	444 ±2.89	462.5 ±3.53
Vitamin C(mg/100g)	19.5 ±3.53	15.4 ±3.11	9.75 ±0.77	9.45 ±0.49
Riboflavin(mg/100g)	0.42 ±0.02	0.52 ±0.42	0.88 ±0.02	1.42 ±0.11
Niacin(mg/100g)	2.23 ±0.00	3.04 ±0.00	3.84 ±0.22	2.84 ±0.06
Thiamin(mg/100g)	0.59 ±0.09	0.72± 0.00	0.91 ±0.55`	1.69± 0.12

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 micro-organisms (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.

Table 4. composition of 2 varieties of monkey kola (*C.parchycarpa* and *C.lepidota*) membrane (mg/100g).

Nutrient	CPSEM	CPSSM	CLSEM	CLSSM
Flavonoids	44 ±2.82	33 ±9.89	24.78± 0.40	31.21 ±1.39
Alkaloids	784 ±2.26	646 ±7.63	342 ±2.54	2.88 ±2.82
Saponins	43 ±1.41	20.5 ±2.12	27 ±4.24	20.5 ±2.12
Phenols	76.95± 1.27	30 ±1.41	43 ±9.89	30.5± 3.53
Tannins	17.5 ±2.26	23 ±3.39	28.05±1.26	23 ±3.39

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.

Fiber is essential in maintaining the health of gastrointestinal tract and in weight management (Ramulu, 2013); excessive intake can result in some micro mineral deficiencies. Carbohydrate and energy were generally low; however carbohydrate and energy obtained for *C. lepidota* membrane were 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).

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 most common fruits (Stadlmayr *et al*., 2012), while Mg value fell within values reported for avocado, baobab and date palm (Stadlmayr *et al*., 2012). Ca is needed in the body for bone formation and maintenance, nerve transmission, muscle contraction and blood-clothing (Zinmmerman and Snow, 2012); apart from maintenance of bone, Mg function as a co-factor for numerous reactions in the body (Smolin and Grosvenor, 2010).

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.

REFERENCES

Angiosperm Phylogeny Group (APG) (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society. 2009;161(2):105–121. Accessed 18 February 2011.Available: http://www.enotes.com/topic/APG_III_system.

AOAC (Association of Official Analytical Chemists) (2006). Official Methods of Analysis. The Association of Official Analytical Chemists Inc., 18th Ed. Arlington, VA, USA.

Bosch CH, Siemonsma JS, Lemmens RHMJ, Oyen LPA (editors). (2002). Plant resources of tropical Africa. Basic list of species and commodity grouping. Wageningen, the Netherlands: PROTA Programme. 9-12, 216-228.

Brown, J. (2011).Nutrition through the lifecycle. Cengage learning, USA pp.22.

Eknayake, S., Jansz, E. R., and Nair, B.M. (1999). Proximate composition, mineral and amino acid content of mature *Conovalia gladiate* seed. Food Chem. 66(1): 115-119.

Ene-Obong HN, Okudu HO, Asumugha VU (2014). Nutrient and phytochemical composition of two varieties of monkey kola (*Cola parchycarpa, Cola lepidota*). An underutilized fruit. J. Food Chem. 193: 154-159.

Erdman JW, Balentine D, Arab L (2007). Flavonoids and heart health.Proceedings of the ILSI North America Flavonoids Workshop May 31-June 1 Washington, DC. J. Nut. 137: 718S-737S.

Harboune JB (1973). Phytochemical methods: A guide to modern technique of plants analysis. Chapman and Hall: London. pp 60-64.

Heim KE, Tagliaferro AR, Bobilya DJ (2002). Flavonoid antioxidants:Chemistry, metabolism and structure-activity relationship. J. Nutr. Biochem. 13: 572–584.

JohnsT (2003). Plant biodiversity and malnutrition simple solution to complex problems. J. Food. Agric. Nut. Dev. 1: 45-52.

Kant AK, Schatzkin A, Ziegler RG (1995). Dietary diversity and subsequent cause specific mortality in the NHANES 1. Epidemiological follow-up study. J. Am. Coll. Nut. 14: 233-238.

Keay RWJ (1989). Trees of Nigeria. New York: Oxford University Press. 476.

Kirk RS, Sawyer R (1991). Pearson' composition and analysis of foods. 9th Ed. Longman Scientific and Technical. United Kingdom.

Mallavadhani U, Sudhakar A, Sathyanarayana KVS, Mahapatra A, Li W, Richard B (2006). Chemical and analytical screening of some edible mushrooms. Food Chem. 95**:** 58-64.

Makkar HPS, Becker K (1996). Nutritional value and anti-nutritional components of and ethanol extracted *Moringa oleifera* leaves. Animal Feed Sci. Technol. 63: 211-238.

Makkar HPS, Borker, Schmook B (1998). Edible provenances of *Jatropha carcus* from Quinatana Roo State of Mexico and effect of roasting on the toxic factors in seeds. Plant Foods for Human Nutr. 52: 31-36.

Meregini AOA (2005). Some endangered plants producing edible fruits and seed in southeastern Nigeria. Fruits. 60: 211-220.

Ogbu JU, Essien BA, Kadurumba CH (2007). Nutritional value of wild *Cola* spp.

(*Monkey kola*) fruits of Southern Nigeria. Nig. J. Hort. Sci. 12: 113-117.

Pamplona-Roger GD (2008). Encyclopedia of Foods and their healing power. In: Umeh, AS, Nwadialu MA (2010). Production and proximate analysis of jam (food spread) prepared from *Cola pachycarpa* JHER 13: 152-158.

Popkin BM (2002). An Overview on the nutrition transition and its health implications: The Bellagio meeting. Pub. Health Nut. 5: 93–103.

Ramulu P, Rao PU (2003). Total, insoluble and soluble dietary fiber contents of Indian fruits. J. Comp. Anal. 16: 677-685.

Sachdeva S, Sachdeva TR, Sachdeva R (2013). Increasing fruit and vegetable consumption: challenges and opportunities. Indian J. Community Med. 38: 192-197.

Sharma SK, Anup GA, Radhakrishman J,Thapa L, Shrestha NR, Pandel N, Gurung K, Maskey R, Budathoki A, Baral N, David BD (2011). Prevalence of hypertension, obesity, diabetes and metabolic syndrome in Nepal. Int'l. J. Hypertension. pp. 821-971.

Singh B, Gupta V, Bansal P, Singh R, Kumer D (2010). Pharmacological potential of plant used as asphrodisiacs. Int'l J. Pharm. Sci. Review and Research. pp. 104-107.

Shiundu KM (2002). Role of African Leafy Vegetables (ALVs) in Alleviating Food and Nutrition Insecurity in Africa. AJFNS. 2: 96-97.

Smolin LA, Grosvenor MB (2010). Nutrition Science and application. Courier kandallville, United States of America. pp. 483-484.

Stadlmayr B, Charrondiere UR, Enujiugha VN, Romric GB, Etel G, Fagbohoun Samb B, Addy P, Barikmo I, B, Ouattara F, Oshaug A, Akinyele I, Annor GA, Bomfeh K, Ene-Obong H, Smith IF, Thiam I, Burlingame B (2012). West Africa Food Composition Table/ Table de composition des aliments d'Afrique de l Ouest. Food Agriculture Organization of the United Nations. Rome Italy.

Tanaka M, Kuei CW, Nagassiima Y, Taguchi T (1998). Application of antioxidative maillard reaction products from histidine and glucose to sardine products. Nippon Suisan Gakkal Shi. 54: 1409-1414.

Voorrips LE, Goldbohn RA, Van-Popel G, Sturmaus F, Hermus RJJ, Vanden-

Brandt PA (2000). Vegetable and fruit consumption and risks of colon and rectal cancer in a prospective cohort study on diet and cancer. Amer. .J. Epidemiol. 152:1081-1092.

Williams IO, Edet AJ, Agiang MA, Lawal OO (2009). Fruit and vegetable intake pattern and body mass index (BMI) of postgraduate students in the University of Calabar, Nigeria. Nig. J. Nut. Sci. 30: 43-47.

World Health Organization (2003). Chronic disease: key risk factors include high cholesterol, high blood pressure, low fruit and vegetable intake. Retrieved January 27, 2014 from www.who.int/dietphysicalactivity/media/en/gsfs-chronic-disease.pdf

Zinmmerman M, Snow B (2012).An introduction to Nutrition. Creative commons. pp.22.