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Full Length Research Paper

The chemical and sensory properties of juice developed from two varieties of monkey kola (*Cola parchycarpa, Cola lepidota*).

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Abstract

This study was aimed at evaluating the chemical and sensory properties of juice developed from two varieties of monkey kola (*Cola parchycarpa, Cola lepidota*). Two varieties of Monkey kola (*Cola parchycarpa* and *Cola lepidota*) were bought from the Umuahia Main Market Abia State. The fruits were purchased from at least five randomly selected vendors and pooled to obtain the sample for the study. The juice was prepared and evaluated for chemical and sensory properties using standard methods. Most of the proximate content of the juices were not significantly different from each other. *C. parchycarpa* juice however had higher crude protein (1.14g/100g) and energy (111.6KJ) values. Ca (93.7mg/100g), Mg (39.8mg/100g) Zn (0.08mg/100g), and Cu (0.35mg/100g) were also higher in *Cola parchycarpa* juice while Na (30.9mg/100g) and K (96.5mg/100g) were higher in *Cola lepidota* juice. B-carotene (3119.1mcg/100g) was significantly higher in *C.parchycarpa* juice; however all the phytochemical constituents analysed were higher *C. lepidota juice*. The result of sensory evaluation showed that the colour (6.3), general acceptability (5.6) for *C.parchycarpa juice* were comparable with the scores for colour (6.3), general acceptability (5.8) for the control (orange juice). The control had the highest score for flavor (5.8) and for taste (5.8). The low energy, low fat and low protein of juice produced from Monkey kola makes juice suitable to be incorporated into the diet of individuals with physiological condition.

Keywords: Product development, *C. parchycarpa*, C. *lepidota* , β-carotene, Juice, Sensory attributes

INTRODUCTION

Fruits and vegetables are usually surplus in Nigeria during their respective seasons and are wasted in large quantities due to absence of facilities and technical know-how for proper handling, distribution, marketing and storage. Although processing plays important role in the conservation and better utilization of fruits and vegetables it also ensures fair returns to growers to improve their economic condition which in turn help to mitigate the problem of under-employment during off-seasons in the agricultural sectors (Vidhya and Narain, 2010). In some countries, like the Caribbean and the Pacific, transformation of fruits and vegetables into juices, jams, and chutneys have reduced spoilage and are forming the basis for lucrative value chains (CTA, 2012).

Monkey kola is an under-utilized fruit found in South-Eastern Nigeria. It belongs to the family Sterculiaceae; and genus *Cola*. It is made up of three varieties: red (*Cola latertia*), yellow (*Cola parchycarpa*) and white (*Cola lepidota*) (Singh *et al*., 2010). The red specie is not very common but the white and yellow species are commonly found in Southern Nigeria between the months of June to November (Ogbu *et al*., 2007). 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 South-eastern Nigeria (“achicha” or “ohiricha” in Igbo and “ndiyah” in Efik). Monkey kola has record of nutritional and medicinal value (Singh, 2010).

In Nigeria monkey kola is mostly consumed fresh and like most fruits and vegetables it has a very short life span probably due to its high moisture content and its hard texture also limits its consumption particularly among the vulnerable group (young children, Aged) due to poor dentition. There is therefore need to process monkey kola fruit into a more stable, easier to use form like jams, jellies and juice in order to derive maximum benefit from it (Woodroof and Luh, 1986; Kansci *et al.,* 2003). This study is designed to develop and determine the chemical and sensory attributes of juice from two varieties of monkey kola (*Cola parchycarpa* and *Cola lepidota*).

Source of materials/ selection of fruits for juice production

The Monkey kola (*Cola parchycarpa* and *Cola lepidota*) were bought from the Umuahia Main Market Abia State. The samples were purchased from at least five randomly selected vendors in the market and pooled to obtain the sample for analysis. Mature and undamaged fruits were selected for the production of juice. Sorting was done by hand. Any fruit that was moldy was sorted and removed. The fruits were washed to remove dirt. Grading of fruits was done based on firmness, size, maturity, colour, shape and freedom from foreign matters, insect damage or mechanical injury. The fruits were washed using chlorinated water (1 tablespoon of bleach to 5 liters of water). The fruits were open longitudinally with a sharp kitchen knife to extract the seeds. The pulp was placed in water containing lemon juice (250ml lemon juice per liter of water) to stop them from browning.

Preparation of juice

Juice preparation as described by ‘the wonder of carrot juice (2011) was adopted for the preparation of juice. About 600g of monkey kola (pulp) was cut into ½ cm and placed in an electric blender, one cupful at a time until the blender was ¾ ways filled. Twenty ml of water was added to the monkey kola in the blender for each blend (A total of about 100 ml of water was used for blending). The monkey kola was blended into a smooth pulp. The pulp was removed and poured into a large mixing bowl. Two hundred and fifty ml of water was added to the pulp. A clean muslin cloth was used to filter the pulp. The monkey kola juice was drained into another container through a clean muslin cloth so as to stop any unblended pulp from getting into the final product. Twenty five grams of sugar was added. The juice mixtures were pasteurized at 70^{o}C for 20minntes.

Chemical analyses

The proximate compositions of the sample were determined using standard A.O.A.C. (2006) methods. Moisture content of the juice was determined gravimetrically. The crude protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The crude fat content of the juice sample was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600^{o}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 A.O.A.C (2006). 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^{o}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 β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (2006). While ascorbic acid was determined as described by AOAC (2006) using titration method. Gravimetric method (Harborne, 1973) was used to determine alkaloids. Saponin was determined by gravimetric oven drying method as described by the method of A.O.A.C (2006). Tannin content of the sample

Table 1. Energy and Proximate Composition of Monkey kola(*C.parchycarpa* and *C.lepidota*) juice

Nutrients	CPJu	CLJu
Water (g/100g)	93.3 ± 0.2^{a}	94.7 ± 0.2^{a}
C/Protein (g/100g)	1.14 ± 0.01^{a}	0.82 ± 0.0^{b}
C/Fat (g/100g)	0.24 ± 0.02^{a}	0.13 ± 0.0^{a}
C/Fibre (g/100g)	0.02 ± 0.0^{a}	0.01 ± 0.0^{a}
Ash (g/100g)	0.46 ± 0.1^{a}	0.62 ± 0.0^{a}
CHO (g/100g)	4.9^{a}	3.8^{b}
Energy (Kcal) KJ	$(26.3)111.6^{a}$	$(19.3)81.6^{b}$

Means with different superscripts along the same row are statistically different from each other (P<0.05). CPUJu-C. Parchycarpa Juice; CLUJu -C. Lepidota Juice.

was determined spectrophometrically as described by Kirk and Sawyer (1991). Phenol was determined by the folin-ciocatean spectrophotometry method (AOAC 2006). Flavonoid was determined by gravimetric oven drying method as described by Harborne (1973).

Sensory evaluation

Sensory evaluation of the juice was carried out with a set of 20 panelists. Commercial orange juice (chi vita brand) products were used as the controls. The panelist consisted of randomly selected staff and students (both males and females) from College of Applied Food Sciences and Tourism. The evaluation was carried out in the food laboratory of the Department of Home economics. The judges evaluated the products using a seven point hedonic scale where 7 = like very much and 1 = dislike very much. Panelists scored the sample for four sensory attributes – flavour, colour, consistency and over all acceptability. The order of presentation of the sample to the judges was randomized. A cup of potable water was given to the panelist to rinse his/her mouth after each tasting.

RESULTS AND DISCUSSION

Energy and proximate composition juice developed from monkey kola *c. parchycarpa* and *C.lepidota.*

The proximate composition of the juice is on Table 1. The major components of monkey kola juices were moisture, carbohydrate and protein. The moisture content (94.7g/100g) of *C. lepidota* juice (CLJu) was slightly higher than that of *C. parchycarpa* juice (CPJu) (93.3g/100g). The moisture found in the juices in this study was higher than 89.5% reported for ripe pawpaw 84%, 82% for pineapple and soursop juices (Akubor and Egbekum, 2007). The high moisture of monkey kola juice may be due its state of freshness and maturity (Pamplona-Rogers, 2008). Moisture content of fruit is a function of its quality which determines its freshness at harvest or storage duration before analysis (Adepoju and Adeniji, 2008); it is also a function of its shelf-life stability. The crude protein (1.14g/100g) of *C. parchycarpa* juice was significantly higher than that of *C. lepidota* juice (0.82g/100g). The differences in their protein values may be due to varietal differences. There was no similar work to compare this result with but when compared with other works, the crude protein values of Monkey kola juices (0.82 – 1.1g/100g) were higher than 0.78% reported for orange juice, 0.51% reported for water melon (Nwokocha and Akobundu, 2013), 0.52% reported for African bush mango, but fell within 0.3 -1.0% (Obizoba *et al.*, 2004), and 0.9% reported for pineapple and soursop juices (Onimawo, 2002). The relatively high protein of Monkey kola juices makes it an important source of protein that can be used to complement other sources of protein.

The crude fat content of the juices from monkey were all low. *C. parchycarpa* juice had 0.24g/100g, while *C. lepidota* juice had 0.13g/100g. Nwokocha and Akobundu (2013) observed low fat in orange juice, pineapple juice and water melon juice. Akubor and Egbekun (2007) also reported low value of fat in *Spondias mombin* juice. The low fat value of monkey kola fruit juices (0.13, 0.24g/100g) will be beneficial to health. It can be used in diets designed for weight reduction. The crude fibre contents of the juice were not significantly different from each other. *C.parchycarpa* juice had 0.02g/100g crude fiber value while, *C.lepidota* juice had 0.01g/100g. The crude fiber in juices in this study are comparable with 0.25% reported for unripe pawpaw juice (Chikwendu and Ayogu, 2009), but lower than 0.3%, 0.6% reported for pineapple and soursop juice (Akubor and Egbekun, 2007). The low crude fibre found in this study was not surprising because filtration using muslin cloth must have filtered out most of the fibre. Though, fibre has been shown by many studies to have health benefits, it is also now known that eliminating fibre from juice makes the

Table 2. Mineral Composition of juice developed from Monkey kola (*C.parchycarpa* and *C.lepidota*).

Nutrients	CPUJu	CLUJu
Calcium (mg/100g)	93.7 ± 17.6^{a}	17.2 ± 0.3^{b}
Magnesium (mg/100g)	39.8 ± 4.8^{a}	10.4 ± 0.9^{b}
Sodium (mg/100g)	20.1 ± 1.4^{b}	30.9 ± 2.1^{a}
Phosphorus (mg/100g)	15.9 ± 1.7^{a}	15.8 ± 0.6^{a}
Potassium (mg/100g)	38.4 ± 3.9^{b}	96.5 ± 14.0^{a}
Iron (mg/100g)	1.3 ± 0.4^{a}	$1.0\pm0.^{2}$
Zinc (mg/100g)	0.06 ± 0.0^{a}	0.01 ± 0.0^{b}
Copper (mcg/100g)	0.35 ± 0.0^{a}	0.13 ± 0.0^{b}

Means with different superscripts along the same row are statistically different from each other (P<0.05). CPUJu-C. Parchycarpa Juice, CLUJu -C. Lepidota Juice.

other nutrients more bio available to the body than if the piece of the fruit or vegetable was eaten whole (Hedren, 2002). It therefore implies that low fiber content of monkey kola juices makes them easy digestible food, especially for children. The ash content of *C.lepidota* juice (0.62g/100g) was not significantly (p>0.05) higher than that of *C.parchycarpa* juice 0.46g/100g). The low ash found in fruit juices can be attributed to high fluid content of fruits. Low ash is reported in most common fruit juices (Nwokocha and Akobundu, 2013).

The carbohydrate contents of both juices were observed to be low. The low carbohydrate in the juices was not surprising because juices are generally known to be low in carbohydrate. The carbohydrate content of *Cola parchycarpa* juice (4.9g/100g) was slightly higher than that of *C.lepidota* juice (3.8g/100g). When compared with other juices the carbohydrate content of *Cola parchycarpa* juice (4.9g/100g) was similar to that of unripe pawpaw juice (5.12g/100g) but lower than that of orange and pineapple juices (11.08, 12.78g/100g). The low carbohydrate found in Monkey kola juice may be due dilution effect of water added during the extraction process but which was not the case with the orange and water melon juice extraction (Nwokocha and Akobundu, 2013). The energy values of *Cola parchycarpa* (25.8kcal) was significantly (p<0.05) higher than that of *C.lepidota* juices (19.8kcal). The energy obtained from the juices (25.8, 19.8kcal) in this study were lower than 38.4kcal reported for unripe pawpaw juice (Chikwendu and Ayogu, 2009), 50.1kcal for orange juice 59.92kcal for pineapple juice and 29.04kcal for watermelon (Nwokocha and Akobundu, 2013). The energy values of monkey kola juices were lower because their fat content was lower than the ones mentioned above. Energy value of food is more related to fat than its carbohydrate content (Ihekoronye and Ngoddy, 1985). Monkey kola juices can therefore be best recommended for weight management due to their low energy densities. The low levels of fiber, fat, carbohydrate, and energy observed in monkey kola fruit juices showed that they can serve as a nourishing and refreshing pregame liquid meal for competitors. Fiber-rich foods attract water in the digestive tract and so do not disturb performance while high carbohydrate and fatty foods require more time to digest and these may cause stomach discomfort during performance (Marieb and Hoehn, 2004).

The mineral composition of juice developed from monkey kola (*C. parchycarpa* and *C.lepidota*)

The mineral composition of the juice developed from *C. parchycarpa* juice and *C. lepidota* juice is shown on Table 2. The dominate minerals in the juice were Ca, Mg, and K while Fe, Zn and Cu were relatively low. The calcium content of *C. parchycarpa* juice (93.7mg/100g) was significantly higher than that of *C. lepidota* juice (17.2mg/100g). The high calcium found in *C. parchycarpa* juice relative to that of *C. lepidota* juice can be attributed to varietal differences. When compared to other fruit juices, the calcium content of Monkey kola juices were significantly higher than the ones reported for most common fruit juices (Akubor and Egbekum, 2007; Nwokocha and Akobundu, 2013). 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). *Cola parchycarpa* juice had higher magnesium content (39.8mg/100g) than *C. lepidota* juice (10.3mg/100g). The difference in their magnesium content may also be a result of varietal differences. When compared to other studies the magnesium content of CPJu (39.8mg/100g) was higher than 0.32mg/100g reported for orange juice and 0.28mg/100g reported for pineapple juice (Nwokocha

Table 3. Vitamin Composition of juice developed from Monkey kola (*C. parchycarpa*and *C. lepidota*).

Nutrients	CPJu	CLJu
β- Carotene (mcg/100g)	3119.1±470.9[a]	31.7±4.9[b]
Riboflavin (mg/100g)	0.01±0.0[b]	0.01±0.0[a]
Niacin (mg/100g)	0.09±0.0[a]	0.01±0.0[b]
Thiamin (mg/100g)	0.2±0.0	0.16±0.0

Means with different superscripts along the same row are statistically different from each other (P<0.05). CPUJu-*C. Parchycarpa* Juice CLUJu -*C. Lepidota* Juice.

Table 4. Phytochemical composition of juice developed from Monkey kola(*C. parchycarpa* and *C. lepidota*).

Phytochemical	CPJu	CLJu
Alkaloid (mg/100g)	10.1±1.5[b]	14.3±0.2[a]
Saponin (mg/100g)	17.9±0.7[b]	29.5±2.0[a]
Tannin (mg/100g)	1.1±0.0[a]	0.78±0.1[a]
Phenol (mg/100g)	0.42±0.1[b]	0.72±0.1[a]

Means with different superscripts along the same row are statistically different from each other (P<0.05)
CPUJu-C. Parchycarpa Juice; CLUJu - C. Lepidota Juice

and Akobundu, 2013). Magnesium was found to be next highest mineral component in this study. Similar observation was made in other studies. Magnesium has reported as an activator of many enzymes systems and maintains the electrical potential in nerves.

The sodium and potassium content of *C. lepidota* juice was (30.9, 96.5 mg/100g) were significantly higher than those C. *parchycarp*a juice (20.1, 38.4mg/100g). The sodium and potassium found in Monkey kola was higher than the ones reported for most common fruits (Nwokocha and Akobundu, 2013). High sodium in foods is said to be unsuitable for people on sodium-restricted diet however, the potassium/sodium ratio (3.1:1) found particularly in *C.lepidota* was in line with the statement that ideal foods should be high in potassium but low in sodium (Cuthbertson, 1989). The high potassium contents of the juices compared to their sodium content therefore made them suitable drinks for individuals particularly those with physiological conditions. There was no significant difference between the phosphorus content of the fruit juices. *Cola parchycarpa* had 15.8mg/100g while *C. lepidota* had 15.9mg/100g. Though the phosphorus content of the juices was low, they were still higher than the ones reported for common fruit juices (Nwokocha and Akobundu, 2013). The phosphorus content of Monkey kola can supply about 3% of the 500mg/d RDA needs of children (Wardlaw and Hampl, 2007). The iron, zinc and copper values of *C.parchycarpa* juice (1.3, 0.06, 0.35mg/100g) were significantly (p<0.05) higher than those of *C.lepidota* juice (1.0, 0.01, 0.13mg/100g). Iron and zinc are important micronutrients in human diet. Iron is involved in psychomotor development, maintenance of physical activity, and resistance to infection, while zinc is needed for catalysis, stabilization of cell membranes and regulation of gene expression (Black, 2003).

The vitamin composition of juice developed from monkey kola (*c. parchycarpa* and *C.lepidota*).

The β- Carotene content of *C. parchycarpa* juice (3119.1mcg/100g) was significantly higher (P<0.05) than that of C*. lepidota* juice (37.7mcg/100g). The higher β-Carotene found in *C. parchycarpa* is likely to be due to its deep yellow coloration (Liu *et al.*, 2005). The amount of beta carotene in the juices particularly that of *C. parchycarpa* juice (3119.1mcg/100g) when combined with those in foods considered not good sources of beta-carotene would be cumulatively important (Akubor and Egbekum, 2007). Beta- carotene acts as a precursor to vitamin A which is important in human eye light reception and can also act as an antioxidant (Craft and Wise, 1993). The juices from Monkey kola had similar riboflavin value (0.01mg/100g each). The riboflavin in this study compared favorably with the riboflavin in other common fruit juice (Nwokocha and Akobundu, 2013). Riboflavin is associated with decrease lipid peroxidation; it can inhibit the process (Dutta *et al*., 1995). The niacin content of *C. parchycarpa* juice (0.09mg/100g) was significantly

Table 5. Sensory properties of Juice developed from Monkey kola *C. parchycarpa* and *C. lepidpota*

Sample	Colour	Flavour	Taste	General Acceptability
CPJu	6.3 ± 0.4^{a}	4.9 ± 1.7^{c}	4.7 ± 1.7^{b}	5.6 ± 1.2^{a}
CLJu	3.6 ± 1.6^{b}	5.1 ± 1.0^{b}	4.9 ± 1.2^{b}	4.5 ± 1.3^{b}
OJu (Control)	6.3 ± 0.9^{a}	5.8 ± 1.0^{a}	5.8 ± 1.1^{a}	5.8 ± 1.2^{a}

Means with different superscripts along the same row are statistically different from each other (P<0.05).CPJu- C. parchycarpa Juice; CLJu- C. lepidota Juice; OJu- Commercial Orange Juice.

(p<0.05) higher than that of *C. lepidota* juice (0.01mg/100g), while, the thiamin value of *C. lepidota* juice (0.16mg/100g) was statistically higher than that of *C. parchycarpa* juice (0.02mg/100g). Thiamin is required for the metabolism of carbohydrate, fat and alcohol (Bowman and Russel, 2001).

The photochemical composition of juice developed from monkey kola (*C. parchycarpa* and *C.lepidota*).

The alkaloid and saponin content of *C.lepidota* juice (14.3 and 29.5mg/100g) were significantly higher than those of *C. parchycarpa* juice (10.1, 17.9mg/100g). The saponin content of *C.lepidota* juice29.5mg/100g was higher than that of *C. parchycarpa* juice. The tannin content of *C. parchycarpa* juice (1.1mg100g) was not statistically (p>0.05) higher than that *C. lepidota* juice (0.78 mg/100g). These differences can be attributable to varietal difference.

Sensory attributes of juice developed from *C. parchycarpa* and *C.lepidota.*

The result of sensory evaluation for juice developed from *C.parchycarpa* and *C.lepidota* is shown on Table 5., using commercial orange juice as control. Orange and *C.parchycarpa* juices had similar scores (6.3) for colour. Their score for colour was significantly (p<0.05) different from that of *C.lepidota* juice (3.6). The bright yellow colouration due to β-carotene in both the orange and *C.parchycarpa* juices must have enhanced their acceptability for colour. The score for flavour varied from each other. Orange juice had the highest score (5.8), followed by *C.lepidota* juice (5.1), while *C. parchycarpa* juice had the least (4.9). The general acceptability of orange juice and *C.parchycarpa* juice (5.8, 5.6) were not significantly (p>0.05) different but differed significantly (p<0.05) from that of *C.lepidota* juice (4.5). The taste of orange juice was most preferred and the reasons maybe because orange drink has been a conventional drink which people are used to.

CONCLUSION

Most of the proximate compositions of the two juices produced were not significantly different from each other. *C. parchycarpa* juice however had higher crude protein and energy values. Ca, Mg , Zn, and Cu were also higher in *Cola parchycarpa* juice while Na and K were higher in *Cola lepidota* juice. B-carotene was significantly higher in *C.parchycarpa* juice; however all the phytochemical constituents analysed were higher *C. lepidota juice*. The result of sensory evaluation showed that the sensory attributes such as colour, general acceptability for *C.parchycarpa juice* were comparable with the scores for colour, general acceptability for the control (orange juice). The control however had the highest score for flavour and for taste. The low energy, low fat and low protein of juice produced from Monkey kola makes juice suitable to be incorporated into the diet of individuals with physiological condition.

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