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Evaluation of Proximate, Mineral and Phytochemical Compositions of *Carapa procera* (Family Meliaceae)

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Abstract: This study was conducted to evaluate the medicinal value of *C. procera* seeds. The seeds of *C. procera* were collected from the Tsampoko village, district of Gamboma, in northern area of Congo on 14th March 2013. Nuts were dried in an oven at 70°C for 24 h and milled into powder. The powder was used for proximate, mineral and phytochemical analysis. The proximate analysis of the seed revealed high moisture (47.92%), fat (23.14%), carbohydrate (17.13%) and energy value (1285.60 Kg/100 g) while the crude protein (8.13%) and the ash (3.68%) were found to be low. The mineral analysis showed that Phosphorus (15.72%) was the most abundant element, followed by iron (2.82%) and potassium (1.23%). Calcium and magnesium were found in low concentrations (0.22 and 0.23%, respectively) while sodium and manganese were detected in trace quantities (0.01-0.02%). The phytochemical screening of crude solvent extracts revealed the presence in methanol of alkaloids, flavonoids, glycosides, saponins, steroids, tannins, triterpenoids, anthocyanins and phenols. In carbon tetrachloride steroids and tannins were not detected. Anthraquinones were absent in all the screened extracts of both solvents. Quantitative analysis of the seeds showed high alkaloid, flavonoid and phenolic concentrations (5.67±0.18, 5.98±1.38 and 7.46±0.15%, respectively) while saponins and anthocyanins were detected in low quantities (0.92±0.10 and 2.01±0.12%).

Key words: Proximate, mineral, phytochemical, analysis, carapa procera

INTRODUCTION

In Africa little is known about unexploited plant resources used in the food system or in traditional medicine to cure various diseases. Legumes and fruits constitute an important part of staple foods and dishes for rural populations in tropical Africa and are rich sources of proteins, carbohydrates, vitamins, fiber, carotene, ascorbic acid, folic acid and minerals such as calcium, iron and phosphorus (Fasuyi, 2006; Balogun and Olatidoye, 2012).

Carapa procera D.C. (family Meliaceae) is a species of forest tree, 17 m high in swamp forest and about 25 m high with a clear bole of 1.80 m girth in lowland rainforest away from swamps, rivers (Burkill, 1985), include lake-shores, riparian, mid-altitude forest and sandy soils. The species is widely distributed, being found from Senegal to Angola and in East Africa, as well as in tropical America, in the Amazon basin (Paulo de TB Sampaio, 1993; SID, 2004).

The bark is used in traditional medicine to treat paralysis, epilepsy, convulsions, spasms, skeletal and eye problems and as a genital stimulant/depressant. The bark and leaves are used to treat malnutrition, debility and stomach troubles. With the seed-oil they are used against arthritis, rheumatism, cutaneous and subcutaneous parasitic infection, leprosy, pulmonary troubles, venereal diseases and as emetics and febrifuges. The seed oil which is known as an antidote and a pain-killer is used against skin mucosa and yaws. The bark, root and seed oil are also known as laxatives and vermifuges (Burkill, 1985).

The seeds are reported to be analgesic, anti-inflammatory, insecticidal, anti-bacterial, anti-parasitic, anti-allergic and anti-cancer remedies (Alessandra *et al*., 2006; Ferraris *et al*., 2011). *Carapa* trees produce wood and a number of Non-Timber Forest Products (NTFPs), such as fruits, seeds or bark used in animal nutrition, human medicine or cosmetics and as insect repellents, etc. (Fleury, 2008). The plant parts are used in the fabrication of various products: fiber, exudations-gums, resins, soap, hunting and fishing apparatus, pastimes-carming, musical instruments, games, toys, building materials, chewing gum and in farming, forestry, pottery, etc. (Burkill, 1985).

There are some reports on the physico-chemical composition of these indigenous seeds (Asante Franc Adu, 1993; Mizangi *et al*., 2011), but no studies on the chemical and the phytochemical properties of the genus

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from Congo have been found so far. Therefore, the aim of this study was to evaluate the medicinal value of *C. procera* seeds.

MATERIALS AND METHODS

Collection and processing of plant materials: The experimental seeds were collected from the Tsampoko village, district of Gamboma, Northern area of Congo, on 14th March 2013. The plant materials were identified and authenticated by Nkouka Saminou from the National Herbarium of the Vegetal Research Centre of Brazzaville (ex-OROSTOM-Congo) where voucher specimens are conserved. The nuts were dried in an oven at 70°C for 24 h and milled into powder with a mechanical blender. The powder was stored at room temperature under dry conditions before analysis. Chemical analysis was carried out on the dried powder materials.

Chemical analysis

Proximate analysis: The moisture content of *C. procera* seeds was determined by drying at 105°C in an oven, until a constant weight was reached. For total ash determination, the plant samples were weighed and converted to dry ash in a muffle furnace at 450 and then incinerated at 550°C. The crude fat content was determined by extraction with dichloromethane, using a Soxhlet apparatus. All these determinations were carried out according to AOAC (1990). The Kjeldahl method was used for crude protein determination. Carbohydrate content was determined by calculating the difference between the sum of all the proximate compositions from 100%. Energy values were obtained by multiplying the carbohydrate, protein and fat by the Atwater conversion factors of 17, 17 and 37, respectively (Kilgour, 1987).

Mineral analysis: Mineral analyses of the seeds were carried out according to Martin-Prevel *et al.* (1984) Elemental analyses were carried out using an atomic absorption spectrophotometer and a flame photometer to determine calcium, sodium, potassium and magnesium content. Aluminum, iron and phosphorus were determined calorimetrically. The concentration of each element in the sample was calculated on a dry matter basis.

Preparation of fat free sample: The dried powder sample (30 g) was defatted in diethyl ether (150 mL) for 24 h at room temperature. The mixture was filtered and the lipid fraction discarded. The defatted sample was air dried for 24 h in order to evaporate the remaining solvent before the extraction procedure.

Extraction procedure: Extraction of bioactive compounds was carried out by hot percolation in methanol and carbon tetrachloride. Twenty grams of the defatted sample were soaked in 150 mL of each solvent at room temperature for 72 h. The mixture was then filtered and the filtrate was concentrated by evaporation using a boiling water bath. The obtained solvent extracts were submitted to phytochemical screening.

Preliminary phytochemical screening: Qualitative analysis of *C. procera* seeds was carried out following the methods described by Trease and Evans (1989), Sofowora (1993), Harborne (1994) and (1998), Kokate (2001) and Aguzue *et al.* (2012), to determine the presence of alkaloids, flavonoids, glycosides, saponins, triterpenoids, steroids, tannins, phenols, anthocyanins and anthraquinones.

Quantitative analysis: Quantitative phytochemical analysis of the seeds was performed in order to confirm the presence of bioactive compounds as described by Boham and Kocipai (1994), Harborne (1973), Obadoni and Ochuko (2001), Onyeka and Nwambeke (2007) and Iqbal *et al.* (2011).

The phytochemicals determined included alkaloids, flavonoids, saponins, phenols and anthocyanins.

Statistical analysis: Data were reported as means±SD of triplicate determination.

RESULTS AND DISCUSSION

Proximate composition: The proximate composition of the sample is shown in Table 1. The results revealed high concentrations of moisture, carbohydrate, fat and energy mean values of *C. carapa* which were 47.92, 17.13 and 23.14% and 1285.60 Kg/100 g, respectively when compared with the mean values of others nutrients.

The moisture content of *C. procera* was higher than the 9.73 and 9.81% recorded for *cola acuminate* and *cola nitida* nuts (Dewole *et al.*, 2013). This value was also higher than the range of 5.55 to 14.22% reported for some selected medicinal plants species (Zain *et al.*, 2013). Dewole *et al.* (2013) reported that the high moisture content is index of spoilage. It gives an indication of water soluble vitamins present in the sample (Adinortey *et al.*, 2012) and could be a suitable source of raw materials for the biofuel industry (FAO, 2008).

The carbohydrate content recorded in the present study was favorably compared to the 18.61±0.44% reported for *P. mildbraediby* leaves (Akinyeye *et al.*, 2010). However, this was found to be much higher than the 2.36% recorded in *B. Oleracea* (Emebu and Anyika, 2011).

Carbohydrates provide necessary calories in the diet, promote the utilization of dietary fats and reduce wastage of proteins (Balogun and Olatidoye, 2012). The high carbohydrate content of *C. procera* suggested that it could be considered as a good source of energy, supplying the body with its requirements to carry out daily activities (Yisa *et al.*, 2010).

Table 1: Proximate analysis of *C. procera* seeds

Parameters	Composition (%)
Moisture	47.92
Crude fat	23.14
Crude proteins	08.13
Carbohydrate	17.13
Total ash	03.68
Energy (Kg/100 g)	1285.60

Table 2: Mineral composistion of *C. carapa* seeds

Mineral element	Content (%)
Calcium	0.22
Magnesium	0.23
Potassium	1.23
Sodium	0.01
Manganese	0.02
Iron	2.82
Phosphorus	15.72
Ca/P	0.01
Na/K	0.01

The fat mean value of *C. procera* was in line with the 24.05% recorded in *A. senegalensis* but this value was higher than the 16.49% recorded in *D. alba* (Zain *et al.*, 2013) and 17.10% in *M. oleifera* (Yameogo *et al.*, 2011) Fat is important in diets because it is considered as a source of lipid biomolecules (Iheanacho and Udebuani, 2009). The high fat content of *C. procera* suggests that the seed could serve as an oil source for various purposes.

The calculated metabolizable energy value of *C. procera* (1285.60 KJ/100 g) fell within the range of 1086 to 1703.95 KJ/100 g reported for *P. mildbraedi* (Akinyeye *et al.*, 2010), *H. myriantha* (Andzouana and Mombouli, 2012a) and *Velvet bean* (Balogun and Olatidoye, 2012). The high energy value recorded in the present study is mainly linked to the high carbohydrate and fat contents. The energy value of *C. procera* seeds makes the plant a useful source of energy and therefore it could be recommended for food supplementation.

The results of the present study (Table 1) showed that the protein and ash contents were low. The protein value of 8.13% of *C. procera* was found to be lower than the 24.90 and 33.21% reported *for S. africana* and *M. angolensis*, respectively (Tairo *et al.*, 2011). The RDA for protein is in the range of 28-65 g for children, lactating mothers, pregnant women and adults (Adinortey *et al.*, 2012).

The present result suggests that *C. carapa* can be ranked as a poor protein species and cannot be used for diet supplementation.

The ash content value (3.68%) of the seeds was lower than the 21.15% recorded in *C. album* (Zain *et al.*, 2013) and the range of 17.44 to 33.60% reported for mushroom species (Egwim *et al.*, 2011). The low ash content of these seeds is an indication of their low mineral content and also of their high organic content (Egharevba and Kunle, 2010).

Mineral composition: The results of the mineral analysis are reported in Table 2. The mineral composition of the *C. procera* seeds indicated that phosphorus (15.72%), iron (2.82%) and potassium (1.23%) were the most abundant elements. Calcium and magnesium were recorded in low concentrations (0.22 and 0.23%, respectively) while sodium and manganese were found in trace quantities (0.01-0.02%). Walnuts contain high levels of potassium, phosphorus and magnesium but have a low sodium content (Lavedrine *et al.*, 2000; Akca *et al.*, 2005). This is in agreement with the present results except for magnesium, which was recorded in a low concentration. *C. procera* showed a relatively high level of all the recorded minerals when compared with a vegetable like *O. dicellandroides* (Andzouana and Bienvenu, 2012b).

Minerals play important metabolic and physiologic roles in the living system (Enechi and Odonwodo, 2003; Ujowundu *et al.*, 2010) and they serve as cofactors for many physiological and metabolic functions (Balogun and Olatidoye, 2012). Minerals are essential for proper tissue functioning and a daily requirement for human nutrition (Iniaghe *et al.*, 2009).

For instance phosphorus is required in normal development of bones and teeth. It helps in regulation of the body fluids and enzymes and their functioning (Kathirvel, 2012). It plays a significant role in CNS function and is involved in regulation of enzyme activities and nerve conduction. As phosphate ion its constitute the extra and intracellular fluid and is involved in absorption of dietary constituents and helps to maintain the blood at a slightly alkaline level (Karade *et al.*, 2004). Iron in the body makes tendons and ligaments, certain chemicals of the brain are controlled by the presence or absence of iron and it is also essential for the formation of hemoglobin, which carries oxygen throughout the body (Vaughan and Judd, 2003).

The high potassium content of the seed of *C. procera* recorded in the present study could be an advantage for people who take diuretics to control hypertension and who suffer from excessive excretion of potassium through the body fluids (Siddhuraju *et al.*, 2001). Ilelaboye and Pikuda (2009) reported that potassium dominates in seeds of lesser-known crops. This finding is in contrast to the result of the present study.

Calcium and magnesium were detected in small quantities. The magnesium content found in this study could not satisfy the needs of the woman's body for this element (Balogun and Olatidoye, 2012). Nevertheless they are involved in women's physiology. It has been shown that K, Ca and Mg take part in neuromuscular transmission and, together with other elements like Mn, they are involved in biochemical reactions in the body. The mineral are known as constituents of biological molecules and co-factors for various metabolic processes (Mayer and Vyklicky, 1989; Brody, 1994).

Though manganese and sodium were detected as trace elements, they are important for the health care of women, since even at these levels they participle to the metabolism process. For instance, sodium makes the seeds important as food for consumers in the management of hypertension to avoid increased calcium loss in urine (Wardlaw, 1999).

The Na/K ratio (0.01) of the sample was lower than the recommended 0.6 (Akinyeye, 2010). A diet high in K and low in Na help in blood pressure and cardiovascular regulation (Luft, 1990). The Na/K ratio observed in the present study suggests that the seed of *C. carapa* could be recommended in diets and may have health implication (Appiah, 2011).

The Ca/P ratio of the sample was found to be low. According to SCSG (2007) a good menu should have a Ca/P ratio over 1 and a poor if it is below 0.5 (Akinyeye, 2010). The increase in dietary P as low dietary Ca intake have tendency to health complications (Appiah, 2011). The Ca/P ratio of the studied sample suggested that the *C. procera* is a poor mineral species and could not be used in diet supplementation.

The seeds could be used in the human diet to supply the body with minerals, although some of these minerals were recorded at the low levels they required in human physiology and the management of women's health.

Phytochemical screening: The results of the phytochemical screening of *C. procera* seeds extracts (Table 3) showed the presence of alkaloids, flavonoids, saponins, steroids, tannins, triterpenoids, phenols and anthocyanines in methanol. However in carbon tetrachloride, steroids and tannins were not detected. Anthraquinones was absent in all the screened extracts of the seeds.

Quantitative phytochemical analysis: The result of quantitative analysis of the seeds (Table 4) showed high alkaloid, flavonoid and phenol concentrations (5.67±0.18; 5.98±1.38 and 7.46±0.15%, respectively) while saponins and anthocyanins were detected in low amounts (0.92±0.10 and 2.01±0.12%).

Phenols showed the highest concentration when compared with those of all the screened phytochemicals.

The content of flavonoids and phenols in the studied sample was favorably compared to 4.13±0.14 and 8.93±0.23% recorded by Ekpo *et al.* (2012) in *Xylopia aethiopica* for both compounds, respectively. However both values were found to be lower than the 21% of flavonoids recorded in the blue flowering sample of *S. marianum* (Syed *et al.*, 2011) and the 31.19±0.72% of phenol recorded in stem bark of *xylopia aethoipica* (Ekpo *et al.*, 2012).

Table 3: Qualitative analysis of *C. procera* seeds

	Extract	
Phytochemical	CH_3OH	CCL_4
Alcaloides	+	+
Flavonoides	+	+
Glycosides	+	+
Saponins	+	+
Steroids	+	-
Tannins	+	-
Triterpenoids	+	+
Anthocyanins	+	+
Phenols	+	+
Anthraquinones	-	-

+: Present -: Absent

Table 4: Quantitative analysis of *C. carapa* seeds

Phytochemical	Amount (%)
Alcaloides	5.67±0.18
Flavonoides	5.98±1.38
Glycosides	00.00
Saponins	0.92±0.10
Phenols	7.46±0.15
Anthocyanines	2.01±0.12

Phenols are reported to have antimicrobial activity and could be used to treat skin diseases (Iqbal *et al.*, 2011) and they are known to be antioxidant, mainly due to their redox properties. They act as reducing agents, hydrogen donors and singlet oxygen quenchers and have a metal chelation potential (Basile *et al.*, 2005).

Flavonoids are known to possess antibacterial, anti-inflammatory, anti-allergic, antiviral and anti-neoplastic activity (Ali, 2009). They act as antioxidants to neutralize free radicals, which contribute to a variety of health problems, including cancer, heart disease and aging (Stauth, 2007).

The alkaloid concentration of *C. carapa* was found to be comparable to the 5.61% and the range of 5.22±0.22 to 6.22±0.11% recorded in the flower of *B. tomentosa* L. (Sathya *et al.*, 2013) and *Xylopia aethiopica*, respectively (Ekpo *et al.*, 2012). However this alkaloid value was lower than the 12.07% reported for *C. aconitifolius* (Aye *et al.*, 2012).

Alkaloids have been reported to be powerful pain relievers, to exert an anti-pyretic, stimulating, anesthetic action (Edeoga and Enata, 2001) and inhibiting activity against most bacteria (Al-Bayati and Sulaiman, 2008).

The saponin content of the sample was favorably compared to the range from 1.30 to 1.99%, reported by Ayeni and Yahasa (2010); however this value was lower than the 7.67% reported by Aye (2012) for *C. aconitifolius* and also the 7.30±0.25% for *cola acuminate* (Dewole *et al.*, 2013).

Saponins have been found to be potentially useful for the treatment of hyperglycemia. Alkaloids and saponins have been reported to be useful in hypertension treatment (Olaleye, 2007) and as flavonoids to have anti-inflammatory property and aid healing (Krishnaiah *et al.*, 2009).

Truong *et al.* (2010) reported the high anthocyanin content of 663 mg/100 g (DW) for sweet potatoes when compared with the value recorded in this study. Anthocyanins are known to have a wide range of physiological functions including anti-inflammatory activity, antimicrobial activity, ultraviolet light protection and reduction in memory impairment (Suda *et al.*, 2003; Wu *et al.*, 2008). They are involved in the maintenance of normal microcirculatory function including normal capillary filtration of albumin and its uptake by the lymphatic system (Cohen-Boulakia *et al.*, 2000).

The presence of alkaloids, flavonoids and phenols in high concentrations in the seed of *C. carapa* suggests that they might exert these reported properties on consumers.

The effects of saponins and anthocyanins on the body metabolism may be important because at these low levels they can act probably in synergy with other compounds. On the other hand, the low levels of bioactive compounds in the sample could be an advantage to avoid adverse effects on women's health.

Conclusion: This study reveals that the samples of C. procera can be considered as an alternate source of energy and other nutrients which are important in fighting against malnutrition for children and poor people in developing countries.

The proximate, mineral and phytochemical compositions of *C. carapa* led us to conclude that the seeds could be important both for man as nutrition, or useful for their medicinal value linked to the presence of bioactive compounds. The seeds can be seen as a potential source of useful drugs in traditional medicine.

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