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 KJ/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, terpenoids, 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 alkaid, flavonoid and phenolic concentrations (5.67±0.18, 5.98±1.38 and 7.48±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, 2008; Balogun and Olstidoye, 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-carring, 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 Carapa procera.
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 14\textsuperscript{th} 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°C 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 colorimetrically. 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 (1983), Harborne (1984) 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 Kociapi (1984), Harborne (1973), Obadoni and Ochuko (2001), Onyeka and Nwambike (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 other 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. mildbraedlbby leaves (Akinwuye 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 Oladitoye, 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).
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. dicellindroides (Andzouana and Bienvenu, 2012b). Minerals play important metabolic and physiologic roles in the living system (Enechi and Odonwodo, 2003; Upowundu 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 (Iniahe 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 (Kathivvi, 2012). It plays a significant role in CNS function and is involved in regulation of enzyme activities and nerve conduction. As phosphate ion it 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 (Sidduraju 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.

The present results suggest 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).

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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>47.92</td>
</tr>
<tr>
<td>Crude fat</td>
<td>23.14</td>
</tr>
<tr>
<td>Crude proteins</td>
<td>08.13</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>17.13</td>
</tr>
<tr>
<td>Total ash</td>
<td>03.69</td>
</tr>
<tr>
<td>Energy (Kg/100 g)</td>
<td>1295.60</td>
</tr>
</tbody>
</table>

### Table 2: Mineral composition of C. carapa seeds

<table>
<thead>
<tr>
<th>Mineral element</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>0.22</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.23</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.23</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.01</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.02</td>
</tr>
<tr>
<td>Iron</td>
<td>2.82</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>15.72</td>
</tr>
<tr>
<td>Ca/P</td>
<td>0.01</td>
</tr>
<tr>
<td>Na/K</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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 1088 to 1703.95 KJ/100 g reported for P. mildebraedii (Akinveye et al., 2010), H. myriantha (Andzouana and Momboul, 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 (Taio et al., 2011). The RDA for protein is in the range of 28-65 g for children, lactating mothers, pregnant women and adults (Adinority 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).
Though manganese and sodium were detected as trace elements, they are important for the health care of women, since even at these levels they participate in 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 (Akinseye, 2010). A diet high in K and low in Na helps 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 (Akinseye, 2010). The increase in 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 (5.87±0.18, 5.98±1.38 and 7.46±0.15%, respectively) while saponins and anthocyanines 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. mariannum (Syed et al., 2011) and the 31.19±0.72% of phenol recorded in stem bark of xylopia aethiopica (Ekpo et al., 2012).

<table>
<thead>
<tr>
<th>Phytochemical</th>
<th>CH₃OH</th>
<th>CCl₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Glicosides</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Saponins</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Steroids</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Tannins</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Triterpenoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Phenols</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Anthraquinones</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>#: Present</td>
<td>-</td>
<td>Absent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phytochemical</th>
<th>Amount (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>5.67±0.18</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>5.98±1.38</td>
</tr>
<tr>
<td>Glicosides</td>
<td>0.00</td>
</tr>
<tr>
<td>Saponins</td>
<td>0.92±0.10</td>
</tr>
<tr>
<td>Phenols</td>
<td>2.01±0.12</td>
</tr>
<tr>
<td>Anthocyanines</td>
<td>7.46±0.15</td>
</tr>
</tbody>
</table>

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 (Basilie 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 (Staunton, 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. tormentosa 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 Ayen 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 acuminata (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., 2009). They are involved in the maintenance of normal microcirculatory function including normal capillary filtration of albumin and its uptake by the lymphatic system (Cohen-Boulákia 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.

REFERENCES


