African Journal of Biotechnology Vol. 10(84), pp. 19631-19636, 26 December, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.1518
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

The chemical constituents of calabash (*Crescentia cujete*)

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Accepted 14 November, 2011

Virtually, all parts of the calabash (*Crescentia cujete*) tree have been found to be useful; the wood for tool handles, ribs in boat building, cattle yokes, and the gourd is used for cups, containers and musical instruments. The calabash (*C. cujete*) fruit was studied for its chemical constituents- proximate and mineral composition as well as phytochemical properties. The sugar content, energy content, electrical conductivity and pH of the fruit were also determined. The value of the fat, protein, nitrogen, crude fibre, moisture content, sucrose, fructose, galactose and energy content are quite high viz; 1.13, 8.35, 1.34, 4.28, 84.92, 59.86, 25.09, 18.24 and 88.69%, respectively. The pH of the fruit falls within the acidic range (4.80) and the mean value recorded for the electrical conductivity was 163.24 μS/cm. The results obtained for the mineral elements show that sodium and phosphorus have high mean concentrations, while low mean concentrations were recorded for others. Also, the results show relatively low mean concentrations for the heavy metals; but high mean concentrations for manganese, iron, zinc and copper. The presence of phytochemicals like saponins, flavonoid, cardenolides, tannins and phenol as well as the presence of hydrogen cyanide were observed in the fruit sample. The findings on the phytochemical constituents, mineral composition and proximate composition of the *C. cujete* suggest that the fruit can make useful contribution to both human and animal nutrition and possesses medicinal values.

Key words: *Crescentia cujete*, chemical constituents, like saponins, flavonoid, cardenolides, tannins.

INTRODUCTION

Calabash tree or *Crescentia cujete* tree belongs to the family of Binoniacea. It is also known as the gourd tree. The calabash tree is 6 to 10 m tall with a wide crown and long branches covered with clusters of tripinnate leaves and gourd-like fruit. The branches have simple elliptical leaves clustered at the anode. The greenish flowers arise from the main trunk and blooms at night (Gilman, 1993). It is propagated either by seed or stem cuttings.

Calabash fruit is a seasonal fruit that develops after pollination by bats. It appears at the end of dry season, and the fruit is up to 12 to 14 cm in diameter. It is globular with smooth hard green woody shell. It takes about six to seven months to ripen and eventually falls to the ground (Gilman, 1993). Small flat seeds are embedded in the pulp (Micheal, 2004; Burkill, 1985).

The calabash tree is widely distributed in the Caribbean region, Mexico, Northern and Southern American and later introduced to tropical Africa from Senegal to Cameroon then to other parts of Africa (Micheal, 2004). In Nigeria, the tree is widely grown in the Northern states but little in other parts of the country.

Virtually, all parts of the tree have been found to be useful. The wood is used for tool handles, ribs in boat building and cattle yokes; and the gourd for cups, containers and musical instruments. The fruit is reported to have medicinal application (Michael, 2004; Burkill, 1985; Plant Database, 2004).

MATERIALS AND METHODS

A mature calabash fruit was plucked from the tree at Erusu-Akoko North West Local Government Area of Ondo State, Nigeria. The

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Table 1. Result for phytochemical screening

Phytochemical	Test for phytochemical constituent	Observation	Inference
Tannins and phenols	10 ml of sample + distilled H_2O + heat + filter + 1% F_eCl_3	Blue black coloration	Present
Saponins	20 ml of sample + distilled H_2O + heat	Foaming which persisted on warming	Present
Alkaloids	10 ml of Sample + 5 ml Of 1% HCl + heat + filter + picric acid solution	The resulting solution became turbid	Present
Flavonoid	10 ml of sample + 10 ml ethyl acetate + heat + filter + 1 ml of NH_3	Yellow colour observed	Present
Anthraquinone	10 ml of sample +10 ml of benzene + filter + 50 ml of 10% NH_3	Pink colouration was observed	Present
Cardenolides	5 ml of sample + glacial acetic acid + filter + few drop of F_eCl_3 + 1 ml of concentrated H_2SO_4	Brown colour was observed	Present
Phiobatannin	5 ml of sample + distilled water + filter + heat + 1 ml of 1% HCl	No red precipitate was observed	Absent

fresh fruit was cut open and pulp was scooped out. The flat seeds were carefully removed from the pulp, and the pulp was blended to obtain a homogeneous sample. The wet sample of the pulp was now ready for study.

The tannins, phenol, cardenolides, anthraquinone and phiobatannins were determined by the method described by Trease and Evans (1989). Alkaloids, flavonoids and saponins were determined by the method of Harborne (1973). The moisture content, protein, crude fibre and fat were determined by the method of James (1995). Sugar content of the fruit sample was estimated by the method described by Miller (1959). The composition of each sugar from the fruit extract was measured spectroscopically as reported by Leopold (1962). The mineral elements were determined from the fruit sample using atomic absorption spectrophotometer (AAS) (Huang et al., 1995). Hydrogen cyanide (HCN) was determined by the AOAC (1990) method.

RESULTS AND DISCUSSION

Phytochemical constituents

Summary of the results for the phytochemical constituent determination of *C. cujete* fruit is shown in Table 1. Phenol and tannins were present in the fruit sample. Phenol and phenolic compounds have been extensively used in disinfections and remain the standard with which other bactericides are compared in official test (Cater, 1979). This may explain why *C. cujete* was used as disinfectant and bactericides in emollient healing and in the treatment of burns (Micheal, 2004; Burkilli,1985; Plant Database, 2004; Morton, 1981). Tannins have astringent properties that hasten the healing of wound, prevent decay and have antimicrobial activity (Chukwuma et al., 2010). Tannins and their compounds are known to be responsible for preventing and treating urinary tract infections and other bacterial infections (Plants Database, 2004; Morton, 1981; Michael, 2004). The presence of tannins in the fruit therefore suggests that it may serve as a useful antibacterial agent.

Flavonoids found in *C. cujete* can act as anti-oxidants and protect the cells of the body from free radical damage; free radicals are reputed to damage cell and contribute to various health related problems (MacArthur, 1992). The presence of alkaloid was observed in the fruit sample. Alkaloids are very important in medicine because, some alkaloids have been used as basic medicinal agent for their analgesic, anti-spasmodic and bactericidal effects (Frantisek, 1998). Alkaloids in *C. cujete* may explain why it is been used as analgesics in the treatment of coughs and as anti-inflammatory agents (Plants Database, 2004; Morton, 1981; Michael, 2004; Burkill, 1985). Saponins were present in *C. cujete*. Saponins are known to serve as natural antibiotics and also boost energy (Lipkin, 1995). Saponins are also useful in reducing inflammation of the upper respiratory passage and also as foaming and emulsifying agent and detergents (Frantisek, 1998). Saponins in *C. cujete* may serve as anti-inflammatory agent and as antibiotics in treating diseases and ailments.

Cardenolide and anthraquinone were also present in the fruit sample. Cardenolides are cardiac stimulants, which suggests that it may be useful in treating some heart related diseases (Finar, 2000). Anthraquinone on the other hand is used as laxative (Muller-Lissner, 1993). The presence of anthraquinone in *C. cujete* may explain why it is used as laxative (Michael, 2004; Burkill, 1985, Plant Database, 2004; Morton, 1981). The presence of phiobatannins was not observed in the fruit sample. Phiobatannins are said to be useful in medicine, as they serve as precursors in the preparation of drugs (Soforowa, 1993).

Table 2. Analytical data for proximate composition of *C. cujete* fruit.

Parameter	Value
Moisture content (%)	84.92
Crude fibre (%)	4.29
Crude protein (%)	8.38
Crude fat (%)	1.13
Crude carbohydrate (%)	18.61

Table 3. Mean values of the sugar content, pH, E.C. and energy of the *C. cujete* fruit.

Parameter	Value
Sucrose (%)	59.86
Fructose (%)	25.09
Galactose (%)	18.24
pH	4.80
E.C. (μS/cm)	163.24
Energy (%)	88.69

Proximate composition, sugar content, pH, electrical conductivity and energy

The results for the proximate composition, sugar content, pH, electrical conductivity and energy are given in Tables 2 and 3, respectively.

Generally, fruits are not good sources of fat. Low fat diets are said to reduce the level of cholesterol and obesity (Gordon and Kessel, 2002). The lipid value recorded for the fruit sample was 1.13% (Table 2). Therefore, the fruit can be recommended as part of weight-reducing diet, because of its low fat content. The mean value for the crude protein was 8.38% (Table 2); this is higher than the value reported for pineapple (0.4%), cashew and apple (0.7%) (Ogbuagu, 2008). Protein is vital for maintaining health, therefore the fruit could serve as a source of protein in human diet. The value recorded for the crude fibre of the fruit sample was 4.29% (Table 2). This value is averagely reasonable. A range of values between 0.1 and 6.8% has been reported for selected fruits (Osee, 1970). Crude fibre provide roughage that aids digestion (Eva, 1983). Thus, the value of crude fibre recorded for the fruits suggests that it can serve as a good source of crude fibre.

The moisture content data showed that the fruit has a high moisture content of 84.92%. The high moisture content of the fruit can serve the purpose of table water in human diet when consumed. However, high moisture content in fruits or foods is said to reduce the shelf life of such fruit or food (APO, 2006). The crude carbohydrate value was found to be 18.61% (Table 2). The fruit can be considered as a good source of crude carbohydrate. Carbohydrate supplies energy to cells such as brain, muscle and blood. They contribute to fat metabolism and spare proteins as an energy source and as mild natural laxative for humans and generally add to the bulk of the diet (Gordon, 2000). A diet that does not contain carbohydrate can lead to muscle break down, ketosis and dehydration, which can be prevented by 100 g of carbohydrate per day (Australian Research Institute, 1990).

Table 3 shows the mean values for the sugar content of *C. cujete*. The three sugars isolated include sucrose, fructose and galactose. The mean value of sucrose recorded for the sample was 59.86%, which is higher than that reported for *Eugenia jambosa* fruit (20.12%) (Noomrio and Dahot, 1996). The high sucrose content of the fruit makes it a good source of ethanol production via fermentation (Osei, 2001). The mean value of fructose of 25.09% was recorded, for the fruit. This may explain why it is used in treating diabetes (Plant Database, 2004; Morton,1981). Also, the mean value of fructose; 25.09% in *C. cujete* was found to be higher in comparison with 12.23% in *E. jambosa* fruit (Noomrio and Dahot, 1996). The mean value recorded for galactose was 18.24%. Galactose is said to combine with glucose to form lactose, the sugar of milk, produced in large quantities in the mammary gland of lactating animals (McDonald, 1982). The amount of galactose present in the fruit suggests that the fruit can serve as a source of galactose in lactating animal's diet. Similarly, the mean value of galactose in *C. cujete* was high when compared with that

Table 4. Mean values of mineral composition of *C. cujete* fruit.

Mineral	Concentration
Calcium (%)	0.04
Magnesium (%)	0.01
Potassium (%)	0.02
Sodium (ppm)	59.77
Manganese (ppm)	21.74
Iron (ppm)	7.88
Zinc (ppm)	3.97
Copper (ppm)	6.90
Phosphorus (ppm)	53.01
Lead (ppm)	0.17
Chromium (ppm)	0.07
Nickel (ppm)	0.10
Cobalt (ppm)	0.03
Cadmium (ppm)	0.01
Selenium (ppm)	0.02
Arsenic (ppm)	0.00
Tin (ppm)	0.01
HCN (ppm)	0.11

of *E. Jambosa* fruit; 11.17%, (Noomrio and Dahot, 1996).

The mean energy value recorded for the fruit was 88.69%. The value of the energy recorded was reasonably high when compared with those of banana (10%) and other fruits, and lower when compared with that of carrot (110%) (Timberlake, 2007). Consumption of *C. cujete* fruit can supplement daily energy requirement in both man and animal. The pH value recorded for the fruit was 4.80 (Table 3). This pH value is acidic and can give an astringent taste to the fruit. pH values of 3.8, 4.2, 3.5, 2.9, 3.83 and 3.82 have been reported for fruits like apple, tomato, orange, *Carisa carindas*, *Punica granatum* and *Capparis decidua*, respectively (Timberlake, 2007; Noomrio and Dahot, 1996). It was reported that lower pH of sample is favourable for higher shelf life (Noomrio and Dahot, 1996). The value recorded for the electrical conductivity was 163.24 μS/cm; this value falls within that of drinking water (50 to 500 μS/cm) (Wikipedia, 2011). Electrical conductivity is an indirect measure of the amount of dissolved solids/ions contained in a sample (Wikipedia, 2011).

Mineral composition

The summary of the results for the mineral composition is given in Table 4. The mean values recorded for calcium, magnesium, potassium and sodium were 0.04%, 0.01%, 0.02% and 59.77 ppm, respectively (Table 4). Calcium helps in regulating the passage of nutrients through cell walls and the correct contraction of the muscles. It also helps in the clothing of blood and the transfer of signal by the nerves (Gordon, 2000; Suzanne, 2002). Magnesium provides bone and tooth strength, helps in blood clotting, aids nerve impulse transmission required for muscle contraction (Gordon, 2000; Barbara and Robert, 2001; Suzanne, 2002). Also, potassium is essential for keeping a normal water balance between the cell and body fluids, that is, it plays an important role in proper heart function (Gordon, 2000) while sodium functions as electrolytes and plays key role in ion and extracellular fluid balance and a major factor in nerve impulse transmission (Gordon, 2000). The fruit is rich in sodium and hence could serve as a sodium supplement in diet. Also, the fruit could serve as a source of calcium, magnesium and potassium, though their values are relatively low.

The mean value recorded for manganese, iron, zinc, copper and phosphorus were 21.74, 7.88, 3.97, 6.90 and 53.01 ppm, respectively (Table 4). Manganese functions in enzyme reactions with regards to blood sugar metabolism and thyroid hormone function (Realtime, 2011). Iron is another important element in both animal and human diet, as it helps in haemoglobin formation (Ramlingam, 2001). Also, zinc is said to be important in protein and carbohydrate metabolism and according to Popenoe (1969), it is known to aid wound healing of worn out tissues. Copper is involved in the absorption, storage and metabolism of iron and the formation of red blood cells (Realtime 2011). Phosphorus in its own contribution functions in combination with calcium for the formation of bones, teeth and nerve cells (Gordon, 2000; Suzanne, 2002). The fruit with high concentration of phosphorus and manganese could serve as a good source of both elements and thereby enhance the functionality of the two metals in human body when consumed. Also, the mean value of iron, copper and zinc could be said to be relatively high, implying that the fruit is a good source of micro-nutrient element.

The value recorded for lead, chromium and nickel in the fruit sample were found to be 0.17, 0.07 and 0.10 ppm, respectively (Table 4). Lead is known to be a very toxic element and its presence in humans and animal diet is not ideal (Reis et al., 2010). Chromium on the other hand is not a particular toxic element and a wide range of safety exists between the normal amounts ingested and those likely to produce detrimental effect (McDonald et al., 1982). Nickel is reported to play a role in nucleic acid metabolism (McDonald et al., 1982). As a relatively non-toxic element, it is poorly absorbed from the digestive tract and rarely cause a serious health hazard (McDonald et al., 1982). The value of chromium and nickel obtained for the fruit extract may not necessarily have any recognized health hazards. However, the concentration of lead remains a matter of great health concern. This is unconnected with the high toxicity nature of lead in humans. The WHO recommended safety value for lead in portable water is 0.01 mg/L (WHO, 1993). The mean value of lead in the fruit greatly exceeds this, suggesting that the consumption of the fruits by man or animal could be a good source of lead toxicity.

0.03, 0.01 and 0.02 ppm were the mean values recorded for cobalt, cadmium and selenium, respectively in the fruit (Table 4). Cobalt is known to help in haemoglobin formation (Ramlingam, 2001). On the other hand, cadmium is known to be a toxic element, though a wide safety margin exists between the normal amount ingested and those likely to produce deleterious effects. Selenium is reported to function as an antioxidant that works in conjunction with vitamin E and is also necessary for the body to function properly (Realtime, 2011). The mean values for these elements are all relatively low, an indication that they may not pose any deleterious health impact on human when consumed, rather, its consumption could serve as a supplement especially for cobalt and selenium.

The arsenic and tin mean value recorded for the fruit sample were 0.01 and 0.01% (Table 4). The standard value given for arsenic in water by EPA (2000) is 0.10 ppm. High concentration of arsenic in fruits or in water is said to cause lung cancer and changes in skin pigmentation (Brown et al., 2001). It has been reported that tin is an essential trace element for mammals (McDonald et al., 1982). Tin is poorly absorbed from the digestive tract and ingested tin has low toxicity (McDonald et al., 1982). The mean value for the metals was found to be exceptionally low, however, the continual consumption of the fruit may trigger arsenic toxicity and hence, it should be discouraged for health reasons.

The mean value of the hydrogen cyanide in the C. cujete fruit sample was found to be 0.11 ppm. Hydrogen cyanide is a chemical asphyxiant; it stops the tissue from utilizing oxygen which makes it a potential fatal poison (Brown et al., 2001). Hydrogen cyanide is found in small quantities in peach such as cherries or apricots. The hydrogen cyanide concentration of 0.11 ppm recorded in the fruit extract was found to exceed the WHO cyanide value for drinking water (0.01 mg/L), meaning that the continual consumption of *C. cujete* fruit extract may eventually lead to hydrogen cyanide toxicity.

Conclusion

The values of fat, protein, crude fibre, moisture content, sugar content and energy content in the fruit were very reasonable, which suggests that the fruit can make valuable contributions to nutrition. The values of the mineral elements like sodium and phosphorus is reasonably high, suggesting that the fruit can serve as a source of these mineral elements in nutrition when consumed. But for the presence of high concentration of heavy metals like lead, arsenic and hydrogen cyanide recorded in the fruit sample, its continual consumption should be discouraged as it can lead to heavy metal toxicity. In addition, it can also make useful contributions to human and animal health, as a result of the presence of phytochemicals observed in the fruit sample.

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