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Physicochemical characterization of exudates from Raffia Palm (*Raphia hookeri*)

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ABSTRACT

The Physicochemical properties and mineral element composition of exudates from Raffia palm (Raphia hookeri) were investigated. The proximate composition of the exudates shows that it contains moisture (90.14%), crude protein (2.5%), ash (9.5%), crude fat (2.64%), crude fiber (0.00%), carbohydrate (85.4%) and calorific value (375kcal/100g). Mineral composition (mg/100g) of the exudates was as follows: Calcium (55.31), Magnesium (26.60), Sodium (23.63), Potassium (20.95), Manganese (8.54), Cobalt (4.77) and Iron (4.57). The anti-nutrients evaluated (mg/100) in the exudates were Hydrocyanic acid (23.76), soluble Oxalate (44.00), total oxalates (61.60) and Phytic acid (7.82). These results indicate that the anti-nutrients and mineral elements present in the exudates are within acceptable levels for humans. The high amount of carbohydrate and low level of the toxicants present in the exudates makes it highly recommendable for use as an additive in food.

Keywords: *Raphia hookeri* Exudates, Proximate Compositions, Mineral Elements and Anti-nutrients.

INTRODUCTION

Raphia hookeri (Raffia palm) is the largest palm in Africa and is restricted to the tropical rainforest, the ideal ecological condition for the Raffia palm (Ndon, 2003). It is one of the most economically useful plants in Africa; the leaves are used for shelter and the stem produces palm sap, which is drank as beverage. The fermented sap could be distilled into alcohol or local gin (Martinez *et al*, 1992). Succulent, oily larvae of weevils and beetles are obtained from infected palms and serve as delicacy. The trunk could serve as firewood. The mesocarp of the ripe fruit yields edible oil (Otedoh, 1976, 1990). While the leaf petiole yield the fibrous piassava.

Exudates are naturally occurring polysaccharides containing hexuronic acid units as salts and a number of neutral monosaccharide units which are often esterified in highly branched structure. These exudates can be produced by deliberately injuring of the fibro vascular tissues of the apex, the inflorescence of the Raffia palm (Ndon, 2003).

Exudates are viscous, translucent, amorphous, water soluble or water dispersible hydrocolloids produced by higher plants as protection from micro organisms. The gum exudes along with the palm wine is normally removed and discarded by tapper (Ndon, 2003).

Although previous authors (Ndon, 2003 and Ekpa, 1993) have reported works on the various uses of this exudate but there is however scanty reports on the physicochemical properties and the nutritional value of the exudates (Alais and linden, 1999). Hence this research aims at investigating the physicochemical properties of the Raffia palm exudates in order to evaluate its industrial applications.

MATERIALS AND METHODS

Raffia palm used in this work was obtained from Ikot Esenam village in Akwa Ibom State, Southern Nigeria. The exudates were produced by injuring the inflorescent part of the raffia palm was removed during tapping. All reagents and chemicals used were of analytical grade.

Chemical Characterization

The following tests were performed on sample of exudates obtained from *Raphia hookeri:*

- **Test for Starch:** 2 drops of iodine solution prepared by dissolving 0.2g of iodine in 10ml of Potassium Iodide was added to suspended exudates and the result was noted and recorded.

- **Test for Lignin:** Phloroglucinol solution prepared by dissolving 1g of the Phloroglucinol with 50ml of distilled water and 50ml of methanol was used (Browning, 1977). A drop of the solution on a glass rod was placed on the sample and the result was noted and recorded.
- **pH and Electrical Conductivity:** Sample was dispersed in distilled water and pH was determined at 27^{o}C using a JENCO Digital pH Meter. Hath Conductivity Meter (Model 44600-00) was used for electrical conductivity measurement.
- **Proximate and Mineral Elements Analysis:** Moisture, ash, crude protein, crude fat, crude fiber, carbohydrate content, energy value, mineral elements and some toxic substances were determined respectively using standard procedures of the Association of Official Analytical Chemists (AOAC., 1995)

RESULTS AND DISCUSSION

Exudates from *Raphia hookeri* were characterized and the results obtained are shown in the following tables.

Table 1: Physico-chemical analysis of *Raphia hookeri* exudates

Parameter	Composition of dry matter (DM) (%)
Moisture per fresh Exudates	90.14
Ash content	9.50
Crude protein	2.50
Crude fat	2.64
Crude fibre	0.00
Carbohydrate	85.40
Starch	-
Lignin	-
pH at 27 ^{o}C	6.2
Energy value (Kcal/100g)	375
Electrical conductivity (µS/cm)	26.3

Indicates absence.

Table 2: Mineral element composition of *Raphia hookeri* exudates

Elements	Concentration (mg/100g)
Calcium	55.31
Magnesium	26.60
Sodium	23.63
Potassium	20.95
Manganese	8.54
Cobalt	4.77
Iron	4.57

Table 3: Anti-nutrient composition of *Raphia hookeri* exudates

Toxicants (Anti-nutrients)	Concentration (mg/100g)
Hydrocyanic Acid	23.76
Soluble oxalate	44.00
Total oxalate	61.60
Phytic acid	7.82

DISCUSSION

Chemical Composition:
Exudates of *Raphia hookeri* showed negative result to starch test indicating absent of starch. Lignin being a constituent of dietary fibre was also absent thus indicating the absence of crude fibre. The pH of 6.2 for the exudates gum at 27^{o}C was an indication of a slightly acidic medium. This is consistent with the presence of a polysaccharide containing hexuronic acid units e.g. 4-O-methylglucuronic acid (Bee *et al.,* 1989). The sample showed an electrical conductivity value of 26.3µS/cm, a condition which is indication of its ability to conduct electricity and thus a possibility for the presence of dissolved metal ions.

Proximate Composition:
Exudates of *Raphia hookeri* showed moisture content of 90.14%. The sample contained 9.5 % dry matter of ash. Ash is the non-volatile inorganic residue that remains after burning off the organic material (Anderson, 1987). The level of ash in the sample is appreciable and is indication of the potential usefulness of the exudate in ceramic production.

The crude protein content of the sample was 2.5% of dry matter. This indicates a possibility of its usage as a supplement to other protein sources in the food.

The crude lipid content of the exudates was found to be 2.64% of dry matter. Generally, fat intake should be minimal; therefore this percentage is sufficient for the requirement of the essential fatty acid (linoleic acid) and fat-soluble vitamins (Ekpa, 1993). Therefore the exudates can be used as food additive to increase fat content. The FAO/WHO experts recommend that for most adults dietary fat should supply at least 20% of their energy from fat. For children of 6-2 months, their diet should supply 30-40% of energy from fat while very active individuals in energy may consume diets with up to 35% of their total energy intake from fat (Eneobong, 2001).

There was no crude fibre in the sample, dietary fibre in the portion of the plant cells that cannot be digested by human alimentary enzymes. The most constituents of dietary fibre are polysaccharides associated with the cell wall, examples are; cellulose, hemicelluloses, lignin, pectin and non-polysaccharides, e.g. are mucilage, saponins, silica and tannin. Dietary fibre slows down the rate at which carbohydrates are digested and absorbed in the body (Eneobong, 2001). Therefore, the percentage of carbohydrate – containing exudates will be completely absorbed by the body, because the exudates have no dietary fibre.

The carbohydrate content of the sample was 85.49% dry matter (Table I). The exudate was very rich in carbohydrate and this makes it recommendable for use in the food industries. Carbohydrates are the most abundant class of organic compounds found in living matter. They constitute three fourths of the dry weight of the plant world and are widely distributed in other life forms. In plants and animals it is one of the most consumed foodstuffs, when metabolized, provides about 4kcal/g of energy.

Energy Value/Caloric Value
The caloric value of the sample was 375 kcal. The amount of carbohydrate, lipids and protein in food/diet determines its caloric or energy value (Ekpa, 1996).

Energy is of prime importance to the body in order to maintain life to support growth and perform voluntary activities. The average physiological fuel value of the energy nutrients have been duly determined bearing in mind the digestibility of each of the nutrient and the values are given as: 1g of carbohydrate yields 4kcal of energy; 1g of lipid or fat yields 9 kcal of energy and 1g of protein yields 5kcal of energy. These values are referred to as Atwater conversion factor (Enebong, 2001).

Mineral Element Composition:
The mineral element composition of exudates from *Raphia hookeri* is shown in Table 2. The analysis showed that *Raphia hookeri* exudates are rich in sodium, calcium, magnesium, iron, potassium, manganese and cobalt. Mineral elements compositions are reported based on the dry matter (DM).

***Calcium (Ca*)**: The exudates were very rich in calcium (55.31mg/100g of dry matter). Generally, humans and other vertebrates require relatively large quantities of calcium for construction and maintenance of bone, blood clothing and nerve transmission. The recommended daily allowance for an adult is 800mg, its absence many result in stunted growth, rickets, osteoporosis, convulsions (Murray *et al,* 2000)

***Magnesium (Mg)*:** The exudates contained 26.60mg/100g of magnesium. The high level of the element shows that the exudates could provide an alternative source of magnesium in diets. Magnesium is required in large quantities by the body for the activation of enzymes involved in protein synthesis. The RDA (Recommended Dietary Allowance) is 420 mg/day for men and 320 mg/day for women. Other sources of magnesium are whole grams, green leafy vegetable. Possible outcomes of deficiency are growth failure, behavioral disturbances, weakness and spasms (Murray *et al*, 2000).

Sodium (Na): The exudates contained 23.65mg/100g of sodium. The sample is very rich in sodium, the body requires in a large quantity in other to maintain acid-base balance, osmotic balance between cells and interstitial fluid and nerve function. The recommended daily allowance of sodium is 115-75000mg/kg for infants, 324-975 mg/kg for children and 1100-3300 mg/kg for adults, (Crook, 2006). Its absence causes muscle cramps, mental apathy and reduced appetite.

***Potassium (K)*:** The exudates contained 20.95mg/100g. Raffia palm exudates has potassium content higher than *Chromolaena odorata* but comparable with *Acalypha wilkesiana* (Ikewuchi, and Ikewuchi, 2009). The high level of this nutrient shows that the exudates could provide alternative source of potassium in food. The body requires potassium in a large quantity for the maintenance of acid-base balance, body water balance and nerve function. The recommended daily allowance for an adult in good health is 2.500 mg. Its absence may result in muscular weakness, paralysis. Other sources of potassium are meat, milk and many fruits.

***Manganese (Mn)*:** The exudates contained 8.54mg/100g of manganese. The exudates have a low level content of the mineral. The body requires in a minute quantity for the activation of various enzymes, including the one required for area formation. The recommended daily allowance (RDA) is 3mg; no deficiency for human has been reported. Other sources of manganese are egg yolk, whole grain, and green vegetable (Hurley, 1976).

Cobalt (Co): The exudates contained 4.75 mg/100g. The exudates contained low level of cobalt. Cobalt is nutritionally Co^{2+} can function as a replacement *in-vitro* for other divalent cations in particular zinc, no *in-vivo* function for inorganic cobalt is known for human (Underwood, 1977).

***Iron (Fe)*:** The exudates contained 4.56mg/100g. It is a trace element needed by the body as it constituent of hemoglobin and enzymes involved in energy metabolism in iron transport. Its functions as essential component of enzymes involved in biological oxidation such as cytochromes c, c1, a1, etc (Malhotra, 1998). The recommended daily allowance for an adult in goods health is 10mg/100g, and its deficiency causes anemia and reduced resistance to infection. Other Sources of iron includes: eggs, lean meat, legumes, whole grains, and green leafy vegetable.

Anti-nutrient Composition:

The anti-nutrient (toxicants) composition of exudates from *Raphia hookeri* is given in Table 3; this was reported based on the dry matter (DM). Manifestations of toxicity range from severe reduction in food intake and nutrient utilization to producing neurological effects and even death. Compounds, which act to reduce nutrient utilization and/or food intake, are often referred to as antinutritional factor (ANF) (Osagie, 1998).

Hydrocyanic Acid (hydrogen cyanide; HCN): HCN content of the exudates was found to be 23.76mg/100g . The occurrence of the cyanogenic glycosides in crops plant such as cassava i.e *Manihot escucenta* (Cooke, 1978) and legumes (Okolie and Ugochukwu, 1989) have been reported. The extracellular enzyme linamarase present in cassava for instance gains access to cyanogenic glycosides after physical disruption of the cell, and then it catalyzes their hydrolysis to glucose and corresponding cyanohydrins. The cyanohydrins break down rapidly to give HCN and acetones in alkaline solution at ambient temperature.

HCN is a true noncumulative protoplasm poison. The lethal level of HCN is put at 35mg/100g of the body weight. The body has a mechanism for continuous removal of small amount of HCN by converting it to thiocyanate which is removed in the urine.

***Oxalic Acid*:** The exudates contained 44mg/100g of the soluble oxalate and 61.6mg/100g of the total oxalate. Oxalate, C_2 dicarboxylic acid anion is produced and accumulated in many crops plants and pasture weeds. Oxalates may be present in plant as the soluble salts, potassium, sodium or ammonium oxalate, as oxalic acid is a calcium oxalate. Oxalic acid is a weak reducing agent that is readily oxidized to carbon dioxide and water by potassium permanganate in H_2SO_4 solution. Certain plants contained appreciable amounts of oxalates e.g. spinach is 0.3 – 1.3%, beet leaves, 0.3-0.0%, tea, 0.3-2.0% and cocoa, 0.5 – 0.9% (Oke, 1969). It causes calcium deficiency both in man and in non-ruminants, at higher dose of 1g to 2g of body weight.

Oxalic acid is toxic to the kidney and heart (WHO, 1996). Symptoms of mild oxalate poisoning include abdominal pains and gastroenteritis. In severe case, it can cause diarrhea, vomiting, convulsions, non coagulability of blood, coma and kidney disease.

The effect of oxalic acid depends on the calcium of the diet that is still available for absorption after a portion of it has been chelated by the acid. Note: 1mg calcium makes 2.25mg oxalic acid insoluble and neutralizes its action (Enebong, 2001).

Phytic Acid: The phytic acid content of the exudates was 7.82mg/100g of dry matter. According to Osagie (1998), phytic acid, a hexaphosphate or inositol is an important storage form of phosphorus in plants. It is insoluble and cannot be absorbed in the human intestines. Phytic acid has 12 replaceable hydrogen atoms with which it could form insoluble salts with metals such as calcium, iron, zinc, and magnesium. The formation of these insoluble salts renders the metals unavailable for absorption into the body.

Studies by Nwokolo and Bragg (1977) have shown that in the chiken there is significant inverse relationship between phytic acid and the availability of calcium zinc, magnesium, phosphorus and zinc in feed stuffs like soya bean, palm kernel, and cotton seed meals. Phytate can also affect digestibility by chelating with calcium or by binding with calcium or by binding with substrate of proteolytic enzymes.

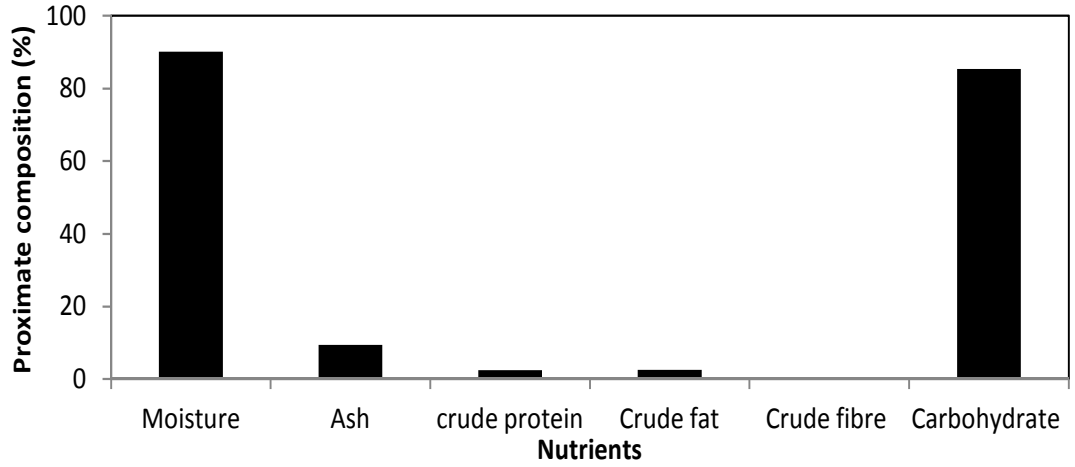

Fig.1: Proximate composition of *Raphia hookeri* exudate

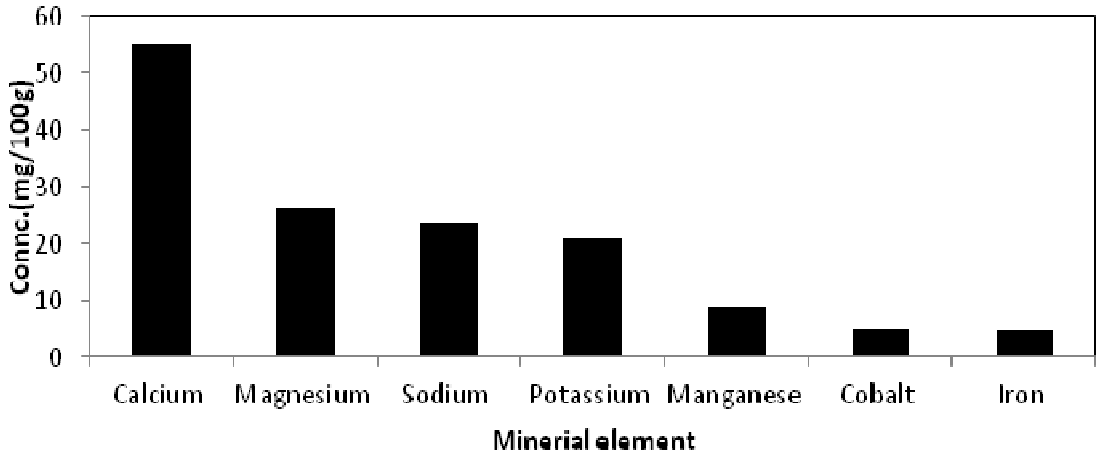

Fig.2: Mineral element composition of *Raphia hookeri* exudates

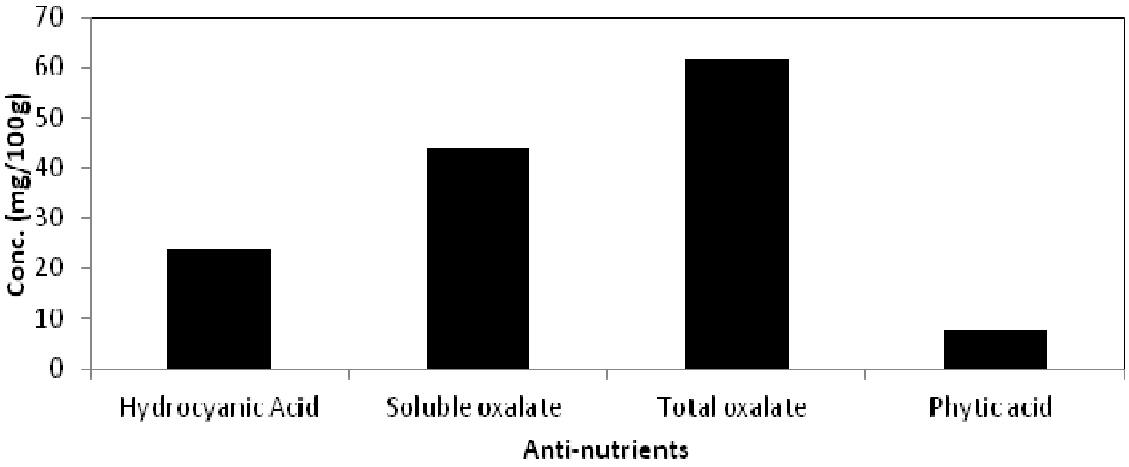

Fig. 3: Anti-nutrient composition of *Raphia hookeri* exudate

CONCLUSION

The physicochemical composition of the raffia palm exudates showed that it has greater percentage of carbohydrate contents, total oxalate and calcium. Crude fibre , starch and lignin were absent. The mineral elements compositions are within the range specified by WHO. Hence raffia palm exudates can be used as an additive in food and other industries.

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