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Nutritional and Electrolyte Values of *Cnidoscolus aconitifolius* (*Chaya*) leaves consumed in Niger Delta, Nigeria.

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ABSTRACT

Evaluation of the nutritive and electrolyte values of edible plants is currently essential for human nutrition and safety. This work assessed the proximate and mineral composition of the leaves of *Chaya* plant (*Cnidoscolus aconitifolius*) consumed in Niger Delta Nigeria for medicinal and nutritional purposes. Chaya is commonly known in this southern area of Nigeria as '*hospital is too far' or 'ogwu obala'*. The study showed that the dried leaves of the plant contain 47.03 ±1.02% of nitrogen free extract; 33.04± 3.14% of crude fibre; 7.03±0.23% of crude fat; 4.03±0.67% of crude protein, while moisture and ash made up 6.10±1.10% and 3.04±0.32%, respectively. A gram of the dried leaves yielded (in mg) 10±1.2, 20±1.6, 0.01±0.1, 100±5.3, 85±4.32, 18±2.1 and 50±2.3 of Iron, Phosphorus, Sodium, Potassium, Magnesium, Manganese and Calcium, respectively. The energy yield of the leaves was 258±4.5kcal/100 mg. These results suggested the comparative richness of the leaves in fibre, high nitrogen free extract (carbohydrate) and essential minerals. Properly prepared leaves are therefore recommended for daily consumption in order to supplement the recommended daily intake of nutrients and minerals and hence prevent nutritional and electrolyte deficiency disorders.

Keywords: *Cnidoscolus aconitifolius, Nutritional, Electrolytes, Values, Niger Delta*

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INTRODUCTION

World Health Organization (WHO) had specified the need to know the composition of biologically active botanical substances considered for usage for nutritional and medicinal purposes. As such scientific evidence will ensure the use of safe, effective and quality products and practices.[1]For this reason, it is pertinent to evaluate the nutritive and electrolyte values of *Cnidoscolus aconitifolius* (CA) consumed in Niger Delta, Nigeria whose phytomedicinal constituents had been characterized.[2, 3]

Cnidoscolus aconitifolius (CA), locally known in Niger Delta as '*hospital is too far'* or *'ogwu obala',* belongs to the family of *Euphorbiaceae*.[4] It has succulent stems which exude a milky sap when cut. It is an evergreen, drought deciduous shrubs up to 6 m in height with alternate palmate lobed leaves, milky sap and small flowers on dichotomously branched cymes. [2, 3]It is commonly found in the tropic and sub tropical regions worldwide, including Africa, South of Sahara, North and South America, India, etc. CA is commonly known as Chaya or Tree Spinach. It is popular in Mexico and Central America and has been introduced into the United States (mainly South Texas and Florida) for potential uses as a leafy vegetable and/or as a medicinal plant. [5] It is a large, fast growing leafy perennial shrub that is believed to have originated in the Yucatan Peninsula of Mexico.[4] It is commonly eaten as vegetable in soup. In fact, levels of leaf nutrients are two to threefold greater than any other land-based leafy green vegetable. [6, 7, 8]

CA leaves have a possible antidiabetic effect; [9, 10] antibacterial activities; [8, 11] and it also ameliorates anaemia and osmotic fragility induced by protein energy malnutrition. [12]

Traditionally, leaves of plants have been identified for their nutritional / and medicinal values. [12-15]In this study, the nutritional and mineral constituents of CA will be assessed to assist in determining its safety.

MATERIALS AND METHODS

Collection and Identification of Plant Material

Fresh sample of *Cnidoscolus aconitifolius* (CA) was collect from private residences in Port Harcourt, Rivers state Nigeria in 2012. The botanical identification and authentification was confirmed at the Department of Pharmacognosy and Natural Medicine, University of Uyo, Akwa Ibom State, Nigeria.

Preparation of Plant extracts

The fresh leaves of CA were air dried and ground to powdered form by using an electric grinding machine in preparation for its proximate composition and mineral analysis to evaluate

its nutritive and electrolyte values.

Proximate composition:

The proximate compositions (crude protein, lipid, moisture content, crude fibre, ash content and carbohydrate), mineral elements (phosphorus, calcium, iron, magnesium, manganese, sodium, potassium, zinc and lead) were determined according to the standard methods as recommended by the Association of Official Analytical Chemists in the Department of Pharmacognosy and Natural Medicine University of Uyo, Akwa Ibom State, Nigeria. [16, 17] these methods include:

Determination of moisture content:

Each dried sample was milled with a Thomas Wiley Milling machine and sieved with 1.00 mm sieve and stored. Two crucibles were properly washed and allowed to dry in an air Fisher Isotemp Oven (Model 175) oven at 110ºC for 10 min to a constant weight. The crucibles were allowed to cooled in a desiccators for 30 min, then labelled A and B and weighed (W 1).

2.0 g of each sample was accurately weighed into the previously labelled crucibles and reweighed (W2). The crucibles containing the samples were placed in the oven maintained at 103ºC for 14 h. They were removed and transferred to desiccators to cooled, finally weighed (W3). The loss in weight represented the moisture content of the sample.

The percentage moisture content was calculated.

Total moisture content= (W2-W3)

$$\% \text{ moisture} = \text{Loss in weight } \frac{(W2-W3) \times 100}{\text{Weight of sample used}}$$

Weight of sample used Determination of ash content:

Muffle Furnace Ignition method was used. Two porcelain crucibles were washed and dried in an oven to a constant weight at 100ºC for 10 min. They were allowed to cool in a desiccators, then labelled A and B and weighed (W1). 2.0 g (W0) of each sample were weighed into each of the previously weighed porcelain crucibles and reweighed (W2). The crucibles containing the samples were transferred into a Muffle Furnace Ignition furnace, which was set at 550ºC for 18 hrs to ensure proper ashing. They were then removed and allowed to cool in the desiccators for about 1hr then finally weighed (W3).

The percentage ash content was calculated.

Weight samples before ignition= (W0)

Weight of sample after ignition (ash)= (W3)

$$\% \text{ of ash} = \frac{\text{Weight of ash } (W2-W3) \times 100}{\text{Weight of sample used}}$$

% of organic matter = Weight of organic matter (W0-W3) X 100 Weight of sample used

Determination of crude fibre:

The Weende method was used. 2.0 g of fat free sample A and B were weighed into two separate round bottom flasks labelled A and B, respectively. 100 ml of 0.25 M Sulphuric acid solutions was added to each sample in the flask, and the mixtures were boiled under reflux for 30 min. The hot solutions were quickly filtered under suction through silk material (cloth) in a Buchner funnel. The residues were thoroughly washed with hot water and after each cooling acidity test carried out until acid free. Each residue after acid digestion was quantitatively transferred into the labelled flasks and 100 ml of hot 0.3 M sodium hydroxide solutions was added and the mixtures were boiled again under reflux for 30 min and filtered quickly under suction. Each insoluble residue was washed with hot water until it was base free. Finally the residue was washed twice with 95% methanol and quantitatively transferred into a porcelain crucible. They were dried to a constant weight in an oven at 100ºC for 2hours, cooled in desiccators and weighed (C1).

The weighed samples were then incinerated, and reweighed (C2).

Percentage crude fibre content was calculated. The crude fibre content was determined from the loss in weight of crucible and its content after ignition.

Determination of crude protein:

Micro Kjeldahl method described was used. Briefly, 0.5 g of sample A and B were weighed and placed on each nitrogen free filter paper, then folded and dropped into a Kjeldahl digestion tubes labelled A and B, respectively. 3.0 g of digesting mercury tablet mixed catalyst (CuSO4 + Na2SO4) and 25 ml of Conc. Na2SO4 were added to each sample in the digestion tube. The mixtures in the digestion tubes were transferred to the Kjeldahl digestion apparatus; the heater was regulated at a temperature below the boiling point of the acid for 1hr to avoid vigorous frothing until frothing ceased. The flask and its content were then heated strongly for 6-8 hrs. The mixtures boil vigorously as temperature was increased, until clear (light) green colour was obtained by occasionally rotating the flask. The digests were allowed to cooled then transferred into 100cm3 volumetric flasks each labelled A and B and diluted with distilled water to make up 100 cm3.10ml aliquot of each digest was introduced into the distillation jacket of the micro steam distillation apparatus that was connected to the main, as the water in the distiller flask boils. 20 ml of 40% NaOH was added to each digest in the distillation jacket. The ammonia liberated was steam distilled into a conical flask with 50 ml of 40% boric acid measured into two 250 ml conical flasks labelled A and B, respectively, four (4) drops of methyl red double

indicator was added each. The conical flasks containing the mixture were placed onto the distillation apparatus with the outlet tubes inserted into each conical flask and NH3 was collected through the condenser. The distillation continued until 25 ml of the distillate were trapped into the boric acid solution and colour changes from red to yellow. The distillates were then titrated with 0.02 M HCL until a purple-pink colouration was obtained and the titre values were recorded. A blank was set up using water instead of the sample.

Percentage nitrogen and crude protein was calculated. Nitrogen content= a x K of nitrogen. % Protein= a*K*K2/ W

Where a=amount of 0.1NHCL neutralized. K= 0.014g of nitrogen (N-constant) K2= 6.25 Protein factor W= weight of sample used for digestion.

Determination of crude lipid content:

The method described was used. Fat was determined by the continuous solvent extraction method using Sohxlet apparatus. 5.0 g of sample A and B were placed in two different extraction thimbles respectively then covered with cotton wool. The extraction thimbles containing the samples were placed in the extraction jacket. Two clean dried 500 mL round bottom flasks containing few anti-bumping granules was weighed (W1) and 300 mL of petroleum either was poured into each flask fitted with Sohxlet extraction units. The round bottom flasks and the condenser were connected to the Sohxlet extractor, the extraction apparatus was set up with the flask sitting in the water, heating mantle connected to a reflux condenser and cold-water circulation was put on. The heating mantle was switched on the heating rate was adjusted until the solvents were refluxing at a steady rate. Extraction was carried out for 6 h. As the ether evaporated, it condensed and dropped into the thimble extracting the ether soluble content into the round bottom flask. The solvent containing the extracted lipid was recovered, distilled off using a water bath. The lipid extracted was left in the flask. The oil was dried in the oven at 70ºC for 1 h. The round bottom flask and oil was cooled and then weighed (W2). The lipid content was calculated. The amount of lipid extracted was obtained from the difference between the weight of the flask and the solvents extracted.

Determination of carbohydrate:

The total carbohydrate content was determined by difference method. The sum of the percentage moisture, ash, crude lipid, crude protein and crude fibre was subtracted from 100% . Carbohydrate = 100 - (% moisture + % ash + % protein + % lipids + % fibre).

Determination of the mineral content:

This method described was adopted. Calcium (Ca), magnesium (Mg), potassium (K), sodium

(Na), zinc (Zn), iron (Fe), and manganese (Mn), phosphorus and lead were analyzed from the triple acid digestion (wet digestion method). Exactly 1 g of sample A and B were weighed each into a 150 mL beaker, and 10 ml of conc. HNO3 was added to each sample in the beaker and allowed to soak thoroughly. 3 ml of 60% HClO4 and tetra-oxosulphate (VI) acids (1:1:1) was added and the mixtures were heated slowly at first until frothing ceases. Heating was continued until HNO3 evaporated; the heating was stopped as charring occurred. 10 ml cone HNO3 was added and heating continued until white fumes were observed. The digests were allowed to cool and 10 ml conc. HCL was added and transferred to 50 ml volumetric flask. The volume of the solutions was made up to the mark with distilled water, and then transferred to a bigger flask. The solutions were further diluted to 100 ml with distilled water. Calcium and Mg were determined by the Versenate Complex metric titration method using EDTA (ethylene diamine tetra acetic acid) as indicator with NaOH while K and Na were measured by Flame photometer analyzer. Phosphorus (P) was determined calorimetrically with Vanado Molybdate-Yellow procedure. Micronutrients (Fe, Mn and Zn) concentrations in the digest were measured using atomic absorption spectrophotometer (AAS – unicam 939/959 model).

RESULTS AND DISCUSSION

Organic constituents: The nutritive and electrolyte values of locally available CA in Port Harcourt were evaluated using standard procedures 16, 17 and the results were shown in Tables 1 and 2.

Table 1 showed that proximate analysis of CA which is locally called or nicknamed '*hospital is too far'* shows the percent composition of moisture, ash, crude protein, crude fat, crude fibre and nitrogen free extract i.e. carbohydrate. It also estimated the energy released by 100mg of the extract.

Table 1: Proximate Composition of *Cnidoscolus aconitifolius* leaves

S/N	Composition	Percent composition (%)	RDI or Daily Reference Values [25] (g)
1	Moisture	6.10±1.10	variable
2	Ash	3.04±0.32	See below (mineral content)
3	Crude Protein	4.03±0.67	50
4	Crude Fat	7.03±0.23	65
5	Crude Fibre	33.04± 3.14	25
6	Nitrogen Free Extract (carbohydrate)	47.03 ±1.02	300
7	Energy	258±4.5 kCalorie/100mg	2000

The data obtained showed that CA has high carbohydrate and fibre content. Like most leaves, it is low in fat and protein contents as compared to carbohydrate content.

The result of the low fat content may imply that it is without any risk of obesity. [18] So daily consumption of CA may not predispose one to obese-associated diseases like diabetes and hypertension.

The low moisture content probably may not encourage microbial growth and enzyme activities [19] However, the fresh leaves are succulent green and often preserved by drying.

The high content of carbohydrate may confer good source of energy and building block for the body. However, the ash values and the carbohydrate content which were high in the present study are in line with previous studies.[10, 22-24] Daily consumption of CA will supplement the glucose needed for energy

Protein requirements are complicated because the amount we need changes with age and sex. For instance, infants need 11 grams per day; adult men need about 56 grams a day while adult women need about 46 grams a day. One important exception is pregnant or lactating women. The recommended intake for them rises to 71 grams of protein a day.

The low fat content may imply that it is without any risk of obesity [18] and the low moisture content probably may not encourage microbial growth and enzyme activities. [19]

The *ash content* is a measure of the total amount of minerals present within a food. Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food. Ash contents of fresh foods rarely exceed 5%. The ash content of CA is in agreement with the previous result. [20]

Fibre is one of the most important nutrients in the diet, but it is also one of the most under-consumed. Both types of fibre, crude and soluble, help improve digestion and can prevent numerous health problems as constipation. According to Colorado State University (CSU), crude fibre makes up between 14 and 50 percent of total dietary fibre in foods. 100mg CA contains crude fibre of 29.00% to 36.18% (29.00-36.18mg). Kids should consume between 19 and 25 grams of both soluble and insoluble fibres per day, men between 30 and 38 grams, and women between 21 and 26 grams daily. Pregnant and lactating women need at least 28 grams of both types of fibre per day. Unfortunately, CSU reports that the average American only consumes 14 grams of dietary fibre a day, so most people could benefit from increasing their fibre intake.[21]

Mineral content is a measure of the amount of specific inorganic components present within a food. Determination of the ash and mineral content of foods is necessary to assess the quality, microbiological stability and nutritional value of the leaves.

Table 2 showed the mineral composition of the CA dried leaves in milligram per gram compared with the spinach and the Daily Recommended Allowance (DRI).[22-25] These minerals include iron, phosphorus, sodium, potassium, magnesium, manganese and calcium. They are essential components of body fluid electrolytes are involved in vital metabolic processes. Their dietary deficiencies or overloads may therefore cause clinical disorders. [26-35]Consequently, each mineral has a Recommended Daily Allowance (RDA) and dietary intake as the best physiologic source. The spinach used to compare with CA is from Australia.[22]

Table 2: Mineral Composition of *Cnidoscolus aconitifolius (CA)* dried leaves compared with Spinach and Recommended Daily intake (RDI)

S/N	Composition	mg / g CA	mg/g spinach [22,23]	RDI (mg) [24, 25]
1	Iron (Fe)	10±1.2	10	15
2	Phosphorus (P)	20±1.6	150	1000
3	Sodium (Na)	0.01±0.1	250	2400
4	Potassium (K)	100±5.3	4000	3500
5	Magnesium (Mg)	85±4.32	480	350
6	Manganese (Mn)	18±2.1	Trace (µg)	5
7	Calcium (Ca)	50±2.3	1250	1000

For instance, RDA of iron for men is 10 milligrams or less and 15-18 milligrams for women and the average child while pregnant and nursing women need about 50–60 mg per day. [28] The result implied that consumption of one gram of the CA leaves will supply about 10mg of iron. Consequently, daily consumption of the leaves of CA will minimize iron deficiency anaemia, weakness and fatigue. An adult will therefore consume up to two grams daily of CA to obtain 20 milligrams of Iron that is an overdose.[24]

Deficiency of calcium can manifest itself in the form of rickets in children and osteomalacia and osteoporosis on adults. An adult will therefore consume up to thirty grams daily of CA to obtain 1500 milligrams of Calcium that is an overdose.[24]

Following FDA recommendation daily intake (RDI) of 250mg for Phosphorus, an adult will need about 12.5 grams of CA to achieve the RDI. While phosphorus deficiencies are rare, they cause bone and muscle weakness, bone pain and anorexia.

Daily intake of 400 milligrams of Magnesium can cause overdose. This may result from daily consumption of about 5 grams of CA. Deficiency of magnesium can cause muscle weakness and cramps, nausea and cardiac arrhythmias.

Sodium and Potassium metabolism is essential for excitable tissues. Their deficiencies can cause nausea, anorexia, irritability and muscle weakness. These may be a result of prolonged diarrhoea. Due to lack of adequate research the results of this deficiency are yet unknown in humans but

Manganese is believed to help in strengthening tendon and bone structures. However, 1 gram daily of CA supplies its RDI.

These results suggested the comparative richness of the leaves in fibre, high nitrogen free extract (carbohydrate) and essential minerals and safe content of moisture, fat and electrolytes. Properly prepared leaves are therefore recommended for daily consumption in order to supplement the recommended daily intake of nutrients and minerals and hence prevent nutritional and electrolyte deficiency disorders.

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