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Nutrient's composition of *costus lucanusianus* stem

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Abstract

The search for solution to malnutrition problem in it various forms particularly in developing countries necessitated the exploration of indigenous plants and spices that has been widely utilized for diverse purposes. The study was aimed at evaluating the nutrients composition of *costus lucanusianus* stem which include proximate, minerals, vitamins and amino acids analyses. Proximate composition was assessed by AOAC methods, minerals by (AAS), and vitamins by U.V spectrophotometer and amino acid by Gas chromatography spectrophotometer. Proximate composition revealed moisture content (74.87±0.70mg/100g), carbohydrate (19.44±0.98mg/100g), crude fiber (3.24±1.29mg/100g), crude fat (1.10±0.26mg/100g) and ash (0.89±0.19mg/100g) the least. Caloric value (kcal/100g) was 89.54±6.46. Macro and micro minerals includes calcium (28.14±27.11mg/100g),Phosphorous (20.50±17.17mg/100g) and Potassium (18.34±17.12mg/100g) Iron (35.56±17.12) and Zinc (21.91±0.63). Vitamin present include vitamins B_2 (*1.85±0.65), B_6* (*1.75 ± 0.01), B_9* (*1.75 ± 0.01mg/100g), B_1* (*1.36 ± 0.10mg/100g), A (*1.04±0.00mg/100g), *and E* (1.20. ±0.07mg/100g). Amino acid present include lysine (20.38 ± 0.15mg/100g), threonine (18.58 ± 0.24mg/100g), methionine (16.21 ±0.57mg/100g) and Phenylalanine (13.47 ±0.41mg/100g). Glutamine (41.41±0.93mg/100g), cystein (37.90 ±0.39mg/100g), asparagine (27.25±0.10mg/100g), alanine (23.33±0.40mg/100g), aspartic acid (21.36±0.41mg/100g) and glutamic acid as the least (0.07±0.02mg/100g). *Costus lucanusianus* stem, could serve as herbal nutritional supplement considering its rich macro and micro nutrients constituent.

Keywords: Nutrient; *Costus lucanusianus* stem; Proximate; Vitamin; Amino acid

1. Introduction

The therapeutic use of natural products from ethno medicinal and nutritional purposes has grown tremendous interest among scientist to search for bioactive component [1, 2]. That are benefit to man. Medicinal plants have evolved over the centuries as essential parts of African civilization and are widely recognized today as representing it rich cultural and scientific heritage. Medicinal plants according to [3] are sources of raw materials for pharmaceutical drug formulation. The increasing demand for medicinal plants product has renewed interest in the plant pharmaceutical industry, production of herbal based cosmetic products and herbal nutritional supplement.

Costus is a group of perennial herbaceous plants in the family (Costaceae) described by Linnaeus as a genus in 1753 and there are about 150 species and about 11 species are common in Nigeria. In Africa, many studies have indicated that a vast number of indigenous wild plants play a significant role in the diet of the populace [4]. *Costus lucanusianus* is an herbaceous plant that grows up to three meters tall. It is often gathered from the wild for its use as a medicinal herb. It is planted in home gardens for medicinal purposes, and has been introduced as an ornamental, mainly in the United States and South America [5].

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The plant *Costus lucanusianus* (Costaceae) is among 150 species of stout, perennial and rhizomatous herbs of the genus *Costus* [6]. It can be found in the forest belt of Senegal, South Africa, Guinea, Niger, Sierra Leone, Cameroun, Gabon, Fernando Po and the southern part of Nigeria [6, 7]. *Costus lucanusianus is* commonly called monkey sugarcane, in the Niger Delta region of Nigeria but known as spiral ginger in other parts of the world. It grows tall reaching a full height of 12 feet; its leaves are light green, narrowly elliptic while its base is rounded. *Costus lucanusianus* has a taxonomic distinction with *Costus afer* in that, if not looked carefully one will mistake the both plant for each other. *Costus lucanusianus* and *C. afer* are closely related species in terms of the number of flowers enclosed by the bracts and the colour of the flowers. The only difference is that the inflorescence of *C. afer* is cone-like with each bract covering two flowers and the corolla is white with a yellow throat. However, *C. lucanusianus* has a globose inflorescence and each bract covers only one flower with a white corolla and a red lip and yellow throat. The people of Rivers State while using them alike recognize *costus lucanusianus* as the 'male' (owêiogbodo) which has no much work done when compared to its counterpart.

In southern Nigeria *costus lucanusianus* and *costus afer* are crossed to produce a hybrid. The extract of the inflorescence and stem of this entire species are consumed to treat cough and stomach upsets, leaf and stem extracts as eye drops to treat eye infections and nose drops to cure headaches [8]. The plant stem can be boiled and used as vapour bath to treat oedema and treat urethral discharges, general diseases and jaundice and to prevent miscarriage [9].

In Nigeria, most spiritual homes will always request for the juice from the stem which is usually very expensive to purchase and used for the prevention of certain diseases and possesses such properties as antioxidants, hormonal actions, stimulation of enzymes, interference with DNA replication and physical actions [10]. It is commonly used for diarrhea, pyrexia, pain, inflammatory conditions dysmenorrhea [11].

Micronutrient is an umbrella term used to represent essential vitamins and minerals required from diet to sustain virtually all normal cellular and molecular function [12]. They include micro minerals and vitamins While, the required amount of micronutrients is very small, the micronutrient deficiency can have a wide range of health impacts that will ultimately result in the death of untreated. The micronutrient deficiency is common, affecting an estimated 2 billion people worldwide [13].

Vitamins are organic compounds and vital nutrient that human requires in limited amount and cannot be synthesized by human hence must be obtain through diet. It is basically classify into water and fat soluble vitamin. Many medicinal plants have been identified to possess a lot of antioxidant properties which enables their extract and active principle compact oxidative stress and mediate effective free radicals scavenging activities [14].

Minerals are essentially required for osmotic adjustment and to activate enzymes [15]. Man do not synthesize minerals rather, we obtain minerals from our diet [16]. Major minerals such as P, K, Ca, Na, and Mg function in cell metabolism and acid base balance, as well as aid in prevention and treatment of diseases [17].

Amino acid are defined as those molecule that cannot be synthesized in our bodies, but instead have to be obtain from food. The study of amino acid is important as it reveals the nature of enzyme responsible for the biogenesis of various compounds in the plants. The study of amino acid present in the plants is important from the point of view that will open up new research avenue [18]. The aim of this work is to determine the nutrients composition of *Costus lucanusianus* stem.

2. Material and methods

2.1. Sample Collection and Identification

The plant (stem) *Costus lucanusianus* was harvested in the bush behind Ofrimma Faculty of Science building, Abuja campus of University of Port Harcourt, Rivers State, Nigeria. It was authenticated by Dr. Ekeke Chimezie of the Department of Plant Science and Biotechnology (PSB) Faculty of Science, University of Port Harcourt with herbarium number UPH/V/ 1292.

2.2. Sample Preparation

The fresh sample (stem) was collected and oven dried in the laboratory. The grinding machine was used to grind the sample until it is finally ground to a powder form which was used for the analysis.

Figure 1 *Costus lucanusianus* plant stem

2.3. Proximate Analysis

Proximate chemical composition of *Costus lucanusianus* stem was determined using the Association of Official Analytical Chemists [19] method. The micro-Kjeldahl method was employed to determine the total nitrogen and the crude protein was obtained by multiplying the nitrogen value obtained by 6.25. The weight difference method was used to determine moisture and ash levels while crude lipids were extracted with petroleum ether, using a Soxhlet apparatus following methods outlined in [20]. The carbohydrate content was determined by calculation using the difference method.

(Equation 1)

% Carbohydrate = [100− %(protein + fat+ moisture + ash + fiber)] (1)

Gross energy was calculated using the Atwater factors for protein (4), fat (9) and carbohydrate

(4) Following the method of [21].

(Equation 2)

Gross energy = 4 (crude protein %) + 9(crude fat %) + 4 (carbohydrate %) (2)

2.4. Mineral Analysis

The micro mineral and macro minerals constituent of *Costus lucanusianus* stem were determined by Atomic Absorption spectrophotometer.

2.4.1. The wet digestion method of the sample (Costus lucanusianus stem).

A total volume of 100ml of H_2SO_4, HNO_3 and HCLO in the ratio of 40%: 40%:20% was mixed together and using this method the following steps were observed.

1g of the sample was weighed into conical flask which was digested in a fume cupboard with hot plate until white fume appear. It was cooled and pottered into 100ml volumetric flask and make up to the ml mark with distilled water.

2.4.2. Procedure

Hollow cathode lamp of the desired metal was installed and wavelength dial and slit was set. Ass was turned on for 10-20 minutes to warm instruments for energy stability, current was re-adjusted after warm up as well as wavelength until optimum energy gain is obtained, the lamp was aligned according to manufacturer instruction to give maximum sensitivity for the metal been measured. Acetylene was turned and the flow rate adjusted to the value specified. The flame was ignited, blank and zero instrument as well as standard solution was aspirated. The aspiration rate of nebulizer was adjusted to obtain maximum response. Blank was aspirated again as well as standard with concentration near middle of the linear range, the absorbance was recorded. When analysis is finished, the flame was extinguished by turning off acetylene first and then air.

2.5. Vitamin Analysis

The water soluble vitamins and fat soluble vitamins constituent of *Costus lucanusianus* stem were determined by ultra-violent ray spectrophotometer.

2.5.1. Determination of vitamin A

500 UI of vitamin A acetate was taken into a round bottom flask, and 2ml of potassium hydroxide solution (50% w/v), 10ml glycerol and 50ml methanol were added into the same round bottom flask and the combination was mixed thoroughly. The mixture was reflex for 45minutes on a boiling water bath and cooled. The flask was washed with distilled water and the mixture was taken to separator and then extracted with 4x25 ml of diethyl ether. The water layer was discarded while the ether layer was taken to and passed through dried 100ml volumetric flask anhydrous sodium sulphate and was made up to 100ml with diethyl ether. Its absorbance was recorded at a wavelength of 325nm against blank.

2.5.2. Determination of vitamin D

4,000,000 IU vitamin D3 of sample was weighed and put in 25ml volumetric flask with a solution mixture (Chloroform and methanol in ratio 1:9) and dissolved. Thereafter diluted with the solution and made up to the marked level. Absorbance was recorded at 264nm wavelength against blank.

2.5.3. Determination of vitamin E

5ml of the standard sample and blank solution was taken into the 5ml volumetric flask. In each volumetric flask, 2ml of 0.1% of 2, 2-bilyridil solution (in methanol) and 1ml of ferric chloride solution (in water) was added and mixed well. It was diluted with 25ml of methanol and absorbance was taken at 525nm wavelength against blank.

2.5.4. Determination of Vitamin K

5ml of the standard sample and blank solution was taken into test tubes. In each test tube, 2ml of 0.2% solution of 2, 4-dinitrophenyl hydrazine (In hydrochloric acid and alcohol in ratio of 1:5 v/v) was added and mixed well. It was heated in a water bath to almost dryness and was cooled at room temperature. 15ml of solution mixture (Ammonia and alcohol in ratio of 1:1) was added to each test tube and its absorbance was recorded at 635nm wavelength against blank.

2.5.5. Determination of Vitamin B_1 (Thiamine hydrochloride)

5ml of standard and 5ml of the sample were taken to the labeled test tubes. In each test tube, 5ml of NH_4OH (0.1M) and 0.5ml of 4-aminophenol was added and mixed thoroughly and allowed to stand for 5minutes. 10ml of chloroform was added and chloroform layer was separated and the absorbance recorded at a wavelength of 430nm against blank.

2.5.6. Determination of Vitamin B_2 (Riboflavin)

5ml of the standard solution and sample were put in labeled test tubes. To each test tube, 2ml of hydrochloric acid (1M), 2ml of glacial acetic acid, 2ml of hydrogen peroxide, 2ml of potassium permanganate (15% w/v) and 2ml of phosphate buffer (pH 6.8) were added and mixed thoroughly and absorbance recorded against blank at 444nm wavelength.

2.5.7. Determination of Vitamin B_3 (Nicotinamide)

2ml of the standard solution, sample and the blank were transferred to three labeled test tubes.

To each of the test tube, 5ml of sulphanilic buffer (pH 4.5), 5ml of water and 2ml of cyanogen bromide solution (10% w/v) were added and mixed thoroughly. The absorbance reading was taken against blank at an interval of minutes at wavelength of 450nm.

2.5.8. Determination of Vitamin B_5 (pantothenic acid)

This involves hydrolysis of standard and sample. 5mls of standard and sample solutions were transferred into two labeled 50ml volumetric flask. To each volumetric flask, 2ml hydrochloric acid (1M) was added and mixed thoroughly and then heated for 5hours at $69^0C \pm 1^0C$ to effect hydrolysis and cooled at room temperature. Thereafter, 2ml of hydroxylamine reagent (7.5%) in 0.1M sodium hydroxide, 5ml sodium hydroxide (1M) were added and kept for 5minutes. 1M hydrochloric acid was added to adjust to pH 2.7 ± 0.1 and the volume made up with water.

2.5.9. Procedure

5ml of hydrolyzed standard and sample solution were taken in the marked test tubes.

To each test tube, 1ml of 1% ferric chloride solution (in water) was added and mixed thoroughly to remove air bubbles. Absorbance reading was recorded against blank at 500nm wavelength in a U.V spectrophotometer.

2.5.10. Determination of vitamin B_6 (pyridoxine)

2ml of the standard solution and sample were introduced in test tubes labeled blank, standard and sample. 1ml of 20% sodium acetate (in water), 1ml of 5% boric acid (in water) and 1ml dye (2.6-dichloroquinine chromide) solution were added and mixed thoroughly.

Absorbance reading was taken in U.V spectrophotometer against blank at 650nm wavelength.

2.5.11. Determination of Vitamin B_7 (biotin)

Accurately weighed 500mcg (microgram) of the sample was put into 100ml volumetric flask and 10ml of dimethyl sulfoxide was added to dissolve it. The flask was placed on water bath and heated to 60^0C to 70^0C for 5minutes and the volume was made up to the mark with distilled water. The solution was filter and absorbance reading recorded at wavelength of 294nm against blank.

2.5.12. Determination of vitamin B_9 (folic acid)

2ml of the standard solution and sample solution were transferred in two labelled test tubes. In each test tube, 2ml of 0.02% potassium permanganate solution, 2ml of 2% of sodium nitrate solution, 2ml of (4M) of hydrochloric acid solution, 1ml of 5% of ammonium sulphamate solution and 1ml of dye solution (0.1% N, N diethyl aniline dye solution in isopropyl alcohol) were added into each test tube and mixed thoroughly and kept for 15minutes at room temperature.

Absorbance recorded against blank is 535nm.

2.5.13. Determination of vitamin B_{12} (Cyanocobalamine)

Accurate weighed equivalent to 1mcg (microgram) of the sample was transferred into 25ml volumetric flask and 10ml of water was added to dissolve. About 1.25g of dibasic sodium phosphate, 1.1gm of anhydrous citric acid and 1.0gm of sodium metabisulphate were added.

The volume was made up to the mark with water and the solution was Autoclaved at 121^0C for 10minutes. The solution was filter and absorbance reading recorded at 530nm wavelength against blank.

2.5.14. Determination of vitamin C (Ascorbic acid)

2ml of the standard solution and blank solution were transferred into 25ml volumetric flask.

To each volumetric flask, 2ml of sulphuric acid (10% v/v) and 5ml of ammonium molybdenum (10% w/v) were added and mixed thoroughly and cooled for 50minutes at room temperature.

2ml was diluted with distilled water and absorbance reading recorded at wavelength of 450nm against blank.

2.6. Amino acid analysis

Amino acid constituent of *Costus lucanusianus* were determined by Gas chromatography mass spectroscopy. Powdered sample (3 mg) was hydrolyzed with HCl 6 M at 150°C for 6 h. After hydrolysis, the acid was removed by rotary evaporation (RE500 Yamato Scientific America Inc.). Sample was re-suspended in 2 ml of sodium citrate buffer pH 2.2. Sample derivation was achieved by adding o-phthalaldehyde (OPA) 7.5mM to the sample on citrate buffer (OPA reagent contains β-mercaptoethanol and Brij (35). The HPLC method precision and accuracy was evaluated using external and internal standards. The amino acid reference standard consisted on fifteen amino acids (0.05 µmoles mL-1 each amino acid) and was utilized to determine the retention times for each amino acid. As well, internal standard α-amino butyric (0.05umoles mL-1) was added to amino acid reference standard and plant sample to normalize and quantify the amino acid content.

A gradient mobile phase of sodium acetate 0.1MpH 7.2 and methanol (9:1) elute sample for amino acid separation trough C18 column reversed-phase octadecyl dimethylsilane particles (100 x 4.6 mm x 1/4" Microsorb 100-3C18). Fluorescence detection was realized using an excitation-emission wavelength of 360 and455 nm respectively. Star Chromatography work station (Varian version 5.51) software was used to achieve amino acid peak integration.

2.7. Data analysis

Results were analyzed using statistical package for social sciences (SPSS) version 15. All data were represented as mean ± standard deviation (M±SD) using descriptive statistics and analysis of variance (Anova) confidence level was fixed at $p \leq 0.05$.

3. Results

Table 1 Proximate composition of *costus lucanusianus* stem

Parameters (%).	Dry weight	Energy level (kcal/100g)
Carbohydrate	19.44 ± 0.98	77.76 ± 3.92
Crude protein	0.47 ± 0.05	1.88 ± 0.20
Crude fat	1.10 ± 0.26	9.9 ± 2.34
Crude fiber	3.24 ± 1.20	-
Ash	0.89 ± 0.19	-
Moisture	74.87± 0.70	-
Total Metabolizable energy		89.54 ± 2.34

Data were represented in mean ± standard deviation (M ± SD) in triplicate determination

Table 2 Minerals constituent of *costus lucunusianus* stem

Minerals	Concentration (ppm)	RDA in mg/day		
Calcium (ca)	28.14 ± 27.11	210-270[a]	500-800[b]	1000-1200[c]
Magnesium (Mg)	14.13 ± 12.01	30-75[a]	80-130[b]	240-400[c]
Sodium (Na)	5.18 ± 4.64	0.12-0.37[a]	1.0-1.2[b]	1.5-1.9[c]
Phosphorous (P)	20.50 ± 17.17	100-275[a]	460-500[b]	700-1250[c]
Chlorine (Cl)	8.25 ± 7.43	0.18-0.57[a]	1.5-1.9[b]	2.0-2.3[c]
Potassium (k)	18.34 ± 17.12	0.4-0.7[a]	3.0-3.8[b]	4.5-4.7[c]
Iron (Fe)	35.46 ± 1.34	0.27-11	7-10[a]	8-11[c]
Zinc (Zn)	21.91 ± 0.63	2-3[a]	3-5[b]	8-11[c]
Chromium (Cr)	10.78 ± 1.83	0.2-0.5[a]	11-15[b]	25-35[c]
Copper (Cu)	8.09 ± 1.58	200-220[a]	340-440[b]	700-900[c]
Selenium (Se)	5.56 ± 0.88	15-20[a]	20-30[b]	40-55[c]
Iodine (I)	8.85 ± 1.58	110-130	90[b]	120-150[c]

Data were represented in mean ± standard deviation (M ± SD) in triplicate determination (n=3). Recommended dietary allowance culled from the (Food and Nutrition Board institute of medicine and national academics, 2006). [a]Infant[b]Children[c]Adult

Table 3 Vitamin content of *costus lucanusianus* stem

Vitamins	Concentration (ppm)	RDA in mg/day		
Vitamin A	1.04±0.00	400-500a	300-500b	600-900c
Vitamin D	0.78±0.06	5a	5 – 10b	10 – 1c
Vitamin E	1.20. ±0.07	4 -5a	6 – 7c	6 – 7c
Vitamin K	0.92±0.05	2.0-2.5a	30-55b	60-12c
Vitamin B1	1.36 ± 0.10	0.2-0.3a	0.5-0.6 b	0.9-1.2c
Vitamin B2	1.85 ±0.65	0.3-0.4a	0.5-0.6b	0.9-1.3c
Vitamin B3	0.87 ± 0.10	2 – 4a	6 – 8b	12 – 16c
Vitamin B5	0.99 ± 0.48	1.7-1.8a	2-3b	4-5c
Vitamin B6	1.75 ± 0.01	0.1-0.3a	0.5-0.6 b	1.0-1.7c
Vitamin B7	0.91 ± 0.02	5-6a	8-12b	20-30c
Vitamin B9	1.71 ± 0.01	65-80a	150-200b	300-400c
Vitamin B12	0.11 ± 0.01	0.4-0.5a	0.9-1.2a	1.8-2.4c
Vitamin C	1.57 ± 0.35	40-50a	15-25b	45-90c

Data were represented in mean ± standard deviation (M±SD) in triplicate determination (n=3). Recommended dietary allowance culled from the (Food and Nutrition Board Institute of Medicine and National Academics, 2006). [a]Infant[b]Children[c]Adult

Table 4 Essential Amino acid content of *costus lucanusianus* stem

Amino acid	Concentration(mg/100g)
Valine	13.30 ±0.14
Leucine	6.60 ± 0.41
Isoleucine	5.24 ± 0.09
Methionine	16.21 ± 0.57
Threonine	18.58 ± 0.24
Phenylalanine	13.47 ± 0.41
Lycine	20.38 ± 0.15
Argenine	ND
Tryptophan	ND
Histidine	ND

Data were represented in mean ± Standard Deviation (M±SD) in triplicate determination (n=3).

Table 5 Non-essential amino acid content of *costus lucanusianus* stem

Amino acid	Concentration (mg/100g)
Alanine	23.33 ± 0.40
Glycine	8.16 ± 0.10
Proline	10.53 ± 0.21
Serine	12.92 ± 0.21
Aspertic acid	21.36 ± 0.41

Cystein	37.90 ± 0.39
Tyrosine	17.70 ± 0.35
Glutamic acid	0.07 ± 0.02
Glutamine	41.41 ± 0.93
Asparagine	27.25 ± 0.10

Data were represented in mean ± Standard Deviation (M±SD) in triplicate determination (n=3)

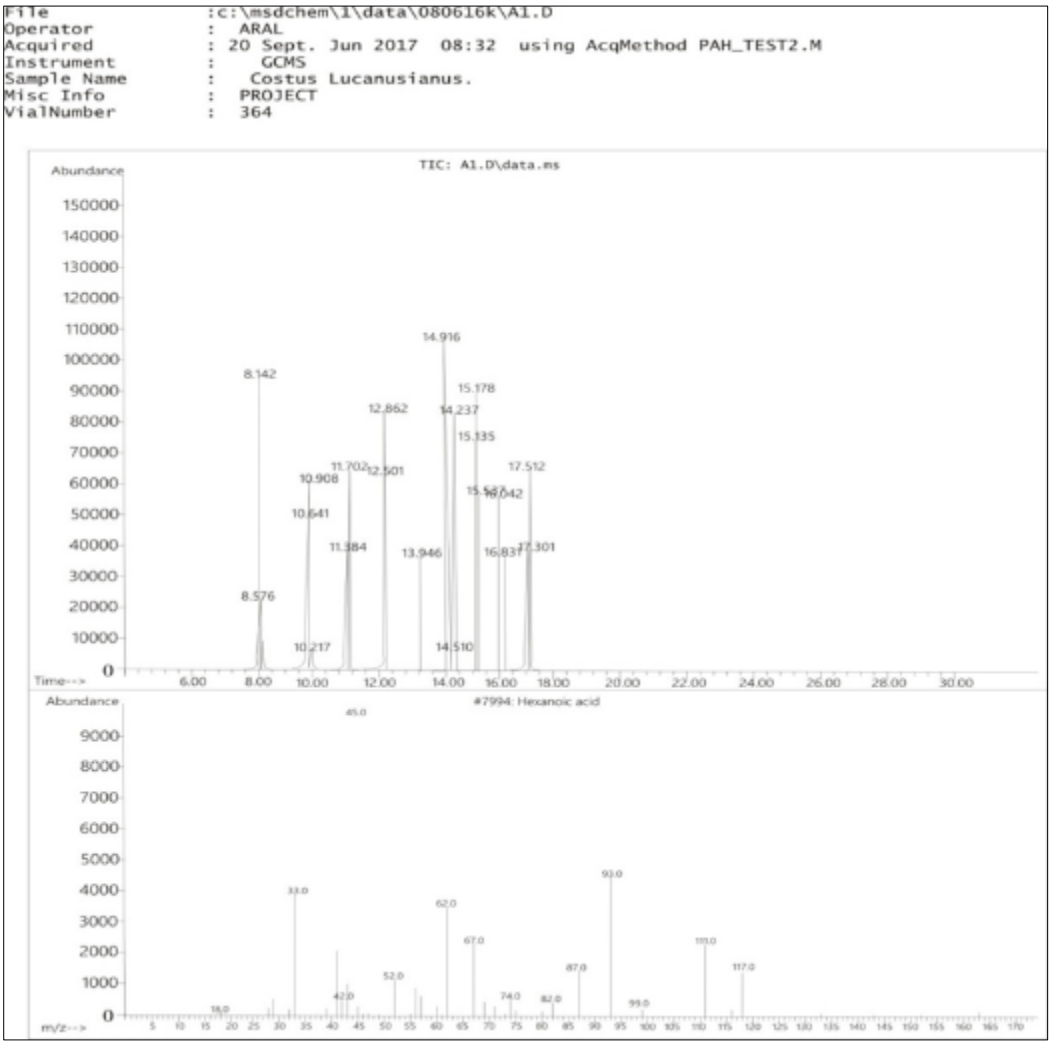

Figure 2 Amino acid chromatograph

4. Discussion

Result from Table 1 shows the proximate composition of *costus lucanusianus* stem (monkey sugarcane) as carbohydrate (19.44±0.98), crude protein (0.47±0.05), crude fat (1.10±0.26), crude fiber (3.24±1.29), Ash (0.89±0.19), and Moisture (74.87±0.70).The highest proximate constituent was moisture content, followed by carbohydrate while crude protein had the least composition. Moisture content of *costus lucanusianus* was higher than that reported by [22] 7.76%, [23] 33.6%, [24] and [25] 56.4% for *Costus afer* (bush cane) and those of other medicinal plant stem like *Tinospora cordifolia* 34.39% [26], *M. aboensis* stem 34.89%, *I. involucrata* stem 65.25% [27]. The moisture content for the stem fell above the acceptable limit of about 6%-15% for the most vegetable drugs [28]. Moisture makes up part of the mass of a specimen, it accounts for about two third (2/3) of the body weight. It primarily means of nutrient transfer and it helps to maintain body temperature [29].

The carbohydrate content of *costus lucanusianus* stem was found to be (19.44±0.98%). This result is consistent with reports by [23, 25] on the moisture content of *costus afer* stem (20.14%) and is in variance with reports on moisture composition of *costus afer* stem by [22, 24] which were (50.38%) and (54.98%) respectively. The concentration is relatively low when compared to other medicinal plant stem like *Datura innoxia miller* 51.32%, *solanum nigrum* linn. 24.78%, *Solanum surattense* and *withania sominefera* linn. 48.81% [30]. Carbohydrate is the main source of energy for the body especially the brain. Lack of it causes ketosis, fatigue and even breakdown of essential body protein [31]. Carbohydrates provide necessary energy required to drive cellular metabolism, cellular work and maintenance of body temperature [32].

Fiber and ash contents of *costus lucanusianus* were observed to be (3.24±1.29%) and (0.89±0.19%) lower than the amounts reported by [23, 22, 33 and 34] for *costus afer* stem. Dietary fiber adds bulk to faeces thereby making defecation easier [35]. High intake of fiber inhibits cholesterol absorption from small intestine thereby releasing the bad cholesterol [36].

The crude protein constitutes the least abundant in *costus lucanusianus* stem. The percentage composition of 0.47±0.05 is below that recorded for *costus afer* by [22, 25, 24]). Proteins are necessary for growth and tissue formation and its deficiency lead to kwashiorkor and marasmus [37]. The protein dietary intake value assigned by the FDA is 50g for adult; however the dietary assign by Food and Nutrition Board is 46g for adult female and 56g for adult male [38].

Crude fat content of *costus lucanusianus* in this work was (1.10 ± 0.26), consistent with results of work done by [22, 24 35] on same plant but vary with result of [25] on same plant species (*costus afer*). Lipids are another source of energy to the body via gluconeogenesis when oxidized. It also insulates the body environment temperature changes and pressure body heat [39]. Dietary reference value for fat for an average adult was 70 grams, but it was later increased to 78g [40].

The Gross caloric value in the present study (89.54±6.46kcal/100g) is lower than the gross caloric value of 165.08kcal/100g, 228.99kcal/100g, and 199.44± 1.25kcal/100g reported by [23, 22 and 25] on *costus afer* plant stem.

Result from Table 2 showed the presence of calcium, magnessium, sodium phosphorous, chlorine, potassium, iron, zinc, chromium, copper and selenium. Calcium and iron were the most abundant macro and micro minerals respectively. The result for calcium is lower than what was reported by [23, 25] and higher than the result reported by [22] on same plant species. Calcium plays an important role in building strong, dense as well as in the keeping of healthy bones and teeths both early and later in life.

Iron makes up part of many proteins in the body. It plays a vital role in many metabolic reaction and transfer of oxygen by haemoglobin. Iron deficiency is the most common nutritional deficiencies common among pre-menopausal women and young children resulting to a condition known as microcytic hypochromic anemia characterized by difficulty in breathing on exertion, fatigue, weakness, apathy, and low resistance to cold temperatures [41].

Vitamin B2 (Riboflavin), B6 (Pyridoxine), B9 (Folic acid) and C were the most predominant constituent vitamins in *costus lucanusianus* stem.Vitamin B2 helps to release energy from food and also promote good vision and healthy skin. The concentration of vitamin B2 content of *costus lucanusianus* agrees with the report of [35], B6 is the second highest with concentration (175±0.001) is within the recommended dietary allowance for adult and act as essential co-enzymes that facilitate the biosynthesis of sphingoipids. [42].Vitamin B9 is involved in the synthesis of nucleic acid DNA and RNA also it is essential for the formation of healthy red blood cells. The concentration of vitamin B9 is relatively low when compared to recommended dietary allowance for folic acid. Vitamin C prevents the oxidation of nitrate [43]. It also interacts with other nutrient which aid in absorption of iron and copper [44, 45]. The concentration of Ascorbic acid in this study is relatively lower than the RDA value for Vitamin C.

Results from Tables 4 and 5 revealed the presence of 7 essential and 10 non-essential amino acids in *costus lucanusianus* stem shown as valine, leucine, isoleucine, methionine, threonine, lysine, phenylalanine, glutamine, cysteine, asparagines, alanine, aspartic acid, tyrosine, serine, proline, glycine and glutamic acid.

Lysine was the highest essential amino acid while glutamine, cysteine, and asparagines were the three predominant non-essential amino acids detected in this study. Lysine is essential for both receptor-dependent pro-inflammatory and receptor- independent cytolytic activities [46] and lysine is a precursor compound of arginine and histidine. Arginine is an indispensable amino acid in children as a result of its role in growth and development. Glutamine aid in synthesis of protein, as well as amino acid.

5. Conclusion

Costus lucanusianus stem has high moisture content, moderate micro and macro minerals, water and fat soluble vitamins and essential and non-essential amino acids. In view of the aforementioned, *costus lucanusianus* could serve as herbal nutritional therapeutic agent in the management of constipation and dehydration.

Compliance with ethical standards

Disclosure of conflict of interest

All the authors contributed in the design, interpretation of data, discussion and proof reading of the manuscript hence do not have any conflict of interest.

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