Open Journal of Research

www.britishjr.org

Original Article

Proximate, Vitamins and Mineral Composition of *Salacia senegalensis* Lam (DC) Leaves

Adumanya OCU*[1], Obiloma AA[2] and Essien EB[3]

[1]*Department of Science Laboratory Tech. Imo State Polytechnic, Umuagwo Imo State, Nigeria*
[2]*Department of Nutrition and Dietetics, Imo State Polytechnic, Umuagwo Imo State, Nigeria*
[3]*Department of Biochemistry, University of Port-Harcourt Rivers State, Nigeria*

*Corresponding author e-mail: adumso2@yahoo.com

A B S T R A C T

The fresh leaves of *Salacia senegalensis* (a medicinal plant) were collected from the forest at Orji, Owerri North L.G.A, Imo State, South-East zone Nigeria and were subsequently cleaned, cut into pieces and air dried at room temperature. Dry leaves were grounded into a coarse powder and analysed for the proximate, vitamins and mineral compositions which are yet to be reported. The proximate analysis showed that the leaf contains 57.28 % carbohydrate, 24.85 % crude fibre, 22.27 % moisture, 18.00 % protein, 1.82% lipids and 0.63 % ash, while the energy value is 317 Kcal/100g. Minerals found were mainly Ca (27.31 mg/100g), Mg (16.01 mg/100g), Na (11.83 mg/100g), Fe (11.75 mg/100g), K (9.57 mg/100g), Mn (3.01 mg/100g), Zn (1.01 mg/100g), Cu (0.95 mg/100g) and Ni (0.02 mg/100g). Vitamin analysis revealed that the leaf is rich mainly in vitamins C (45.01 mg/100g), B_3 (0.14 mg/100g), B_2 (0.08 mg/100g), B_1 (0.03 mg/100g) and E (0.01 mg/100g). The result indicates that *S. senegalensis* leaf could supplement for carbohydrate, crude fibre and protein, while its relative high Ca and Mg values could be used for the management of bone ailments. Also it could serve as source of antioxidant due to its high content of vitamin C.

Keywords: Proximate, Mineral, Composition, Medicinal, Analysis.

INTRODUCTION

Salacia senegalensis belong to the Kingdom-*plantae,* Order-celastrales, Family -*Celastacea,* Genus-*Salacia,* Species-*senegalensis*[1-3]. *Salacia senegalensis* Lam (DC) (**Figure 1**) is an erect or climbing shrub with white or pale greenish cream

petals and orange or yellow flowers. It is found in tropical forests. It belongs to the family Celastraceae. The Igbo name is "Nriaturu" or "Nriatulu". Traditionally, the extract of its leaf is used in malaria treatment, as a lotion for sick children and in the treatment of skin problems like eczema by the people of South-East zone of Nigeria[4]. A decoction or alcohol extract of *Salacia senegalensis leaf* is used by the Orji people of Owerri North local government area (L.G.A), Imo State, South-East Nigeria as a remedy for malaria[4]. The antimalarial activities of its leaf have been reported[5]. Also[6] reported the terpenes composition of its leaf. However, scientific data on the proximate, vitamins and mineral composition of its leaf is yet to be reported, therefore, this work was aimed at analyzing proximate, vitamins and mineral composition of *Salacia senegalensis* leaves.

MATERIALS AND METHODS

Determination of the moisture and dry matter content

The AOAC Official Method 967.03 [7] was adopted.

Principle

When tissues are subjected to prolonged exposure to high temperature of about 100-105^{0}C, they gradually lose water and consequently, lose weight. This weight loss continues until they attain a constant weight when they can no longer lose water. This constant weight is the dry matter content while the weight loss is the moisture content.

Materials

These include (i) the sample. (ii) Crucible, dessicator, weighing balance (Mettler Toledo AB204; Mettler Toledo, Switzerland) and oven (Plus II Sanyo, Gallenkamp PLC, England).

Procedure

A fire-polished empty crucible was allowed to cool in the dessicator, after which its weight was taken. Then 2g of the sample was placed in the crucible. The crucible and content were then placed in the oven at 105^{o}C, for 3 hr, and was weighed regularly until a constant weight was obtained after cooling. This procedure was repeated for triplicate samples.

Calculation

Moisture content (%) = weight of fresh sample (g) – weight of dry sample (g) X 100 / weight of fresh sample (g).

Dry matter content (%) = weight of dry sample (g) X 100 / weight of fresh sample (g).

Determination of the ash content

The AOAC Official Method 942.05[7] was adopted.

Principle

When heated to high temperature of between 560 and 600^{o}C, the organic portions of samples are converted to volatile compounds (e.g. oxides, etc.), leaving a grayish-white residue of the inorganic portion. Ash is determined by weighing the resulting inorganic residue.

Materials

These include (i) the sample. (ii) Crucible, dessicator, weighing balance (Mettler Toledo AB204; Mettler Toledo, Switzerland), timer and muffle furnace.

Procedure

Two grammes of the sample was added to a pre-weighed, clean, fire-polished empty crucible, and placed in the muffle furnace at 600^{o}C. After 7 hr, when only a grayish-white residue of the sample was left, the crucible and content was removed and cooled in a dessicator. The weight of the

 ISSN 2394-3718

crucible and residue was taken. This procedure was repeated for triplicate samples.

Calculation

Ash content (%) = weight of residue (g) X 100 / weight of fresh sample (g).

Determination of the total carbohydrate content

The Anthrone Method as reported by[8] was adopted.

Principle

Perchloric acid hydrolyzes the available carbohydrates to sugar (glucose) which is then dehydrated by concentrated H_2SO_4, to furfural or furfural derivatives that react with anthrone to give a blue-green complex. The blue-green solution formed, has absorption maxima at 630nm.

Materials

These include (i) the sample. (ii) 52% (v/v) perchloric acid in concentrated H_2SO_4; 0.1% standard glucose; 0.2% Anthrone Reagent in concentrated H_2SO_4. (iii) Spectrophotometer [Model 752S (Spectrumlab)], weighing balance (Mettler AB204; Mettler Toledo, Switzerland), water bath, timer, volumetric flask, glass filter, pipette, cuvette, test tubes and test tube rack.

Procedure

The procedure involved deproteination, extraction and hydrolysis of the sample. To 0.1 g of the ground sample in a 25ml volumetric flask was added 1.0ml of distilled water and 1.3ml of 52% perchloric acid and mixed thoroughly. The flask was stoppered and the mixture allowed standing for 20 min, with shaking to ensure complete hydrolysis. The content was then made up to the 25ml mark with distilled water and allowed to stand for 30 min to enable extraction, after which it was filtered through a glass filter. The filtrate (0.1ml) was used as test solution. Three test tubes were set up labeled T_1 (blank), T_2 (glucose standard) and T_3 (test sample). T_1 contained 0.1ml of distilled water; T_2 contained 0.1ml of standard glucose solution while T_3 contained 0.1ml of test filtrate. To each tube was added 0.9ml of 0.2% Anthrone Reagent. The contents were thoroughly mixed, placed in boiling water bath for 12 min, cooled and absorbance read at 630 nm in the spectrophotometer. This procedure was repeated for triplicate samples.

Calculation

% Carbohydrate content = absorbance of filtrate X C X 25 / absorbance of standard.

Where c = concentration of standard (mg/ml); 25 = final volume of hydrolyzed sample (ml).

Determination of the protein content

The determination of the protein content was based on the semi-macro Kjeldahl method as described by[9].

Principle

In this method, the product was digested with concentrated sulphuric acid using copper sulphate as a catalyst to convert organic nitrogen to ammonium ions. Alkali was added and the liberated ammonia distilled into an excess of boric acid solution. The distillate was then titrated with hydrochloric acid to determine the ammonia absorbed in the boric acid.

Materials

These include (i) the sample. (ii) Kjeldahl catalyst [Na_2SO4 and $CuSO_4.5H_2O$, (10:1 w/w)]; concentrated H_2SO_4; 40% NaOH; 2% boric acid; 0.1 M hydrochloric acid; double indicator [2 parts of 0.2% (w/v) methyl red in ethanol to 1 part of 0.2% (w/v) methylene blue in ethanol].

 ISSN 2394-3718

(iii) Weighing balance, Kjeldahl digestion flask, 100ml volumetric flask, beaker, burette, pipette or measuring cylinder, Buchner funnel and anti-bumping chips.

Procedure

Digestion

To 0.1 g of the sample in a 100 ml Kjeldahl digestion flask, was added 3 g of Kjeldahl digestion catalyst, 25 ml of concentrated sulphuric acid and a few anti-bumping chips, and mixed by greatly swirling the mixture. The flask was fitted to reflux condenser and gently heated until foaming had ceased, and the contents became completely liquefied. Then, the content of the flask as boiled vigorously, with occasional rotation of the flask, until the colour of the digest change from ash to blue-green or pale green colour. The flask was allowed to cool and its contents were quantitively transferred into a 100ml volumetric flask, where it was dilute to the 100ml mark with distilled water.

Distillation

Twenty milliliters of this diluted digest was transferred into a 150ml distillation flask. The flask into which a few anti-bumping chips have been added was connected to a condenser whose receiver was attached to a Buchner funnel immersed in a 400 ml beaker containing 10ml of 2% boric acid solution masked with 2 drops of double (methyl red-methylene blue) indicator. Then, 25ml of 40% NaOH was added to the flask using a syringe. Distillation was stopped when the volume in the beaker was about the same as the original volume, and the colour of the boric acid in the receiving flask changed from purple to pale green. The ammonia was liberated into the boric acid solution. The distillation unit was dismantled and rinsed with distilled water.

Titration

The distillate (boric acid-ammonia solution) was titrated with 0.1 M hydrochloric acid, until the colour changed to pink, which marked the end of titration. Thetitre was recorded and this was used to determine the nitrogen content from which the protein value was calculated by multiplying with the nitrogen conversion factor, 6.25.

Calculation

Kjeldhal nitrogen (%) = $\frac{T*14.01*M}{w*10}$

Where $T =$ titre value (ml); w = sample weight (g); M =molar concentration (moles/L) of the acid; 14.01 = atomic weight (g) of N; and 10 = factor to convert mg/g to percent.

Crude protein content (%) = % Kjeldhal nitrogen * 6.25.

Where 6.25 = factor to convert N to protein.

Determination of the lipid content

The AOAC Official Method 920.39[7] was adopted.

Principle

The lipid content of the sample was extracted with anhydrous diethyl ether and weighed.

Materials

These include (i) sample. (ii) Anhydrous diethyl ether. (iii) Soxhlet extractor, round bottomed flask, oven, Whatman No. 1 filter paper, weighing balance, dessicator, timer and heating mantle.

Procedure

Three grammes of the ground were transferred into a thimble and dried for 3 hr at 100 ^{o}C. The extraction thimble containing the dried samples was in turn inserted into the extraction chamber. The extractor and its

 ISSN 2394-3718

contents were fixed to a pre-weighed empty round bottomed flask which was in turn placed over an electro-thermal heater. Then, 300 ml of anhydrous diethyl either was poured into the flask through the extractor and the condenser was fixed. The sample was then extracted for 6 hr, after which the solvent was distilled off, leaving the lipid in the flask to cool in a dessicator. The flask and content were then weighed.

Calculation

:. Crude lipid content (%) = $\frac{(w2-w1)}{weight\ (g)of\ the\ sample\ used} * 100$

Where w_1 = weight (g) of empty flask; w_2 = weight (g) of flask and lipid.

Determination of the fiber content

This was based on AOAC Official Method 973.18[7].

Principle

A fat-free sample was treated with boiling sulphuric acid and subsequently with boiling NaOH. The residue after subtraction of the ash is regarded as fiber.

Materials

These include (i) the sample. (ii) 1.25% H_2SO_4 solution; 1.25% NaOH solution; 1% HCI solution; petroleum ether (60-80 ^oC); absolute ethanol (iii) Oven, weighing balance, water bath, muffle furnace, dessicator, timer, crucible, spatula, Whatman No. 1 filter paper, conical flask, Buchner funnel, soxhlet extractor and reflux condenser.

Procedure

Two grammes of the ground sample (in triplicate) were transferred into a crucible and dried for 3 hr at 100 ^oC. The dried samples were defatted by extraction with 10 ml of petroleum ether (60-80 ^oC) and air dried. The defatted sample was transferred into a 1000 ml conical flask into which 20 ml of 1.25% H_2SO_4 was added and mixed properly. An aliquot (190 ml) of boiling H_2SO_4 was added into the flask and mixed properly such that a cream was produced. This flask was fitted to reflux condenser and heated before its content was rapidly poured into a shallow layer of hot water contained in a hot Buchner funnel prepared with a wet 12.5cm filter paper. Filtration was done by suction and the rate of suction adjusted such that filtration was completed within 10 min. The residue was washed free of acid with hot distilled water and quantitatively transferred into 100 ml volumetric flask using 200 ml of boiling 1.25% NaOH solution. Refluxing was done for 30 min and the filtrate was allowed to cool for a minute and filtered under suction. The residue was washed with several portions of boiling water (distilled) followed by 1% HCI, finally with boiling water until the wash was acid free. Further washing was done twice with ethanol and twice with petroleum ether. The residue was quantitatively and carefully transferred (using a clean spatula) into a weighed crucible, which was dried in an oven at 105 ^oC for one hour. Then, it was cooled in a dessicator and weighed. The dry residue was then placed in a furnace at 630 ^oC for 3 hr. the crude fiber content was calculated as well as the percentage crude fiber. The weight of the ash was subtracted from that of the residue to obtain the weight of the fiber. This procedure was repeated for triplicate samples.

Calculation

Fiber content (%) = $\frac{weight\ of\ fiber\ (g)}{weight\ of\ fresh\ sample\ (g)} * 100$

Determination of the energy content

The calorific value was obtained by multiplying the values of crude protein, crude fat and total carbohydrates by the Atwater factors 4, 9 and 4, respectively, taking the sum of the products and

expressing the result in kilocalories per 100 g sample as reportedby[10-14].

Determination of vitamin composition

The samples were extracted following the method of[15].

Principle

Esterified extracts are more readily separated by gas chromatography. The effluent can be identified by pulse flame photometric detector.

Materials

These include (i) the sample. (ii) Absolute ethanol; redistilled methanol; chloroform; anhydrous sodium sulphate; standards; Boron Trifluoride Reagent (7 % BF_3 (w/w) in methanol, made from commercially available 14 % BF_3 solution). (iii) Soxhlet extractor, Janke and Kunkel (IKA-LABORTECHNIC) grinder, timer, weighing balance, rotary evaporator, oven, beakers, and GC system with pulse flame photometric detector.

Procedure

The dirt free sample was weighed and pulverized into fine powder, using Janke and Kunkel (IKA-LABORTECHNIC) grinder. One gramme of the pulverized sample was homogenized in 1 mL, of ethanol, and extracted by refluxing with 10 mL of re-distilled methanol, for 6 hr at very low temperature. The process was repeated twice, using fresh solvents, ensure that most of the water soluble vitamins in the pulverized sample was homogenized in 1 mL of ethanol, and extracted by refluxing with 10 mL of chloroform, for 6 hr at very low temperature. The process was repeated twice, using fresh solvents, to ensure that most of the fat soluble vitamins in the pulverized sample were removed. The extract was then evaporated to dryness on a rotary evaporator. To residue was added 4.00 ml of 7 % BF_3 (Boron Trifluoride) Reagent, and heating for 45 min in an oven at 100 ^oC. It was cooled to room temperature, and 1.0 g of anhydrous Na_2SO_4 was added to remove water, after which is was subjected to gas chromatography analysis, using pulse flame photometric detector, for the determination of the component vitamins.

Standard solutions were prepared and the linearity of the dependence of response on concentration was verified by regression analysis. Identification was based on comparison of retention times and spectral data with standards. Quantification was performed by establishing calibration curves for each compound determined, using the standards.

Chromatographic Conditions

Chromatographic analysis was carried out using a GC Model HP6890 powered with HP Chemstation Rev A 09.01 (1206) software (to identify and quantify compounds), with pulse flame photometric detector. The capillary column was a ZB-5 Column (30 m x 0.32 mm x 0.25$^{\mu m}$ film thickness). The oven temperature was held at 30 ^oC for 2 min, and then programmed at 4 ^oC/min for 15 min before changing to 15 ^oC/min for 2 min. Hydrogen was used as a carrier gas. The hydrogen column, hydrogen and compressed air pressures were respectively 25 psi, 22 psi and 28 psi. The injector and detector temperature were kept at 250 and 300 ^oC, respectively; split ratio, 2:1, 0.2$^{\mu L}$ of the sample was injected.

Determination of mineral composition

Atomic Absorption Spectrophotometry was used in mineral determination.

In accordance with the manufacturers' instructions, the instrument, Perkin Elmer atomic absorption spectrophotometer (AAS) PE 600c, was set up. It was switched on and allowed for

15minutes equilibration period. It was then set up by putting in place the hollow cathode tube appropriate for the element being determined. The monochromator was set at the wavelength of the element being determined, Example, 325nm for Copper. With these in place, the instrument was flushed by aspirating distilled de-ionized water in it. It was then calibrated at zero with the reagent blank (HCl solution). Meanwhile, standard solutions of each of the test elements being determined were prepared separately and diluted in series according to chosen concentrations. The diluted solutions of the test elements were aspirated in-turns into the instrument and their respective absorbencies were recorded and plotted into a standard curve. Then the sample extracts were aspirated in-turns into the instrument and their absorbance were also recorded. The standard curve was used to extrapolate contents of the test element in the sample extract.

The general formula below was used to quantify the content of each element in the sample,

$$A\ (mg/100\ g) = \frac{100}{W} * \frac{C}{1000} * D$$

Where: A = element being determined,
W = weight of sample used,
C = concentration (in ppm) obtained from the standard curve,
D = Dilution factor applied

RESULTS

The proximate composition (%) of the leaf of *Salacia senegalensis (S. s.*) is shown in Table 1. The results showed that carbohydrate was highest (57.28 ± 0.01 %) followed by crude fibre(24.85 ± 0.15 %), moisture (22.27 ± 0.04 %), protein (18.00 ± 0.10 %), lipids (1.82 ± 0.01 %) and the least was ash (0.63 ± 0.02 %) as presented in Table 1. The energy value was 317.5kcal/100g as shown in Table 1.

The concentrations of the vitamins assayed as are shown in Table 2. The results showed that vitamin C in the leaf was the highest (45.01 mg/100g), followed by vitamin B_3(0.14 mg/100g), vitamin B_2 (0.08 mg/100g) and vitamin B_1(0.03 mg/100g), while, very low levels of vitamins E (0.008 mg/100g), B_9(folate) (0.007 mg/100g) and B_6 (0.007 mg/100g) respectively were detected.

The concentrations (mg/100g) of minerals present in the leaf of *Salacia senegalensis* are shown in Table 3. Calcium had the highest value (27.31 mg/100g), followed by magnesium (16.01 mg/100g), sodium (11.83 mg/100g), iron (11.75 mg/100g), potassium (9.57 mg/100g), manganese (3.05 mg/100g) and zinc (1.01 mg/100g). Then, copper (0.95 mg/100g), followed by nickel (0.02 mg/100g), and chromium (0.01 mg/100g).While lead and cadmium, were not detected (n.d).

DISCUSSION

The results of proximate composition of *Salacia senegalensis* leaves are shown in Table1. The moisture content of *Salacia senegalensis* leaves was 22.27 ± 0.04 %. The moisture content of any food is an index of its water activity[16,17], and is used as a measure of stability and susceptibility to microbial contamination[18]. Its moisture content is within the range of required value as safe storage limit for plant food materials[19]. This indicates that the leaves can be stored for a long time without the development of mould.

The crude protein of the *Salacia senegalensis* leaves was 18.00 ± 0.10 % per 100g which is comparable to the daily protein requirement of 23-56 g[10,14].

Ash content is a measure of the total mineral content of a food[20]. The leaves had a low value of 0.63 ± 0.02 % ash (mineral) content. Mineral is required by the body for proper physiological functioning.

The carbohydrate content was high (57.28 ± 0.01 %) which is comparable to that

of *Vitex doniana* leaves (67.00%)[21]. This means it could serves as a sources of energy.

The crude fibre content was 24.85 ± 0.15 % which is higher than 15.00 % reported for *V. doniana* leaves[21] or 19.80% for *Asparagus officinalis* tem[22]. Epidemiological evidence suggest that increased fibre consumption may contribute to a reduction in the incidence of certain diseases including colon cancer, coronary heart diseases, diabetes , high blood pressure, obesity, and various digestive disorders[23,24].

Dietary fibre has been associated with alterations of the colonic environment that protect against colorectal diseases. Fibre may also provide protection by increasing faecal bulk, which dilutes the increased colonic bile acid concentrations that occurs with a high fat diet[23,25].

The fibre recommended dietary allowance (RDA) values for children, adults, pregnant and breast feeding mothers are 19-25%, 21-28%, 28% and 29% respectively [20].

The crude fat of 1.82 ± 0.01 % was obtained on analysis of *Salacia senegalensis* leaves. This is lower than that reported (3%) for *V. doniana* by[26].

Fats/oils are very important in human health as it serves as sources of energy and components of biological membranes[27].

Energy value of the *Salacia senegalensis* leaves was 317.5kcal/100g. This again pointed the caloric value of the leaf.

Salacia senegalensis leaves had high vitamin C content (45.01 mg/100g), which is about 99.37% of the total vitamin composition of the leaves. Vitamin C (ascorbic acid) is generally involved in protein metabolism and collagen synthesis [20]. Though this value is lower than the RDA value (60mg/100g) for adult [28], it could supplement for the daily needs. Ascorbic acid is a potent anti-oxidant that serves to regenerate vitamin E from it's oxidized byproduct[29].

Vitamin B_1 (thiamin), B_2 (riboflavin) and B_6 (pyridoxial) are associated in macronutrient metabolism and are present in *Salacia senegalensis* leaves at a low level of 0.03mg/100g, 0.08 mg/100g and 0.01 mg/100g respectively as shown in Table 3. These values are relatively low compared with RDA values of 1.2, 1.4, and 1.5mg/100g respectively[20].

The vitamin E content of *Salacia senegalensis* leaves was 0.01mg/100g (0.02%). Vitamin E serves as an antioxidant of polyunsaturated fatly acid in cell membranes and sub-cellular structures[30]. It influences cellular response to oxidative stress through signal transduction pathways[31].

The vitamin B_3 (niacin) content was 0.14mg/100g (0.32%). This value is relatively lower than the RDA of 14mg/100g [32]. Vitamin B_3 is a precursor to nicotinamide adenine nucleotide and nicotinamide adenine dinucleotide phosphate, which serves as electron and proton acceptors, respectively[32].

The leaves of *Salacia senegalensis* had 0.01 mg/100g of vitamin B_9 (folate), about 0.02% of the total vitamin as shown in Table 3. Folate is required for synthesis of purines and pyrimidines that are needed for DNA production and erythropoiesis[32]. This value is lower than the RDA of 0.4 mg[32].

Table 3 showed that the *Salacia senegalensis* leaves had high calcium content (27.3 mg/100g). Calcium forms component of bones and teeth, necessary blood clothing and muscle contraction[20]. This value is lower than 71.0mg/100g reported in the leaves of *V. doniana*[21].

Salacia senegalensis leaves had 16.01 mg/100g of magnesium. Magnesium is an important element in connection with circulatory diseases and calcium metabolism in bone[33]. The value (16.01 mg/100g) reported here is lower than 124mg/100g reported by[34] and 45.0mg/100g for *V. doniana* leaves[21].

The *Salacia senegalensis* leaves had 11.83mg/100g sodium and 9.57mg/100g potassium. Sodium content in combination with potassium is involved in maintaining proper acid-base balance and in nerve impulse transmission in the body[35]. The variation of potassium to sodium content in this work is of significant importance particularly to a hypertension patient[19]. These value obtained here are lower than the ones obtained from the leaves of *V. doniana*[26] and[21].

The iron content of *Salacia senegalensis* leaves was 11.75mg/100g. Iron is essential micronutrient for haemoglobin formation, normal functioning of central nervous system (CNS) and in the oxidation of carbohydrate, protein and fat[36]. Since it had significant amount of iron, its consumption may be encouragement particularly for menstruating and lactating women[20].

The leaves of *Salacia senegalensis* had 3.05mg/100g of manganese. Manganese is a cofactor of hydrolase, decarboxylase, and transferase enzymes[37]. This value is higher than that of cashew nut[38] and[39].

The zinc content of *Salacia senegalensis* leaves was 1.01 mg/100g. Zinc function as cofactor of many enzymes like lactate dehydrogenase, alcohol dehydrogenase, glutamic dehydrogenase, alkaline phosphatase, carbonic anhydrase, carboxypeptidase, superoxide dismutase, retinenereductase, DNA and RNA polymerase[40]. This value is lower than that of cashew nuts[38,39].

The leaves of *Salacia senegalensis* had 0.93mg/100g of copper, which is grossly lower than 65.0mg/100g reported by[19] of *V. doniana* leaves. This value is lower than the RDA (1.5-3.0) mg/day) of copper[20]. Copper is a constituent of enzymes (cofactor) like cytochrome c oxidase, amino oxidase, catalase, peroxidase, ascorbic acid oxidase, plasma monoamine oxidase, erythrocuprin (ceruloplasmin), lactase, uricase, tyrosinase, cytosolic superoxide dismutase and it plays a role in iron absorption[41]. It is essential for haematologic and neurologic systems[42].

Salacia senegalensis leaves had grossly low levels of chromium and nickel respectively as shown in Table 3. This shows that *Salacia senegalensis* leaves could not be a good source of chromium and nickel respectively. Lead and cadmium was not detected.

CONCLUSION

The result indicates that *Salacia senegalensis* leaf could supplement for carbohydrate, crude fibre and protein, while its relative high Ca and Mg values could be used for the management of bone ailments. Also it could serve as source of antioxidant due to its high content of vitamin C.

REFERENCES

1. Loesener, T (1942). *Celastraceae*, In: Engler A, Harms H, Mattfeld J, Die. Naturlichen Pflanzenfamilien. Duncker, Humlot, Berlin. 20b: 87–197.
2. Simmons, M.P (2004). The Families and Genera of Flowering Plants. *Celastraceae*, in: Kubitzki K edn: Springer, Berlin. 29–64.
3. Chawla, A; Singh, S; Sharma, A. K (2013). *Salacia oblonga Wall*: A Review on its Pharmacognostic, Phytochemical and Pharmacological Aspects, *International Journal of Research in Pharmaceutical and Biomedical Sciences*, 4 (4): 1215- 1228.
4. Nigeria National Medicine Development Agency (NNMDA) (2011).*Salacia senegalensis*, Medicinal plants of South-East Zone, 1: 67.
5. Adumanya, O.C.U; Uwakwe, A.A and Essien, E.B (2014a). Antiplasmodial Activity of Methanol Leaf Extract of *Salacia senegalensis* Lam (DC) in Albino Mice infected with Chloroquine-Sensitive *Plasmodium berghei* (NK65).

International Journal of Ethnopharmacology. 1(1): 002-006.
6. Adumanya, O.C.U; Uwakwe, A.A; Essien, E.B. (2014b). Essential Oil Composition (Terpenes) of *Salacia senegalensis* Lam (DC) Leaf. *British Journal of Research*, 1(2):026-034.
7. AOAC International (2006). Official Methods of Analysis of the AOAC (W. Horwitiz, Editor). 18th edn. Washington DC, USA: AOAC International.
8. Plummer, D.T (1978). An Introduction to Practical Biochemistry. 2nd edn. London: McGraw-Hill.
9. Pellet, P.L. and Young, V.R. (Eds.), (1980). *Nutritional Evaluation of Protein Foods. Report of Working Group Sponsored by the International Union of Nutritional sciences and the United Nations University World Hunger Programme*. The United Nations University: United Nations University Press. WHTR-3/UNUP-129. ISBN: 92-808-0129-5.
10. FAO/WHO/UNU (1991). Energy and Protein Requirements: Report of a Joint FAO/WHO/UNU Expert consultation WHO Technical Report. Series724.ISSN 0512-3054 http://www.fao.org/docrep/t0207e/T0207Eo8. Httm.
11. Onyeike, E.N. and Ehirim, F.C. (2001). Chemical and Sensory Evaluation of Melon fungus (*Pleurotustuberregium*) and Melon fungus Cake. *Journal of Biochemistry & Molecular Biology, 16*(1); 77-81.
12. Onyeike, E.N. and Acheru, G.N. (2002). Chemical composition of Nigerian oil seeds and physicochemical properties of the oil extracts. *Food Chemistry, 77*(4):431-437.
13. Onyeike, E.N; Ihugba, A.C and George, C. (2003). Influence of Heat Processing on the Nutrient Composition of Vegetable Leaves Consumed in Nigeria. *Plant Foods for Human Nutrition, 58*(3):1-11.
14. Chaney, S.G (2006). Principles of Nutrient 1: Macronutrients. In T.M. Devlin (Ed.), Textbook of Biochemistry, with clinical correlation, 6th edn (pp, 1071-1090). New York John Wiley and sons.
15. Zhao, B; Tham, S.Y; Lu, J; Lai, M.H; Lee, L.K.H. and Moochhala, S.M. (2004). Simultaneous Determination of Vitamins C, E and β-carotene in Human Plasma by High-Performance Liquid Chromatography with Photodiode-array Detection. *Journal of Pharmacy & Pharmaceutical Science,* 7(2): 200-204.
16. Olutiola, P.O; Famurewa, O. and Sonntag, H.-G. (1991). *An Introduction to General Microbiology, a Practical Approach.* Germany: Heidelberger Verlagasanstalt and Druckerei GmbH Heidelberg.
17. Pearson, A (1994). Vitamins in fruits. The Biochemistry of fruit and other products. Academic press; New York, 369-384.
18. Uraih, N and Izuagbe, Y. (1990). Public Health Food and Industrial Microbiology Nigeria: Uniben Press.URL:http//www.fao.org/docrep/005/ac45/eob.htm#fn/ll. URL:http://www.spectracell.com/media/patient-brochure-heart-disease.pdf.
19. Umar, K.S; Hassan, L.G and Ado, Y (2007). Mineral composition of Detariummicrocarpum Grown in Kwatarkwashi, Zamfara State, Nigeria, *Inter, J. Pure Appl. Sci.* 1(2): 43-48.
20. Vunchi, M.A; Umar, M.A; King, A.A; Liman, G.J and Aigbe, C.O (2011). Proximate, Vitamins and Mineral composition of *Vitexdoniana* (black plum) fruit pulp. *Nigerian Journal of Basic and Applied Science,* 19(1):97-101.

21. Nnamni, C.V; Oselebe, H.O and Agbatutu, A (2009). Assessment of Nutritional value of three underutilized indigenous leafy vegetables of Ebonyi State, Nigeria. *Afr. J. Biotech*, 8(9):2321-2324.
22. Ali, A (2009). Proximate and mineral composition of the Marchubeh (*Asparagus officinalis*) in Iran. *J. Diary Food Sci.* 4(2):145-149.
23. Food and Agriculture Organization (1990). Roots, Tubers, Plantains and Bananas in Human Nutrition. FAO Corporate Document Repository, Rome http://www.fao.org/docrep/t0207e/T0207Eo8.httm.
24. Scientific Advisory Committee on Nutrition. (2008). Draft SCAN position statement on dietary fiber and health and the dietary fiber definition-August 2008. SACN/08/20. http://www.sacn.gov.uk/pdfs/finai draft sacnstatement on dietary fibre for website.
25. Dillard, C.J and German, J.B (2000). Phytochemicals: Nutraceuticals and Human Health. *Journal of the Science of Food and Agriculture.* 80(12): 1744-1756.
26. Agbede J.O and Ibitoye, A. A. (2007). Chemical composition of Black plum (*Vitexdoniana*); an underutilized fruit. *J. Food Agric. Env*. 5(2): 95-96.
27. Michelle, A; Hopkins, P.J.J; McLaughlin, C.W; Johnson, S.E; Warner, M.Q; Lahart, D.F and Wright, J.D (1993). Lipids, Human Biology, and Health, Eagle Wood Cliffs, New Jersey, USA-Prentice Hall, p1176-1180.
28. Rod, R.S; Trend, S and Philip, T.D.A (1996). Essentials of Anatomy and Physiology 2nd edition, McGraw Hell Companies, 467-469.
29. Sen, C, K and Hanninen, O. (1994).Physiological Antioxidants. In: Sen, CK Packer L, Hanninen O, eds Exercise and Oxygen Toxicity. Amsterdam: Elsevier, 89.
30. Machlin, I.J and Bendich, A (1987). Free Radical Tissue Damage: Protective Role of Antioxidant Nutrients. *FASEB J.* 1:441.
31. Azzi, A; Boscobonik, D and Hensey, C. (1992). The Protein Kinase C family. *Eur. J. Biochem*. 208:547.
32. Lukaski, H.C (2004). Vitamin and Mineral Status: Effects on Physical Performance. *Nutrition,* 20: 632-644.
33. Ishida, H; Suzuno, H; Sugiyaman, N; Innami, S and Maekawa, A (2000). Nutritional Evaluation of chemical component of leaves stalks and stem of sweet potatoes (*Ipomeabatatas*pon). *Food Chem*., 68:359-367.
34. Robert, H.G; Dorothy, J.V; Cassius, L; Louis, E.G; Garret, C.S; Andrezej, P and Mark, M (1997). Amino acid, fatty acid and mineral composition of 24 indigenous plants of Burkino Faso. *J. Food Comp. Anal*. 10:205-217.
35. Adeyeye, E.I (2002). Determination of the chemical composition of the nutritionally valuable parts male and female common West African fresh water crab. *SudnanautesafricanusInt. J. Food Sci. Nutr*., 53:189-196.
36. Adeyeye, E.I and Otoketi, M.K.O (1999). Proximate composition and some nutritionally valuable minerals of two varieties of *Capsicum annum* (Bell and Cherry peppers). *Discovery and Innov.*, 11(1&2): 75-81.
37. Murray, R.K; Granner, D.K; Mayes, P.A and Rodwell, V.W (2000). Harper's Biochemistry, 25th Edition, McGrawHill, Health Profession Division, USA.
38. Nandi, B.K (1998). Cashew nut nutritional aspects. In M.K. Papademetroiu and E.M. Herath (Eds.). Integrated production practices of cashew in Asia. Food and Agriculture Organization of the United Nations

Regional office for Asia and the Pacific Bangkok, Thailand (FAO/RAP Publication: 1998/12).
39. Nutrition Data, (2009). Know what you eat: Nuts, cashew nuts, oil roasted, without salt added. Retrieved March 18, 2011 from http://nutritiondata.self.com/facts/nut-and-seedproducts/3094/2.
40. Soetan, K.O; Olaiya, C.O and Oyewole, O.E (2010). The importance of mineral elements for humans, domestic animals and plants; A review. *African Journal of Food Science* 4(5):200-222.
41. Chandra, R.K (1990). Micro-nutrients and immune functions: An overview *Annal New York Acad. Sci.,* 587:9-16.
42. Tan, J.C; Burns, D.L and Jones, H.R (2006). Servere ataxia, myelopathy and peripheral neuropathy due to acquired copper deficiency in a patient with history of gastrectomy. *J. Paenteral Mutr*. 30:446-450.

Table 1. Proximate composition of *Salacia senegalensis* leaves

Parameters	Amount (%)
Ash content	0.63 ± 0.02
Moisture content	22.27 ± 0.04
Crude fibre	24.85 ± 0.15
Fat and oil	1.82 ± 0.01
Protein	18.00 ± 0.10
Carbohydrate	57.28 ± 0.01
Energy Value	317.50kcal/100g

Values are means ± standard deviation, n=3.

Table 2. Vitamins composition of *Salacia senegalensis* leaves

Name	Amount (mg/100g)
Vitamin B3	0.1444
Vitamin B6	0.0070
Vitamin C	45.0086
Vitamin B1	0.0340
Vitamin B2	0.0831
Vitamin E	0.0083
Vitamin B_9 (folic acid)	0.0074

 ISSN 2394-3718

Table 3. Mineral composition of *Salacia senegalensis* leaves

MINERALS	mg/100g
Lead (Pb)	ND
Chromium (Cr)	0.01
Cadmium (Cd)	ND
Copper (Cu)	0.95
Zinc Zn)	1.01
Nickel (Ni)	0.02
Manganese (Mn)	3.05
Iron (Fe)	11.75
Calcium (Ca)	27.31
Magnesium (Mg)	16.01
Potassium (K)	9.57
Sodium (Na)	11.83

ND = not detected

Figure 1. *Salacia senegalensis*

 ISSN 2394-3718

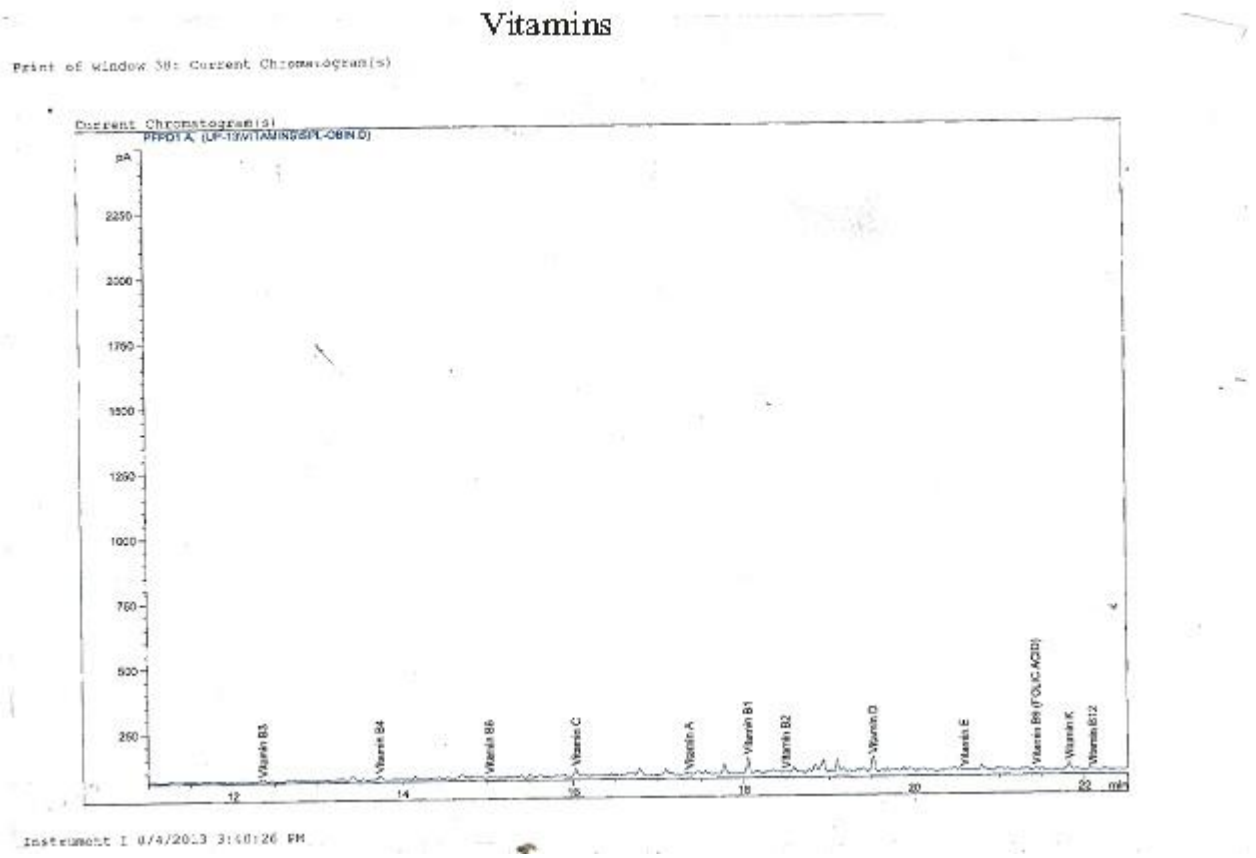

Figure 2. Chromatogram of the vitamins composition of *Salacia senegalensis* leaves