BIOCHEMICAL STUDIES OF DIFFERENT PARTS OF *AFZELIA AFRICANA* SMITH

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ABSTRACT: Phytochemical and proximate analysis was carried out on the seed, leaf, stem bark, stem, root bark and root of *Afzelia Africana* plant. This analysis revealed that phytochemical constituents were mostly predominant in the leaf and lower in other parts of the plant. Steroid was high in the root (0.49±0.01) and lower in the stem (0.04±0.01). Phytate content was high in the seed (0.40±0.03) and lower in the stem. Carbohydrate, protein, fats, ash and moisture content were high in the seed. Fibre was high in the stem (61.1±0.23) and lower in the seed (3.61±0.06). Vit. C (ascorbic acid) was the highest vitamin component in all the plant parts with leaf being the highest (12.69±1.02) and root having the lowest (2.64±1.24). The stem has the lowest content of Vit. A, Vit. B_2, and Vit. B_3. The seed has the highest calcium content (188.80±5.54) while the leaf has the lowest (28.84±0.25). Stem bark has the highest magnesium content (10.08±0.94) and lowest in the root (4.96±0.14). Potassium and phosphorus were high in the leaf (368.67±3.06) and low in the stem. Sodium was high in the seed (11.63±0.40) and lower in the root (5.23±0.23). This study shows that the seed of *Afzelia africana* has the highest biochemical content and could serve as a good food supplement for man and livestock. The presence of phytate is known to induce mineral-related deficiency, its consumption also provides protection against a variety of cancers via its antioxidant properties.

KEYWORDS: Phytochemical, Mineral, Vitamin, *Afzelia africana*, seed, leaf, stem bark, stem, root bark and root

INTRODUCTION

Afzelia africana belongs to the family fabaceae. [14] It is a very attractive medium sized tree. The stem has relatively thick, unequal buttresses with a light concave profile, generally 1-15m tall. The fruits are flat, hard, dark brown or black pods. Each pod contains several oblong black bean-shaped seeds with bright orange aril. It survives harsh weather conditions. [19] Several studies on the plant showed that it contained vital nutrients such as protein, fat, micro and macro minerals.

The quest for plants with medicinal properties continues to receive attention as scientist survey plants, particularly of ethno-botanical significance, for a complete range of biological activities, which range from antibiotic to antitumor. Thus, plants have provided western medicine with an abundance of drugs and treatments for a variety of health problems. [17; 5] Medicinal plants and herbs are of great importance to health and each plant has its own nutrient composition besides having pharmacological importance. Therefore, study is designed to determine the phytochemicals, vitamins and mineral composition of the seed, leaf, stem bark, root bark and root of *Afzelia Africana*.

MATERIALS AND METHODS

Plant collection:

The plant parts of *Afzelia Africana* were obtained from Amuda Isuochi, Umunneochi Local Government Area, Abia State, Nigeria and were identified by Prof. C. U. Okeke, a plant taxonomist in the department of Botany, Nnamdi Azikiwe University, Awka.

Preparation of samples

The stem and roots were manually peeled with the aid of matchet to separate the bark from the woody parts. The harvested seeds, leaves, stem, bark, root, and root bark were oven dried at the temperature of 65ºC. The dried samples were grounded for analysis.

Quality Phytochemical Screening

Phytochemical screening was conducted on the samples to determine the presence or absence of phytochemicals of interest as saponin, flavonoid, tannin, phenols, alkaloid, anthocyanin, steroid, iridoids etc

Test for Saponin

This was done using the saponin froth test. [11] Extract of each sample (2ml) was mixed with 5ml of distilled water in a tube. The mixture was shaken vigorously. The presence of a steady froth indicates the presence of saponin.

Test for Flavonoid

The presence of flavonoid was determined by the acid-alkaline test. [11] Extract of each sample (2ml) was dispersed into a test tube and a few drops of ammonia (NH_3) were added to it. The formation of yellow coloration indicates the presence of flavonoid.

Test for Tannin

5g of each sample was dispensed into 50ml of distilled water. The mixture was left for some hours, then filtered through Whatman No. 42 filter paper. 2ml of filtrate was measured into a test tube and 2 drops of dilute ferric chloride solution was added to the mixture, forming a very dark precipitate indicating the presence of tannin.

Test for Steroids

This was done using the Lieberman-Burchard test. [11] Acetic anhydride (2ml) was added to 5ml of each plant sample extract, followed by 2ml of conc. sulphuric acid down the wall of the test tube to form a layer underneath. The formation of a reddish-violet, brown or green color indicates the presence of steroids.

Test for Phenol

The extract (2ml) was mixed with 5ml of distilled water. The mixture was heated and filtered. Neutral ferric chloride was added to the filtrate and observed for green, blue or black coloration.

Test for Alkaloid

The presence of alkaloid in the test sample was investigated using the Mayer's colorimetric method. [11] Ethanolic extract of the sample was obtained by shaking 2g in 20ml of ethanol for 30 min before filtration. The filtrate was used as extract. 2ml of the extract was mixed with a few drops of Mayer's reagent in a test tube. The formation of an orange precipitation showed the presence of alkaloid.

Determination of Quantitative Phytochemicals

Determination of Alkaloid

This was done by an alkaline ppt gravimetric method. [11] 5g of each sample was dispersed into 50ml of 10% acetic acid sol in ethanol. The mixture was shaken and allowed to stand at room temp for 4hrs. It was filtered using Whatman No. 42 grade of filter. The filtrate was concentrated to a quarter of its original volume by evaporation over a steam bath. Alkaloid in the extract was precipitated by drop wise addition of NH_4OH until full turbidity was obtained. The alkaloid ppt was recovered using a weighted filter paper, and washed with 1% ammonia solution, dried in the oven at 80ºC for an hour. It was cooled in a desiccator and reweighed. By weight difference, the weight of the alkaloid was determined and expressed as a percentage of the sample analyzed, using the formula alkaloid $\% = W_2-W_1*100/1$. Where; $W_1=$ weight of sample. $W_2=$ weight of empty filter paper

Determination of Flavonoid

.10g of the sample was extracted repeatedly into 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered, the filtrate transferred into a crucible and evaporated to dryness over a water bath and weighed. The weight was calculated as Flavonoid $\%= W_2-W_1/$ Weight of the sample x 100/1. Where $W_1=$ weight of empty filter paper. $W_2=$ weight of paper + flavonoid ppt [3]

Determination of Saponin

This was done using the Double solvent extraction gravimetric method. [11] 5g of the powdered sample was weighed out and mixed with 50ml of 20% aqueous ethanol solution. The mixture was heated in a water bath for 90 mins at 55ºC. It was filtered and the residue re-extracted with 50ml of 20% ethanol, both extracts were combined together. The combined extracts were reduced to 40ml over a water bath at 90ºC. The concentration was transferred into a 250 separating funnel where 40ml of diethyl ether was added and shaken vigorously. Separation was by partition during which the aqueous layer was recovered and the ether layer discarded. Re-extraction by partition was done repeatedly until the aqueous layer became clear in color. The saponins were extracted with 60ml of normal butanol. The combined n-butanol extract was washed with 5% aqueous NaCl sol. and was evaporated to dryness in a pre-weighed evaporating dish. It was dried at 60ºC in the oven and weighed. The experiment was repeated twice so as to get an average. The saponin content was determined and expressed as a percentage of the weight analysed. Given by the formula saponin % = $W_2-W_1*100/1$. Where; W_1= weight of sample. W_2= weight of empty filter paper

Determination of Tannin

The tannin content was determined using the Folin-Dennis spectrophotometric method. [27] About 1g of the sample was dispersed in 10ml of distilled water and was shaken. This was left to stand for 30 mins at room temperature while being shaken every 5 mins. It was then centrifuged and the extract was obtained. 2.5ml of the supernatant was dispersed into a 50ml volumetric flask. Similarly, 2.5ml of standard tannic acid solution was dispersed into a separate 50ml flask. 1ml of folin-denis reagent was measured into each flask, followed by 2.5ml of saturated Na_2CO_3 solution. The mixture was diluted and incubated for 90 mins at room temperature. The absorbance was measured at 250 nm in a UV VIS spectrophotometer, readings were taken with the reagent blank at zero. The tannin content was given as tannin %=100/W x A_n/A_s x V_f/V_a. Where A_n= absorbance of test sample. A_s= absorbance of standard solution. C= concentration of standard solution. W= weight of sample used. V_f= total volume of extract. V_a= volume of extract analyzed.

Determination of Phenol

The Follins method was used to determine the presence of Phenol. [27] 0.2g of each sample was dispersed in 10ml of methanol and shaken. It stood for 30min at room temperature and was then filtered using Whatman filter paper. 1ml of each extract was placed in a test tube and 1ml of Follin's reagent with 5nl of distilled water. It was allowed at room temperature for 3-4 hrs so the color can form. The absorbance of the developed color was measured at 760 nm wavelength. The phenol content was calculated thus: %Phenol = 100/W * Au/As * C/100 * Vf/Va * D. Where W= weight of sample analyzed. Au= absorbance of test tube. As= absorbance of standard solution. C= conc. standard (mg/ml). Vf= total filtrate volume. Va= volume of filtrate analyzed. D= dilution factor where applicable.

Determination of Anthocyanins

The total anthocyanin content was determined by the differential pH method [8] based on the property of anthocyanin pigments to change the color. Two dilutions of the two samples were prepared, the first in KCl (0.025M pH 1.0) and the second in a sodium acetate buffer (0.4M pH

4.5) pH being adjusted with HCl 0.24. After equilibrium at room temperature for 15 min, the absorbance of two dilutions was read at 510 nm and 700 nm. $A = (A_{510}-A_{700})_{pH} - (A_{510}-A_{700})_{pH4.5}$

Determination of Hydrogen Cyanide (HCN)

5g of each sample was dissolved in 50ml of distilled water in a conical flask which was left overnight and filtered the next day. 4ml of alkaline picrate was added to 1ml of the sample filtrate in a corked test tube and boiled in a water bath for 5 min. After color development, the filtrate was read in a spectrophotometer at 490 nm. Also, the absorbance of the blank contains 1ml of distilled water and 4ml of alkaline solution. Then the cyanide content was extrapolated using a standard curve. [26]

Determination of Steroids

A 0.5g weight of each sample was dispersed in 100ml freshly distilled water and homogenized in a laboratory blender which is then filtered and the filtrate eluted with normal NH_4OH solution at pH 9. 2ml of the eluted sample was put in a test tube and mixed with 2ml of chloroform, 2ml of acetic anhydride and 2 drops of conc. H_2SO_4 was cautiously added to the mixture. Standard steroid solution was prepared and treated. The absorbance of standard and prepared samples were measured in a spectrophotometer at 420 nm wavelength, with the reagent blank at zero. The experiment was repeated to get an average. Steroid content was calculated as steroid $\% = 100/W \times Au/As \times C/1000 \times V_f/V_a$. Where W= weight of sample analysed. Au= absorbance of test sample. As= absorbance of standard solution in mg/ml. V_f= total volume of extract. V_a = volume of extract analyzed. [24]

Determination of Iridoid

5g of each sample was extracted with 50ml of methanol for 5hrs at 40ºC and evaporated to dryness. It was partitioned with 2*25ml of dichloromethane followed by further partitioning with 2*25ml n-butanol and the butanol fraction was collected into a weighted dish, evaporated to dryness and cooled in a desiccator before re-weighing. The crude iridoid content is given by %iridiod: $100*(W_2*W_1)/W$. Where, W= weight of the sample analyzed. W_1= weight of empty dish. W_2= volume of the dish + dry iridoid extract. [30]

Determination of Phytate

The phytate content was determined by their B_1 pyridine colorimetric method. [26] 2g of each sample was extracted with 50ml of dilute acid (0.1M HCl) for 30 minutes. It was filtered, using whtaman No. 1 filtered paper. 0.5ml of the filtrate was treated with equal volume of 2-2, di-pyridine solution. Standard phytate solution (0.5mg/ml sodium phytate) was prepared and 1ml of it was treated with the di-pyridine solution. Both the sample extract and the standard phytate solutions were diluted to 50ml in a volume flask and their respective absorbance was read in a spectrophotometer at a wavelength of 510 nm. %phytate: $100/W*Au/As*C*Vf/Va$. Where: W= weight of sample analyzed. Au=absorbance of the sample extracted. As= absorbance of standard solution. C= concentration of standard solution. Vf= total volume of extract. Va= volume of extract analyzed.

Proximate analysis

Determination of Ash

The furnace incineration gravimetric method [10] was used. 5g each of the processed samples was measured into a previously weighed porcelain crucible. The sample was burnt to ashes in a muffle furnace at 550ºC. It was then in a desiccator and weighed. The weight of ash obtained was calculated by difference and expressed as a percentage of the sample analyzed: $\&ash= (W_2-W_1)/W*100/1$. Where, W= weight of the sample. W_1= weight of empty crucible. W_2= weight of crucible + ash.

Determination of Crude fibre

The Weeden method was employed. [2] 5g of the defatted sample was boiled in 200ml of 1.25% H_2SO_4 solution under reflux for 30min. The sample was washed with several portions of hot water using a two-fold muslin cloth to trap the particle, then transferred quantitatively back into the flask. 200ml of 1.25% NaOH sol was added to it. Again, the sample was boiled for 30 min and washed with hot water. It was then transferred to a weighed porcelain crucible and dried in the oven at 105ºC for an hour, cooled in a desiccator and reweighed. The loss in weight after incineration was used to determine the crude fibre content and expressed as percentage of the weight of the sample: %crude fibre= $(W_2-W_3)/W_1*100/1$. Where, W_1= weight of sample. W_2= weight of crucible + sample after drying. W_3= weight of crucible + sample (after ashing).

Determination of Fat

Soxhlet extraction method was used in the determination of Fat. [23] 5g of each sample was wrapped with a weighted porous paper (Whatman filter paper No. 40). The wrapped samples were put in a soxhlet reflux flask. The flak was mounted into an oil extraction flask containing 300mlbof petroleum ether and boiled at 60ºC boiling points. The vaporized solvent condensed into the reflux flask and siphons over when it fills up carrying extracted oil down the boiling flask. This cycle was allowed to go on uninterrupted for about 4hrs. The defatted samples were brought out with the aid of forceps and further dried in the oven at 100ºC for 1hr, cooled in a desiccator and weighed. The fat content was determined by weight difference of each sample and expressed as percentage of each weight sample as: %fat= $(W_2-W_3)/(W_2-W_1)*100/1$. Where, W_1= weight of empty filtered paper. W_2= weight of paper + sample before defatting. W_3= weight of paper + sample after defatting and drying.

Determination of Moisture content

The moisture content was determined by the gravimetric method. [4] 5g of the fresh sample was put in a weighted moisture can and dried in the oven at 105ºC for 3 hours, cooled in a desiccator and weighed. The weight was recorded and the sample returned in the oven for further drying. The process was repeated until a constant weight was obtained. By weight difference, the moisture loss was determined and expressed as a percentage of the sample weight analyzed. %Moisture= $(W_2-W_3)/(W_2-W_1)*100/1$. Where, W_1= weight of empty moisture can. W_2= weight of moisture can + sample before drying. W_3= weight of moisture can + sample after drying to constant weight.

Determination of Crude protein

The protein content of each of the samples was determined by the Kjeldahl method. [7] The total was determined and multiplied by the factor 6.38 to obtain the protein content. 1ml of each sample was mixed with 10ml of conc. sulphuric acid in a kjeldahl digestion flask. A tablet of selenium catalyst was added to it and the mixture was digested by heating in a fume cupboard until a clear solution was obtained. Each of the digest was carefully transferred to a 100ml volumetric flask and made up to the mark with distilled water. A 10ml of each digest was mixed with an equal volume of 45% NaOH sol in a kjeldahl distilling unit. The mixture was distilled and the distillate collected into 10ml of 4% boric acid containing 3 drops of mixed indicator (bromocresol green and methyl red). A total of 50mls distillate was collected and titrated against 0.02N H_2SO_4 from green to deep red end point. A reagent blank was also digested, distilled and titrated. The N_2 and protein content was calculated as N_2 %= 100/W * (N*14)/1000 * V_f/V_a * T-B. Where: N= normality of titrant (H_2SO_4). V_f = total volume of digestion. V_a= volume of digest distilled. T= titre volume of sample. B= titre value of reagent blank.

Determination of Minerals

The mineral content of the samples were determined by the dry ash acid extraction method. [6] 5g of each sample was burnt to ashes in a muffle furnace at 50ºC. The resulting ash was dissolved in 10ml of 2M HCl solution and diluted to 100ml in a flask using distilled water and filtered. The filtrate was used for the mineral analysis.

Determination of Calcium and Magnesium

This was carried out by the versenate EDTA complexometric titrimetric method. 20ml portion of each extract was dispersed into a conical flask and treated with inches of masking agents (hydroxylamine hydrochloride, sodium cyanide and sodium potassium ferrocyanide). The flask was shaken and the mixture dissolved. 20ml of ammonia was added to it to raise the p^H to 10.00 (a point at which both calcium and magnesium form complexes with EDTA). The mixture was titrated against 0.02N EDTA solution using Eriochrome Black T as indicator. A reagent black was titrated and titration in each case was done from deep red to a permanent blue endpoint. The titration value represents both calcium and magnesium ions in the test sample. A repeat titration was done Ca^{2+} alone in the test samples, 10% NaOH was used in place of the ammonium buffer and solochrome dark blue indicator in place of Eriochrome Black T. At pH of 12.0 Ca^{2+} complexes with EDTA. % Ca and Mg= (100/W)*EW*N*(Vf/Va)*T-B. Where, W= weight of the sample analysed. EW= Equivalent weight. N= Normality of EDTA. Vf= total volume of extract. Va= volume of extract titrated. T= titre value of sample. B= titre value of blank.

Determination of Potassium and Sodium

Flame photometry was used to determine the concentration of K and Na. Photometer was set up, switched on and allowed to stay for about 10min. The gas and air inlets were opened and the start knob was adjusted to a non-luminous flame. Meanwhile, standard K and Na sol was prepared separately and each diluted to conc 2, 4, 6, 8 and 10ppm. The appropriate conc filter was selected for K and Na. The highest conc standard sol was aspirated and its emission intensity adjusted to 100 units. Therefore, starting with the least conc. (2ppm), each standard sol was aspirated and caused to spray over the non-luminous butane gas flame. The emission

intensity read directly on the instrument and the readings were recorded. Then the samples digests were also aspirated and their reading taken. The emission intensities of the standards were plotted against their conc to obtain a standard curve (calibration graph) for each element. Subsequently, the optical density emission recorded from each of the samples was matched against those in the curve to extrapolate the quantity of each potassium and sodium ions in the sample. The experiment was repeated three times to get a mean concentration. The conc of the test minerals were calculated as follows: %K or Na (mg/100g)= $(100/W)*(1/1000)*X*(Vf/Va)*D$. where, W= weight of sample used. X= concentration (ppm) from curve. Vf= total volume of extract. Va= volume of extract (digest) flamed. D= dilution factor where applicable.

Determination of Vitamins

The spectrophotometric method was employed. [25]

Determination of Vitamin B_1 (thiamine)

5g of each sample was homogenized with 50ml of 1N ethanolic NaOH and filtered. 10ml of the filtrate was treated with equal vol. of 0.1N $K_2Cr_2O_7$ sol in a flask. Meanwhile, standard thiamine sol. was also treated with 10ml of dichromate sol ($K_2Cr_2O_7$) in a separate flask while reagent blank was set up by treating 10ml of the ethanolic NaOH with the potassium dichromate sol. The absorbance of the sample and the standard sol were measured in a spectrophotometer at wavelength of 360 nm with the reagent blank used to calibrate the instrument at zero. The thiamine content was calculated thus: mg/100mg= $(100/W)*(Au/As)*C*(Vf/Va)*D$. where, W= weight of sample analyzed. Au= absorbance of sample. As= absorbance of standard thiamine solution. C= conc. standard thiamine solution. Vf= total volume of filtrate. Va= volume of filtrate analyzed. D= dilution factor where applicable.

Determination of Vitamin B_3 (niacin)

5g of each sample was treated with 50ml of 1N sulphuric acid and shaken for 30 min. The mixture was further treated with 2 drops of aqueous ammonia, mixed well and then filtered. Standard niacin (nicotinic acid) sol was prepared and diluted as desired. The 10ml portion of the standard sol as well as the sample extract and 10ml of the acid sol (treated with a drop of ammonia) were dispersed into separate flasks to serve as standard, sample and reagent blank respectively. Each of them was treated with 5ml of normal KCN sol and acidified with 0.02N H_2SO_4 sol, after which its absorbance was read in a spectrophotometer at a wavelength of 470 nm. The reagent is blank to calibrate the instrument at zero. Niacin content was calculated using the formula: Niacin mg/100mg= $(100/W)*(Au/As)*C*(Vf/Va)*D$. where, W= weight of sample analyzed. Au= absorbance of sample. As= absorbance of standard thiamine solution. C= conc. standard thiamine solution. Vf= total volume of filtrate. Va= volume of filtrate analyzed. D= dilution factor where applicable.

Determination of Vitamin B_2 (Riboflavin)

5ml of each sample was dispersed in 100ml of 5% ethanol solution in distilled water. The mixture was shaken and filtered. 10ml of the filtrate was mixed with an equal volume (10ml) of 5% potassium permanganate (K_2MnO_4) solution 10ml of 30% hydrogen peroxide (H_2O_2) was added to it. The above treatment was also given to a 10ml portion of standard riboflavin

solution as well as reagent blank. All the flasks (standard, blank, and sample) were meant to stand over a water bath for half an hour and 2ml of 40% Na_2SO_4 solution was added to each of them. This was made upto 50ml in a volumetric flask. Their respective absorbance (standard and sample) were measured in a spectrophotometer at 510 nm wavelength. Readings were taken with the reagent blank at zero. Thus riboflavin content was calculated as: mg/100mg= $(100/VW)*(Au/As)*C*(Vf/Va)*D$. W= weight of sample analyzed. V= volume of sample. Au= absorbance of sample. As= absorbance of standard thiamine solution. C= conc. standard thiamine solution. Vf= total volume of filtrate. Va= volume of filtrate analyzed. D= dilution factor where applicable.

Statistical analysis

All data from the analysis of the seed, leaves, stem, stem bark, root and root bark samples were subjected to statistical analysis system (SSA, 2000) software package. ANOVA was done and means of separation using Fisher Least Significant Difference (LSD).

RESULTS

The result of the qualitative phytochemical analysis of the seed, leaves, stem, stem bark, root bark and root of *A. africana* is shown below:

Table 1: Qualitative phytochemical constituent of different parts of *Afzelia africana*

Extracts	Seeds	Leaves	Stem bark	Stem	Root bark	Root
Saponin	+	++	++	+	++	+
Flavonoid	+	++	++	+	++	+
Tannin	++	++	++	+	+	+
Steroid	++	++	+	+	+	++
Phenol	++	++	+	+	++	+
Alkaloid	+	++	++	+	++	+

++ = present; + = slightly present

The quantitative analysis result showed that the phytochemical constituents are all present in the leaves, while they are slightly present in the stem.

Table 2: Percentage proximate constituent of different parts of *Afzelia africana*

Sample	Seed	Leaf	Stem bark	Stem	Root bark	Root
Protein	3.21±0.10e	2.04±0.09d	1.46±0.10c	0.59±0.09a	1.11±0.10b	0.76±0.10a
Fat	5.09±0.11f	2.95±0.07e	2.49±0.06d	0.79±0.06a	2.03±0.11c	1.17±0.04b
Fibre	3.61±0.06a	10.9±0.33b	36.25±0.24d	61.1±0.23f	33.50±0.33c	56.97±0.98e
Ash	4.35±0.07e	2.89±0.03d	2.60±0.06c	1.96±0.08ab	2.21±0.04b	2.03±0.08a
Moisture	8.41±0.03c	6.69±0.03a	7.60±0.03a	6.65±0.07a	7.57±0.08b	6.71±0.23a
Carbohydrate	75.33±0.36e	74.50±0.29e	49.60±0.24c	28.91±0.23a	53.61±0.03d	32.36±1.36b

Results are reported in mean ± SD. Means with same letter in a row are not significantly different ($P>.05$)

The result showed that most of the parts contained more carbohydrate, with the seed having the highest content (75.33±0.36), followed by the leaf, root bark, stem bark, root, and the stem. The highest constituent of the root is fibre (56.97±0.98), with root having the lowest fibre content (3.61±0.06).

Table 3: Percentage vitamin constituent of different parts of *Afzelia africana*

Sample	Seed	Leaf	Stem bark	Stem	Root bark	Root
Thiamine	0.06±0.02c	0.07±0.005d	0.05±0.002b	0.01±0.002a	0.06±0.002bc	0.02±0.002a
Riboflavin	0.21±0.005b	0.31±0.005c	0.40±0.005d	0.00±0.00a	0.40±0.005d	0.00±0.00a
Niacin	0.11±0.006b	0.42±0.005e	0.18±0.16c	0.07±0.019a	0.20±0.006d	0.04±0.005b
Ascorbic acid	4.89±1.02bc	12.91±1.02bc	5.87±1.02c	2.93±1.02ab	5.87±1.02c	2.64±1.24a

Results are reported in mean ± SD. Means with same letter in a row are not significantly different (*P*>.05)

The table above showed that there is high content of thiamine in all parts of *Afzelia africana* with the highest found in the leaf (12.91±1.02) and lowest in the root (2.64±1.24). Niacin content is high in the leaf (0.42±0.005) and low in the root (0.04±0.005). Riboflavin was absent in the stem and root but present in other parts of the plant. Thiamine is high in the leaf (0.07±0.005) and low in the stem (0.01±0.002).

Table 4: Percentage quantitative phytochemical constituent of different parts of *Afzelia africana*

Sample	Seed	Leaf	Stem bark	Stem	Root bark	Root
Alkaloid	0.02±0.03b	1.41±0.03e	1.12±0.04d	0.13±0.01a	0.065±0.01c	0.11±0.01a
Saponin	0.17±0.02c	0.35±0.01e	0.21±0.02d	0.07±0.01a	0.23±0.01d	0.11±0.01b
Flavonoid	0.15±0.01b	0.37±0.01e	0.23±0.01d	0.11±0.01a	0.43±0.02f	0.19±0.02c
Tannin	0.22±0.00c	0.32±0.00f	0.22±0.00e	0.12±0.00b	0.19±0.00d	0.11±0.00a
Phenol	0.22±0.00c	0.72±0.00f	0.57±0.00d	0.18±0.00a	0.68±0.00e	0.20±0.00b
Phytate	0.40±0.03d	0.37±0.02d	0.45±0.01e	0.11±0.01a	0.27±0.01c	0.15±0.02b
HCN	7.60±0.02d	12.99±0.03f	9.05±0.15e	2.33±0.14a	6.74±0.22c	3.00±0.07b
Steroid	0.13±0.01c	0.16±0.00d	0.05±0.01a	0.04±0.01a	0.07±0.01b	0.49±0.01e
Anthocyanin	0.07±0.01a	0.11±0.01b	0.09±0.01b	0.05±0.01a	0.11±0.01b	0.05±0.01a
Iridiod	0.03±0.01ab	0.07±0.01d	0.04±0.00bc	0.02±0.01a	0.05±0.01c	0.030.01ab

Results are reported in mean ± SD. Means with same letter in a row are not significantly different (*P*>.05)

Quantitative phytochemical analysis in the above samples of *Afzelia africana* shows that leaf has the highest content of almost all the phytochemical constituents except flavonoid which is high in the root bark (0.43±0.02), phytate which high in the stem bark (0.45±0.01) and steroid which is high in the root (0.49±0.01).

Table 5: Percentage mineral content of different parts of *Afzelia africana*

Sample	Seed	Leaf	Stem bark	Stem	Root bark	Root
Calcium	188.80±5.4c	28.84±0.25a	35.87±2.02b	36.81±1.20b	34.11±1.74b	31.93±2.02ab
Magnesium	10.04±0.97c	9.06±0.24bc	10.08±0.94c	5.04±0.14a	7.65±2.19b	4.96±0.14a
Potassium	137.33±1.15b	368.67±3.06f	210.67±2.31d	109.33±6.35a	187.00±6.35c	223.33±3.79e
Sodium	11.63±0.40d	9.01±0.09b	9.89±0.39c	5.33±0.23a	9.35±0.67c	5.23±0.23a
Phosphorus	40.33±1.50a	440.33±6.66f	230.67±2.52e	112.00±4.00	191.33±3.06d	104.67±4.62b

Results are reported in mean ± SD. Means with same letter in a row are not significantly different ($P>.05$)

Mineral analysis of different parts of *Afzelia africana* showed that phosphorus content is high in the leaf (440.33±6.66) and low in the seed (40.33±1.50). Potassium was also observed to be more in the leaf (368.67±3.06) and low in the stem (109.33±6.35). Calcium content is higher in the seed (188.80±5.4) and lower in the leaf (28.84±0.25). Magnesium content was higher in the stem bark (10.08±0.94) and lower in the root (4.96±0.14). Sodium was higher in the seed (11.63±0.40) and lower in the stem (5.33±0.23).

DISCUSSION AND CONCLUSION

The analysis of the approximate composition of different parts of *A. africana* showed that fat content was highest in the seed (5.09±0.11). According to Mary and Garvin (2008), fats in the seed could be used in maintaining healthy skin and hair temperature. The crude fibre was high in stem (61.1±0.23) and low in the seed (3.61±0.06). Thus, *A. africana* may be an effective source of dietary fibre which is important for reducing cholesterol levels in the body so as to minimize risk of cardiovascular disease caused by high cholesterol [29]. It also adds bulk to the diet and prevents the intake of excess starchy food [22] and may therefore guard against metabolic conditions such as hypercholesterolemia and diabetes mellitus. [12] Carbohydrates play major roles in mediating interactions among and between cells and other element in the environment [28]. They also serve as storage and transport systems. The high protein, fat and carbohydrate of *A. africana* in seed is desirable in foods. While protein is important in regeneration of cells, fats in diets keep the body warm by insulation and also act as solvent for vitamins. Ash content is a holistic representation of the total of the total mineral in foods. [26] The results obtained from this research shows that the major constituents were higher in the seeds than other parts of the plant. Also, the distribution of these components in the various parts of the plants is attributed to the translocation of synthesized plant constituents in the different storage parts.

The distribution of vitamins in the plant shows high conc. in the leaf and seed whereas the woody parts of stem and roots contain little of the vitamins. The vitamins studied could be used for maintaining normal growth, digestion, and metabolism of protein, fats, carbohydrate and mineral utilization.

The mineral analysis in different parts of the plant showed high levels of phosphorus, potassium and calcium. Calcium (188.80/100g) and Potassium (368.67mg/100g) were highest in the seed and least in the leaf. The results indicate that all parts of the plant tested have the potential of having good medicinal roles. Potassium, sodium and magnesium are important electrolytes which help in osmoregulation to maintain good homeostasis. Intake of calcium is known to aid bone and teeth formation. [20]

According to the result shown in table 4, the conc. of phytochemicals in the tested plant parts showed significant difference. The presence of these secondary metabolites accounts for the usefulness of its part for medicinal purposes. [9] Alkaloid which was found to be highest in the leaf (1.41±0.03) and least in the root (0.11±0.01), are known to be toxic and can have effect on the human physiology [11], but another study observed that alkaloids are recognized more for their pharmacological activities rather than toxicity. Flavonoids are antioxidants which can protect the body against oxidative cell destruction, they have also shown to be antibacterial, anti-inflammatory, antiviral and antineoplastic activity. [1] Statistically, the differences in the flavonoid content of different parts of *A. Africana,* are significant. Saponin is seen to be more in the leaf (0.35±0.01) and least in the stem (0.07±0.01), they are antimicrobial that favorably influences oral health [15], it also supports kupffer cell in the liver and encourages normal detoxification. Tannins were also found in all plant parts studied, they are used to treat intestinal disorders such as diarrhea and dysentery thus exhibiting antimicrobial activity. It was also observed that tannin is remarkable in cancer prevention. [18]

Phytate is highest in the stem bark (0.45±0.01) and lowest in the stem (0.11±0.1). It plays an important role in pancreas function and insulin secretion, lowers the blood glucose and lipids, it also inhibits some cancer cells by depriving them of the minerals they need. The deprivation of essential minerals like iron would serve as a broad treatment for cancer. [13] High levels of phytate and HCN are known as anti-nutritive factors that limit the use of many plants for either food or medicinal purposes because they elicit deleterious effects on man and animals. [16]

In general, there is a wide variation in the accumulation of the different phytochemicals in the different plant parts. This finding underscores the observation that different part of the plant is employed in traditional medical formulas

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