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PHYTOCHEMICAL AND PROXIMATE ANALYSES OF DIFFERENT PARTS OF *AZADIRACHTA INDICA* A. JUSS

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ABSTRACT

This study was conducted to assess the phytochemical and proximate contents of different parts of *Azadirachta indica*. The dried and powdered fruit pulp, seed, leaf, stem, stem bark, root and root bark of *A. indica* were subjected to various sample preparation stages using standard laboratory procedures for determination of phytochemical and proximate composition in the test plant parts. Analysis of Variance (ANOVA) was employed to test for significance. Means were separated using Duncan's New Multiple Range Test (DNMRT). The results of the study revealed that there were marked differences ($P<0.05$) in the phytochemical and proximate contents of the fruit pulp, seed, leaf, stem, stem bark, root and root bark of *A. indica*. Alkaloid was the highest phytochemical compound in the leaf of the test plant. Alkaloid contents of the leaf and root bark showed the highest and equal values (3.42± 3.45) respectively, while steroid showed the lowest content in fruit pulp (0.15± 0.17). Carbohydrate content of the fruit pulp showed the highest value (65.52± 66.13), while the least was fat content of the root (0.42± 0.45). This study suggests that the phytochemical values and nutritional components of fruit pulp, seed, leaf, stem, stem bark, root and root bark of *A. indica,* could be utilized as a good source of nutrient supplement, as well as source of useful pharmaceutical products.

Keywords: Phytochemical, Proximate, Analysis, Parts, *Azadirachta indica*

Introduction

Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources. The use of herbs in the treatment of ailments in Africa is an age long practice. The decreasing efficacy of synthetic drugs, cost, accessibility and increasing contradiction of their usage makes the usage of natural drugs tropical. There is growing awareness by scientific and medicinal communities of the importance of medicinal plants in the health care system of many developing countries (Ame *et al*., 1995).

Traditionally, it is believed that natural products are safe (Said *et al*., 2005). This assumption to a large extent has influenced the indiscriminate use of these formulations by many particularly among rural populace (Mbaka *et al*., 2010). The safety of herbal medicine is of particular importance because majority of these products is self-prescribed and it is used to treat minor and often chronic conditions. Man's continuous reliance on herbs for therapeutic and nutritional benefits cannot be overemphasized. The ethnomedicinal and nutritional uses of wild plants are as old as men as they are sources of food, security and income generation (Akubugwo *et al*., 2007). Some of the most potent drugs in Western medicine are derived from plants, yet they are obtained from only 90 species of estimate 250,000 plant species (Dutta, 2001). Traditional societies have over the years employed medicinal plants in ethno-medicine for the treatment of various diseases without scientific knowledge of the physiologically active ingredients called phytochemicals which were responsible for the plants medicinal and pharmacological potentials (Aja *et al*., 2010).

Azadirachta indica (A. Juss), a member of the mahogany family Meliaceae (commonly called neem plant) has one of the most promising medicinal properties having a wide spectrum of biological activity. Neem is a large tree growing about 25m in height with semi-straight to straight trunk, 3m in girth and spreading branches forming a broad crown. It starts giving fruits after 3-5 years and the plant is reported to live up to two centuries (Ogbuewu *et al*., 2011). Each and every part of neem tree has a wide range of pharmacological properties especially as antibacterial, antifungal, antiulcer, antifeedant, repellant, pesticide, inhibitor and sterilant (Mishra, 2013).

Earlier studies have shown that neem contains active substances in almost every parts i.e. seeds, leaves, roots, bark, trunk and branches and have multiple medicinal properties (Almas and Ansallafi, 1995). Aqueous extract of neem leaf has a good therapeutic potential like an anti-hyperglycemic agent (Bajaj and Srinivasan, 1999). Neem extract has less anti-flammatory effect than that produced by dexamethasone. Neem leaves have antibacterial properties and could be used in traditional medicine to treat infectious conditions especially those involving eye and ear (El-Mahmood *et al*., 2010). The aim of this study is to assess the nutritive and phytochemical constituents present in different parts of *Azadirachta indica*.

Materials and Methods

Source of Materials

Fresh samples of the leaves, fruit, stem, stem bark, root and root bark were collected from Botany garden at Nnamdi

Azikiwe University Awka, Anambra State. They were identified by a plant taxonomist, Prof. C.U. Okeke in the Department of Botany.

Preparation of Plant Samples

Fresh samples were washed and oven dried at 65°C for five days. The dried samples were separately ground with metal hand grinder to fine powder. The dried powdered samples were used for the analysis.

Qualitative Determination of Phytochemicals in *Azadirachta indica*

Qualitative tests were conducted to evaluate the presence or absence of phytochemical of interest. It was conducted using standard methods described below.

Alkaloid Determination

The presence of alkaloid in the samples were investigated using Meyer's colourimetirc method described by Harborne (1973). Ethanolic extract of the samples were obtained by shaking 2g of the samples in 20ml of ethanol for 30mins before filtrating over the funnel using Whatman filter paper in 100ml beaker. 2.5ml of each filtrate was taken and poured in the test tube labelled A, B, C and D, placed in a test tube rack. Few drops of Meyer's reagent were added to each of the test tube respectively. Formation of orange precipitate/colour shows the presence of alkaloid.

Saponin Determination

The froth test and emulsion test described by Harborne (1973) were used to determine the presence of saponin. 5ml of distilled water was used to dissolve 1g of powdered samples in 250ml conical flask. Each of them was shaken and placed in water bath for 5mins. They were filtered hot over the funnel using Whatman filter paper in 100ml beaker. 2.5ml of each cooled filtrate was poured into the test tube labelled A, B, C and D, and placed in a test tube rack. 10ml of distilled water was used to dilute each of the tube respectively.

Froth Test

Each of the flask was shaken vigorously for few minutes and observed. A stable froth (foam) upon standing indicates the presence of saponin.

Emulsion Test

Two drops of olive oil was added to the four test tubes respectively and shaken vigorously. The formation of emulsion indicates the presence of saponin.

Tannin Determination

The presence of tannins was determined using the Harborne (1973) method. 1g of powdered samples were boiled with 5ml of distilled water in a water bath for 5 minutes. They were filtered hot with Whatman filter paper folded over a funnel in 100ml beakers. Four test tubes labelled A, B, C and D, was positioned in a test tube rack. 1ml of the cooled filtrates was added to each test tube accordingly. 10ml of ferric chloride was added to each of the test tube and observed. A greenish brown precipitate was observed which indicates the presence of tannin.

Flavonoid Determination

The presence of flavonoid in the samples was determined using the Harborne (1973), Sofowora (1993) methods. 1g of powdered samples were dissolved with 10ml of distilled water in 250ml conical flask, shaken and placed in water bath for 5mins. They were filtered hot using Whatman filter paper folded over the funnel in 100ml beaker. The filtrates were allowed to cool. Two drops of 20% NaOH was added to 1ml of each of the filtrates in a test tubes labelled A, B, C and D. A

yellow amber colour was observed in tubes A and D, light yellow in B and C. To each of the test tube was also added two drops of one normal sulphuric acid and observed. No colour change was observed in all the samples after addition of two drops of sulphuric acid. It implied that flavonoid is present in the plant due to formation of colourless solution.

Cardiac Glycoside Determination

5ml of each of the aqueous extracts was taken using 5ml syringe into the test tubes labelled A, B, C and D. 2ml of glacial acetic acid was added to each of the tube. One drop of ferric chloride was also added respectively. 1ml of concentrated sulphuric acid was added to the four tubes and observed for brownish or greenish precipitate. Flask A, C and D was found to contain cardiac glycoside as the colour being evident while flask B has clear solution.

Phlobatanin Determination

5ml of aqueous extracts of each of the samples was taken with 5ml syringe and added to four test tubes labelled A, B, C and D. 5ml of 1% HCL was added to each of the tube and placed in a conical flask and boiled in a water bath for 5mins. Red precipitate was observed in flask D only which indicates the presence of phlobatanin.

Terpenoid Determination

5ml of aqueous extracts from each of the samples was poured into the test tube labelled A, B, C and D. 2ml of chloroform was added to each of the test tube. 1ml of concentrated sulphuric acid was also added to each of the flask to form a layer. A reddish brown precipitate at the interface indicates the presence of terpenoid.

Reducing Sugar Determination

To 1g of powdered samples were added 15ml of distilled water in 250ml conical flask. It was shaken and placed in a water bath for 5 minutes. The solution was filtered hot in Whatman filter paper and folded over a funnel in 100ml beaker. 1ml of the filtrates was taken from each of the beaker into a test tube labelled A, B, C and D, and positioned in a test tube rack. To each of the test tube was added 3 drops of 20% NaOH and tested with red litmus paper which turned blue. 1ml of Benedict solution was added to each of the test tube respectively, boiled in a water bath for 5mins and observed for brick red precipitate.

Carotenoid Determination

To 1g of powdered samples was added 10ml of chloroform in a conical flask and shaken. They were filtered with Whatman filter paper over a funnel in 100ml beaker. To 1ml of the filtrates were added three drops of 85% sulphuric acid and observed for blue colouration. No colour change was observed in the four test tubes.

Quantitative Determination of Phytochemicals in *A. indica*

Determination of Alkaloid

2g of each sample was analysed in accordance with the alkaline precipitation gravimetric method (Harborne, 1973). The weighed samples were soaked in 100ml of 10% acetic acid solution in ethanol and allowed to stand for 4 hours at room temperature before filtering using Whatman filter paper. The filtrates were reduced to a quarter of their original volume by evaporation over a steam bath. Alkaloids in the extracts were precipitated by drop wise addition of concentrated NH_4OH solution until full turbidity was obtained. The precipitate was recovered by filtration using weighed filter papers and then washed with 1%

NH_4OH solution, dried in the oven at 100°C for an hour. They were cooled in desiccator and reweighed. By difference, the weight of alkaloids present in the samples were determined and expressed as percentage for the samples and analysed using the formula;

% Alkaloid = W2-W1×100/Weight of sample

Where;

W1= weight of empty filter paper

W2= weight of paper + alkaloid precipitate

Determination of Saponin

Saponin content of the samples were determined by double solvent extraction gravimetric method (Harborne, 1973). 2g of the powdered samples were mixed with 50ml of 20% aqueous ethanol solution. The mixtures were heated with periodic agitation in water bath for 30mins at 55°C. They were filtered, the residues were extracted with 50ml of ethanol and both extracts were put together. The combined extracts were reduced to about 40ml at 90°C and transferred to a separating funnel where 40ml of diethyl ether was added and shaken vigorously. Separation was by partition during which the ether layer was discarded and the aqueous layer reserved. Reaction was carried out until the aqueous layer became clear. The saponins were extracted with 60ml of normal butanol. The combined extracts were washed with 5% aqueous NaCl solution and evaporated to dryness in a pre-weighed evaporating dish. They were dried at 60°C in the oven and reweighed. The saponin content was calculated as percentage of original sample as;

% Saponin = W2-W1×100/Weight of sample

Where;

W1= weight of evaporating dish

W2= weight of dish + sample

Determination of Tannin

The Follins – Dennis spectrophotometric (Pearson, 1976) was used. 2g of the powdered samples were dispensed into 50ml of distilled water in a conical flask and shaken for 30mins in a shaker. The mixtures were filtered. 5ml of the filtrates were measured into 50ml volumetric flask and then diluted with 35ml of distilled water. Also, 5ml of standard tannic acid solution and 5ml of distilled water were measured with separate flasks to serve as standard and blank respectively. They were diluted with 35ml of distilled water separately. 1ml of Follins – Dennis Reagent was added to each of the flask followed by 2.5ml of saturated sodium carbonate solution. The content of each flask was filled to mark level with distilled water and incubated for 90mins at room temperature. The absorbance of the developed colour was measured at 76nm wavelength with the reagent blank at zero. The tannin content was calculated as shown below;

% Tannin = 100/w×AU/As×VF/VA×D

Where;

W = weight of the sample analysed

AU = absorbance of test sample

AS = concentration of standard in mg/ml

C = total volume of extract

VF = volume of filtrate analysed

D = dilution factor (where applicable)

Determination of Flavonoid

Flavonoids determination was done using Bohamand Kocipai method. 10g of the plant samples were extracted repeatedly with 100ml of 80% aqueous methanol in conical flask at room temperature. The whole solution was filtered using a weighed Whatman filter paper. The filtrates were transferred into crucible and

dryness in the oven, cooled in the desiccator and weighed. The percentage flavonoid was expressed as the weight of sample analysed using the formula;

% Flavonoid = W2-W1×100/Weight of sample

Where;

W1 = weight of empty filter paper

W2 = weight of filter paper + flavonoid precipitate

Proximate Analysis

This was carried out using mainly the method described by Association of Official Analytical Chemists (A.O.A.C, 1990). It involves the determination of protein, ash, moisture, fat and carbohydrate content.

Determination of Protein

Protein content of the sample was determined by the Kjeldahl method reported by James (1995). The total nitrogen (N_2) was determined and multiplied by the factor 6.25 to obtain the protein content. 0.5g of the powdered samples were weighed into a Kjeldahl digestion flask and a table of selenium catalyst was added to it. 10ml of conc. H_2SO_4 was then added to the flask and digested by heating under a fume cupboard until a clear solution was obtained. It was transferred to 100ml volumetric flask and made up to with distilled water and 10ml of 45% NaOH solution in a Kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 10ml of 4% boric acid solution containing mixed indicator-methyl red bromoressol. A total of 50ml distillate was collected and titrated against 0.02m H_2SO_4. The total N_2 content was calculated using the relationship that 1ml in H_2SO_4 = 14g N_2. Thus;

% N2 = 100/W [N×14×Vt /100] T-B/Va

Where;

T-B = Titre (less blank)

N = Normality of H_2SO_4 = 0.02m

Vt = Total digest volume = 100ml

Va = volume of digested distilled = 10ml

W = weight of sample analysed = 0.5g

The percentage of protein is thus; % N_2×6.25

Determination of Fat

Fat content was determined by the continuous solvent extraction method using a Soxhlex apparatus as described by Pearson (1976). An extraction flask was washed and dried in oven for 30mins and then placed in a desiccator to cool. 2g of powdered samples were weighed and transferred in a rolled A4 paper, then placed in the extractor thimble. The thimble was placed into Soxhlex extractor. About three quarter of the volume of petroleum ether was poured into the extraction flask. Soxhlex was connected to the flask and condenser turned on. The heater was switched on and the temperature not exceeding boiling point of the petroleum ether was allowed to run for 3-6 hours. At the end of the extraction, the ether recovered before the thimble was removed. Finally, the oil in the flasks was dried at 100°C in an oven. The extracts were weighed. The difference in the weight of empty flask and the flask with the oil gave the oil content of the sample.

Determination of Crude Fibre

The crude fibre was determined by the Weende method described by both Pearson (1976) and James (1995). 2g of samples were weighed and defatted (during fat analysis) and the defatted samples were boiled in 200ml of 1.25% of H_2SO_4 solution in a water bath. Boiling was done for 30mins after which the mixture

was washed with distilled water and filtered using filter paper. The samples were transferred back to the boiling flask and 200ml of 1.25 NaOH solution was added. The mixture was again boiled for 30mins, washed with distilled water and drained. After draining, they were transferred to a weighed crucible and dried in the oven at 105°C to a constant weight. The weight was recorded and the samples were taken to a furnace and burnt to ashes. Also, after cooling in a desiccator, the crucible with its ash content was reweighed. The weight of fibre was determined and expressed as a percentage of the weight of sample and analysed thus;

% Crude Fibre = W2-W1×100/Weight of sample

Where;

W1 = weight of crucible + ash

W2 = weight of crucible + sample after drying to constant weight.

Determination of Moisture

The moisture content of the samples was determined by a sample method described by Pearson (1976) and James (1995). 2g of samples which was sliced up was placed in a pre-weighed moisture can. Then they were placed in an oven to dry at 65°C till brittle. The moisture can with the dried samples were transferred to desiccator to cool to room temperature before being weighed again. The moisture content of the samples was determined by the formula;

% Moisture = W2-W1×100/Weight of sample

Where;

W1 = weight of moisture can with sample before drying

W2 = weight of moisture can with dried sample

Determination of Ash

This was done by furnace incineration gravimetric method described by James (1995). 2g of powdered samples were measured into a previously weighed crucible. The samples were burnt to ash in a muffle furnace at 550°C and allowed to burn for 2-3 hours until the sample became grey ash. The sample in a crucible was carefully removed from the furnace (taking care not to allow air blow them away) and cooled in a desiccator and weighed. The weight of the ash obtained was calculated as a percentage of the weight of the sample analysed as shown below;

Where;

W1 = weight of empty crucible

W2 = weight of crucible + ash

Determination of Carbohydrate

The carbohydrate content was determined by algebraic calculation of the difference as the nitrogen free extractive (NFE), a method separately described by Pearson (1976) and James (1995).

% NFE = 100 - %(a + b + c + d + e)

Where;

a – Protein

b – Fat

c – Fibre

d – Ash

e – Moisture

Statistical Analysis

All data were analysed with Analysis of Variance (ANOVA) to test for significance. Means were separated using Duncan's New Multiple Range Test (DNMRT) at 5% level of probability using Statistical Analysis Software (SAS) package (SAS 1999).

Results

Qualitative Determination of Phytochemical Composition of Various Parts of *A. indica*

The results of the qualitative phytochemical analysis of different parts of *Azadirachta indica* showed the presence of alkaloid, saponin, steroid, flavonoid, tannin, hydrogen cyanide and terpenoid. Alkaloid was present in the fruit pulp, stem, stem bark and root and deeply present in the seed and root bark and very deeply present in leaf. Saponin was present in all parts. Steroid was deeply present in leaf and root bark and present in the fruit pulp, seed, root, stem and stem bark. Flavonoid was present in fruit pulp, leaf, stem, root, stem bark and root bark and deeply present in seed. Tannin was present in fruit pulp, seed, stem, stem bark, root and root bark and deeply present in leaf. Hydrogen cyanide (HCN) was deeply present in seed and leaf and present in fruit pulp, stem, stem bark, root and root bark. Terpenoid was present in all parts (Table 1).

Table 1: Photochemical present in different parts *A. indica*

Photochemical composition	Fruit Pulp	Seed	Leaf	Stem	Stem bark	Root	Root bark
Alkaloid	+	++	+++	+	+	+	++
Saponin	+	+	+	+	+	+	+
Steroid	+	+	++	+	+	+	++
Flavonoid	+	++	+	+	+	+	+
Tannin	+	+	++	+	+	+	+
Hydrogen cyanide	+	++	++	+	+	+	+
Terpenoid	+	+	+	+	+	+	+

Key: + -Present, ++ -Deeply present, +++ -Very deeply present

Quantitative Determination of Phytochemical Composition of Various Parts of *A. indica*

Quantitative phytochemical analysis of various parts of *Azadirachta indica* revealed that alkaloid contents of the leaf and root bark showed the highest and equal values (3.42± 3.45) respectively while steroid showed the lowest content in fruit pulp (0.15± 0.17) (Table 2).

Table 2: Percentage phytochemical composition of different parts of *A. Indica* (%)

Photochemical composition	Fruit Pulp	Seed	Leaf	Stem	Stem bark	Root	Root bark
Alkaloid	1.65±1.68	2.90±2.92	3.42±3.45	2.76±2.72	2.90±2.95	2.14±2.20	3.42±3.45
Saponin	1.34±1.36	1.96±1.92	1.89±1.86	2.28±2.30	2.54±2.60	2.40±2.42	2.48±2.60
Steroid	0.15±0.17	0.26±0.24	0.32±0.30	0.18±0.19	0.24±0.26	0.20±0.20	0.23±0.28
Flavonoid	1.34±1.36	2.34±2.37	1.43±1.48	1.89±1.92	2.65±2.68	2.13±2.19	2.75±2.80
Tannin	1.38±1.40	1.54±1.50	1.78±1.82	1.26±1.25	1.54±1.56	1.18±1.20	1.63±1.65
Hydrogen cyanide	1.48±1.50	1.83±1.90	3.45±3.60	0.76±0.75	0.74±0.76	0.53±0.60	0.80±0.85
Terpenoid	0.60±0.63	0.65±0.63	0.76±0.75	0.28±0.30	0.45±0.48	0.36±0.39	0.54±0.54

Results are in Mean ± Std.

Proximate Composition of Different Parts of *A. indica*

The proximate analysis of the various parts of the *A. indica* indicated that carbohydrate content of the fruit pulp recorded the highest value (65.52 ± 66.13) while the least was fat content of the root (0.42± 0.45) (Table 3).

Table 3: Mean proximate composition of different parts of *A. indica*

	% composition						
Constituents	Fruit Pulp	Seed	Leaf	Stem	Stem bark	Root	Root bark
Protein	15.43±14.64	16.70±16.72	18.30±18.16	6.83±6.90	7.32±7.40	7.42±7.50	8.36±8.30
Fibre	2.89±2.93	3.45±3.38	13.76±13.65	16.30±16.45	16.85±16.74	7.42±7.50	19.24±18.70
Ash	3.86±3.90	4.76±4.90	17.45±16.80	18.52±19.60	20.95±19.84	20.30±20.26	21.76±21.80

Moisture	10.54±10.60	10.16±10.20	11.45±11.42	9.45±9.20	8.95±8.90	8.76±8.90	9.30±9.24
Fat	1.76±1.80	4.60±5.12	1.58±1.53	0.75±0.73	0.65±0.68	0.42±0.45	0.48±0.50
Carbohydrate	65.52±66.13	60.33±59.68	37.46±38.54	48.15±47.12	45.28±46.44	55.68±55.39	40.86±41.46

Results are in Mean ± Std.

Discussion

The result of the study revealed the presence of alkaloid, tannin, terpenoid, steroid, hydrogen cyanide and flavonoid. The result showed that alkaloid content of the leaf and root bark had the highest values (3.42 ± 3.45) respectively while the least was steroid content of the fruit pulp (0.15 ± 0.17). Alkaloids are phytochemical compounds which are widely distributed in all vascular plants (Harborne, 1973). Alkaloids include morphine, cocaine, atropine, quinine and caffeine, most of which are used in medicine as analgesic or anaesthetic (Beckett and Stenlatic, 1988). They have potentials in management of several diseases like diabetes, Hodgkin's disease, childhood leukemia, malaria, rheumatism, laryngitis, dysmenorrhea and high blood pressure (Shibata, 2001).

Saponins are widely distributed and have been reported in over 70 plant families. They are active agent with soap-like properties (Dalziel, 1995). The search for plant saponin was stimulated by the need in source sapogenins, which can be converted to animal steroids in the laboratory, and which are to be used readily in treatment of certain diseases (Harborne, 1973). Some examples of such compounds include cortisone and the estrogenic contraceptive (Dubrosvsky, 2005). Tannins are naturally chemical constituents of plants and are known to be useful in wound healing (Trease and Evans, 1996) as astringents and antimicrobial (Lotito, 2006). Similarly, glycosides are used for treatment of heart diseases (Trease and Evans, 1996), cancer and sickle cell anaemia (Ghani, 1990) and for sanitary purpose in the body. The result also revealed the proximate nutrient composition of different parts of *A. indica*. Carbohydrate (65.52 ± 66.13) was the highest nutrient content found in the fruit pulp, while the least was fat (0.42 ± 0.45) which was found in the root. Carbohydrates are hydrolysed in the body to yield glucose which can be utilized immediately or stored as glycogen in the muscles and liver for future use (Raven *et al*., 1999). When carbohydrate is inadequate in the diet or during starvation, the body protein is utilized for energy (Raven *et al*., 1999). Fats are secondary plant products that yield more energy per gram than carbohydrates. Fats and oils help to regulate blood pressure (McDonald *et al*., 1998). Fibres are parts of fruits, grains and vegetables which can neither be digested nor absorbed by human system (Agarwal *et al*., 2001). They reduce the levels of plasma cholesterol and prevent colon cancer and cardiovascular disease

(Davidson *et al*., 1976). Proteins are important in the body for the production of hormones, enzymes and blood plasma systems. They are immune boosters and can help in cell division as well as growth (Okeke and Elekwa, 2006). Ash content of a plant based food is the function of the mineral elements present (Dutta, 2001). Dietary ash has proved helpful in establishing and maintaining acid-alkaline balance of the body system as well as in controlling hyperglycemic conditions (Trease and Evans, 1996).

Conclusion

This study has therefore established the fact that *A. indica* can be used as a source of useful drugs and food depending on the method of extraction and the process involved in its preparation. The findings of this study have revealed that *A. indica* possessed abundant phytochemicals and nutrient constituents in its parts which vary from one part of the plant to another.

References

Agarwal, A., Shen, H., Agarwal, S. and Rao, A.V. (2001). Lycopene content of tomato products: Its stability, bio availability and in vivo antioxidant properties. Journal of Medicinal Food, 4(1): 9-15.

Aja, P.M., Okaka, A.N., Onu, P.N., Ibiam, U.S. and Urako, A.J. (2010). Phytochemical composition of Talinum triangulare (water leaf). Pakistan Journal of Nutrition, 5: 166-168.

Akubugwo, I.E., Obasi, A.N. and Ginika, S.C. (2007). Nutritional potential of the leaves and seeds of black nightshade – Solanum nigrum L. Var virginicum from Afikpo, Nigeria. Pakistan Journal of Nutrition, 6: 323-326.

Almas, K. and Ansallafi, T.R. (1995). The natural toothbrush. World Health Forum, 6: 206-210.

Ame, I.O., Bakhiet, A. and Salah, E.I. (1995). Therapeutic utility constituents and toxicity of some medicinal plants. Veterinary and Human Toxicology, 37(3): 42-53.

Association of Official Analytical Chemists (1990). Official Methods of Analysis (15th ed.). Washington DC, USA. 122p.

Bajaj, S. and Srinivasan, B.P. (1999). Investigation into the anti-diabetic activity of Azadirachta indica. Indian Journal Pharmacol., 31: 138-141.

Beckett, A.A. and Stenlatic, J.B. (1988). Practical Pharmaceutical Chemistry II. Althane Press, London. 550p.

Dalziel, J.M. (1995). Useful Plants of Tropical West Africa. Crown Agents for Overseas Government, London. Pp. 362-371.

Davidson, S., Pasmore, R., Brock, J.F. and Truswell, A.S. (1976). Human Nutrition and Dietetics (6th ed.). Church Hill Livingstone, London. 342p.

Dubrosvsky, B.O. (2005). Steroids, neuroactive, steroids in Psychopathology. Progress in Neuropsychopharmacology and Biological Psychiatry, 29: 169-192.

Dutta, A.C. (2001). Botany for Degree Students (6th ed.). Oxford University Press, New Delhi. 708p.

El-Mahmood, A.M., Ogbonna, O.B. and Raji, M. (2010). The antibacterial activity of Azadirachta indica (Neem) associated with ear and eye infections. Journal of Medicinal Plant Research, 14: 1414-1421.

Ghani, A. (1990). Introduction to Pharmacognosy (2nd ed.). Oxford University Press, New York. 372p.

Harborne, J.B. (1973). Phytochemical Methods. A guide to modern technique in plant analysis. Chapman and Hall, New York. 278p.

James, C.S. (1995). Analytical Chemistry of Foods. Chapman and Hall, New York. Pp. 10-57.

Lotito, S. B. (2006). Consumption of flavonoid rich foods and increased antioxidant capacity in humans: causes, consequences or epiphenomenon? Free Radical Biology and Medicine, 41 (12): 1727-1746.

Mbaka, G.O., Adeyemi, O.O. and Oremosu, A.A. (2010). Acute and sub chronic toxicity studies of the ethanol extract of the leaves of Sphenocentrum jollyanum (Menispermaceae). Agricultural and Biological Journal of Nutrition, 1(13): 265-272.

Mc Donald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (1998). Animal Nutrition (5th ed.). Longman, London. 607p.

Mishra, M., Neema, N. And Poonam, P. (2013). Antibacterial effects of crude extracts of Azadirachta indica against Escherichia coli and Staphylococcus aureus. International Journal of Science, Environment and Technology, 2(5): 989-993.

Ogbuewu, I.P. (2011). The growing importance of Neem. Research Journal of Medicinal Plant, 5(3): 230-245.

Okeke, C.U. and Elekwa, I. (2006). Proximate and preliminary phytochemical analyses of Avocado pea, Persia gratissima Gaertn. (Family Lauraceae). Nigerian Journal of Botany, 19(1): 156-162.

Pearson, D. (1976). Laboratory Technique in Food Analysis (1st ed.). Butterworth, London. 523p.

Raven. P.M., Johnson, G.B. and Maidson, W.I. (1999). Biology (2nd ed.). Mc-Graw Hill, London. 1567p.

Said, O., Khalil, K., Fulder, S. and Azaizeh, H. (2005). Ethnobotanical survey of medicinal herbs of the middle Eastern region. Journal of Ethnopharmacology, 83: 251-265.

Shibata, S. (2001). Chemistry and Cancer Preventing Activities of Saponin and some Related Triterpenoids Compounds. Korean Medical Science Press. 430p.

Sofowora, A. (1993). Medicinal Plants and Traditional Medicine in Africa (2nd ed.). Spectrum Books Limited, Ibadan, Nigeria. 289p.

Trease, G.E. and Evans, W.C. (1996). A Text Book of Pharmacology (14th ed.). Bailliere Tindall Limited, London. 421p.