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Chemical Characteristics of Some Underutilized Leafy Vegetables

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Abstract

The chemical and nutrient composition of six neglected leafy vegetables; *Cnidoscolus aconitifolius* (Miller) I. M. Johnson, *Crassocephalum crepidiodes* (Benth) S. Moore, *Diplazium sammatii* (Kuhn) C. Chr., *Laportea ovalfolia* (Schumach.) Chew, *Lippia multiflora* Moldenke, and *Tetrogonia expansa* Murr. were investigated. *Cnidoscolus aconitifolius* contained the highest alkaloid (4.39 ± 0.03%) whereas *Tetragonia expansa* contained the least (0.25 ± 0.03%). Averagely the phytochemical content ranges from 0.69 ± 0.03% to 4.39 ±0.03% for alkaloids, 0.79 ± 0.02% to 4.07 ± 0.2% for saponins, 0.93 ± 0.1% to 3.07 ± 0.1% for flavonoids, 0.46 ± 0.0001% to 0.19 ± 0.0001% for Tannins, 0.24 ± 0.002% to 0.11 ± 0.001% for phenol, 6.64 ± 0.1% to 13.69 ± 0.03% for HCN and 0.09 ± 0.01% to 0.1 ± 0.01% for oxalates. The mineral and vitamin contents were also investigated and it was realized that *Cnidoscolus aconitifolus* and *Tetragonia expansa* were quite high in vitamin C. The results show that the vegetables have potential nutritional value and can also be used as raw material in the pharmaceuticals.

Introduction

The leafy green vegetables include a wide and diverse array of vegetables of which the majority have not been reported in literatures or researched on. The noun; vegetable usually means an "edible plant or part of a plant other than a sweet fruit or seeds" that is the leaf or root of a plant. The nutritional content of vegetables varies considerably, though generally they contain little protein or fat and varying proportion of vitamins, pro-vitamins, dietary minerals, fiber and carbohydrate. They contain a great deal of other phytochemicals, some of which have been claimed to have anti-oxidant, anti-bacterial, anti-fungal, anti-viral and anti-carcinogenic properties. They often also contain toxins and anti-nutrients such as α-solanine, α-chasonine, enzyme inhibitors (of cholinesterase, protease, amylase etc), cyanide and cyanide precursors, oxalic acid and more (Ifon and Bassir, 1979). Leafy vegetables contain fiber which is soluble or insoluble, increase colon transit time of food residue and helps to form bulk of stool, absorb toxins and provide an ideal environment for growth of good bacteria. Depending on the concentration, such compounds may reduce the edibility, nutritional value, and health benefits of dietary vegetables. Cooking and other processing may be necessary to eliminate or reduce them. Some of these vegetables that are considered rare and nutritious include:

Diplazium sammatii looks like a fern but in the family Athyraceae. It is referred to as "Nyama idim" in the Ibibio language of Southern Nigeria translated as "the shining brightness of the stream", and also as "Nyama" by the Oboro people of Ikwuano Local Government Area, Abia State of Nigeria. It grows profusely on the banks of village streams. Increased pollution of streams by massive migration of rural dwellers to urban areas has increased the rate of extinction of *D. sammatii*. According to Haynes (1975), various parts of the ferns saprophytes have been and are being eaten by various people throughout the world.

Tetrogonia expansa is in the family *Aizoacaeae* and is commonly known as New Zealand spinach but referred to as "Okorobum" by Amakama people of Umuahia South L.G.A., and "Ojungu" by Ngwa people all in Abia State of Nigeria. Its synonym is *Tetragonia tetragonoides*.

Cnidoscolus aconitifolius in the family *Euphorbiaceae* is commonly called "Hospital is too far". It has succulent stem which exude a milky sap when cut and it is a good source of anti-oxidants. In the binomial system *Cnidoscolus aconitifolius*; the generic name comes from the Greek word "Knido" meaning needle and "scolus" meaning thorn and the specific name means that the leaves (folius) like aconitum.

Laportea ovalifolia is in the family Urticaceae and it is commonly called "Akuwa" or "Akugba" within the Ibo's in the Eastern part of Nigeria. It is widespread in tropical Africa and rare further south. It has synonyms such as *Fleurya podocarpa* and *Fleurya ovalifolia* (Schumach).

Crassocephalum crepidioides in the family Asteraceae (compositae) is commonly known as "Ichoku" by Enugu people and it has a synonym known as *Gynura crepidioides*. It occurs throughout tropical Africa and the extracts show moderate anti-mutagenic activity in *Salmonella typhimurium*.

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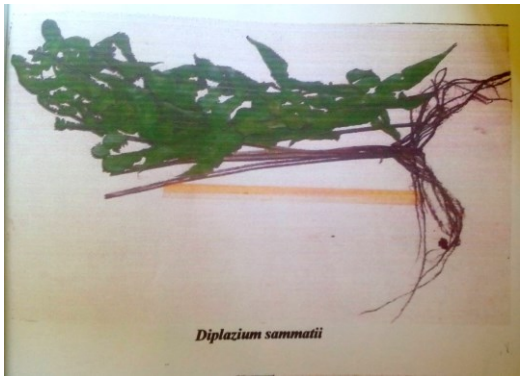
Lippia multiflora is in the family Verbenaceae and it is called tea bush or Gambian tea bush. The plant is often grown in villages for its useful attributes. The leaves are aromatic; thyme- scented and is the most valuable part of the plant (Burkill, 2000).

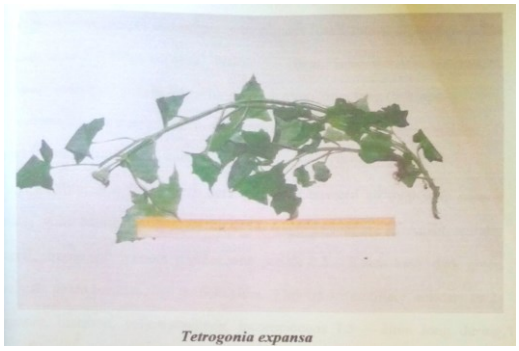


Diplazium sammatii

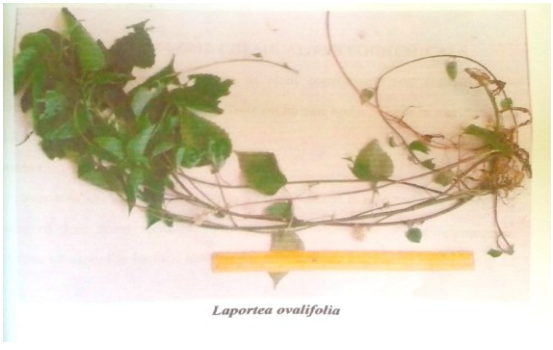
Cnidoscolus aconitifolius

Crassocephalum crepidioides

Lippie multiflora



Tetrogonia expansa



Laportea ovalifolia

Materials and Methods

Collection and Identification of Plant Materials

The vegetables used were collected in different locations in the eastern part of Nigeria. *Diplazium sammatii* was collected at a river bank in Oboro village, Ikwuano Local Government Area, *Cnidoscolus aconitifolis* and *Laportea ovalifolia* were also collected in the villages within Ikwuano Local Government area, *Tetragonia expansa* was collected in Amakama village, Umuahia South L.G.A. all in Abia State. *Lippa multifloraa* and *Crassocephallum biafre* were collected within Enugu state. They were all identified using appropriate

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literatures (Burkill (1984; 1994; 2000; Lemmens and Oyens, 2004; Akobundu and Agyakwa, 1987).

Quantitative determination of the Chemical Constituents
Phenol Determination

The phenol content was determined by the method of the Association of Official Analytical Chemists (AOAC, 1990). 0.2g of the sample was treated with 10 ml concentrated methanol to extract the phenol and filtrate. This was mixed for 30 minutes at room temperature. The mixture was centrifuged at 500 rpm for 15 minutes and the supernatant was used for the analysis. 1 ml portion of the extant from each sample was treated with equal volume of folin-ciocalteu's reagent followed by the addition of 2 ml of 2 % Na_2Co_3 solution, meanwhile the standard phenol solution was prepared and diluted to a desired concentration. 1 ml of the standard solution was also treated with F-D reagent and Na_2Co_3 solution. The intensity of the resulting blue coloration was in a spectrophotometer at 560 nm wavelength. Measurements were made with a reagent blank at zero. The phenol content was calculated and expressed in percentage.

Determination of Alkaloid

The alkaloid content was determined by the alkaline precipitation method described by (Harbone, 1973). 5g of the processed sample was dispensed in 100 ml of 10 % acetic acid in ethanol solution. The mixture was shacked well and allowed to stand for 4 hours at room temperature. After which the mixture was filtered through Whatman no 42 grade of filter paper. The extract was treated with drop-wise addition of concentrated NH_3 solution to precipitate the alkaloid. The dilution was done until NH_3 was in excess.

The alkaloid precipitate was removed by filtration using weighed Whatman no 42 filter papers. After washing with 1% NH_4OH solution, the precipitate in the filter paper was dried at 60°C and weighed after cooling in a desiccator. The percentage alkaloid content was calculated.

Determination of Saponin

Determination of saponin was done using double solvent extraction gravimetric method. 5.0 g of the processed sample was mixed with 50 ml of 20 % aqueous ethanol solution and incubated for 12 hours at a temperature of 55°C with constant agitation. The mixture was then filtered through Whatman No 42 grade of filter paper. The residue was re-extracted with 50 ml of the ethanol solution for 30 minutes and extract weighed together.

The combine extract was reduced to about 40 ml by evaporation and then transferred to a separating funnel and equal volume (40 ml) of dimethyl/ether was added to it. After mixing well; the partition and the other layer with the ether, its pH was reduced to 4.5 with drop-wise addition of dilute NaoH solution. Saponin in the extract was taken up in successive extraction with 60ml and 30ml (PPT) was washed with 5% Nacl solution and evaporated to dryness in a previously weighed evaporation dish. The saponin was then dried in the oven at 60° C (to remove any residual solvent) cooled in a desiccator and re-weighed. The saponin content was determined and expressed in percentage.

Tannin Determination

Tannin content of the sample was determined by Folin Denis colometric method (Kirk and Sawyer, 1998). 5 g of the processed sample was mixed with distilled water in the ratio or 1:10. The mixture was shacked for 30 minutes at room temperature and filtered to obtain the extract. A standard tannic acid solution and equal volume of distilled water were dispensed into a separated 50 ml volumetric flasks to serve as standard and reagent blank respectively. Then 2 ml of each of the sample extracts was placed in their respective labeled flask.

The content of each flask was mixed with 35 ml distilled water and 1 ml of the Folin Denis reagent was added to each. This was followed by 2.5 ml of the saturated mixture to the Na_2Co_3 solution. Thereafter, each flask was diluted to the 50 ml mark with distilled water and incubated for 90 minutes at room temperature. Their absorbance was measured at 760 nm in a spectrophotometer with the reagent blank at zero. The tannin content was found and calculated in percentage.

Flavonoid Determination

Flavonoid was determined using the acid hydrolysis gravimetric method (Harbone, 1973). 5gm of the processed sample was boiled in 100 ml filter paper. The weight was obtained after drying in the oven and cooling in a desiccator. The weight was expressed as a percentage of the weight analyzed.

Determination of Oxalate

According to Onwuka (2005), 2gm of the processed sample was added to 100 ml of water and 10 ml of 6m HCl solution. The mixture was boiled for one hour on a steam bath and was allowed to cool and filtered. Methyl orange was added (few drops) and ammonia was added until faint yellow colour was obtained. This was heated to near boiling, cooled and filtered. The filtrate was heated and allowed to cool before the addition of 10 ml of 5 % $CaCl_3$ solution. It was allowed to stand overnight at room temperature. This was centrifuged the next day at 2500 mg for 5 minutes. The supernatant was decanted and the precipitate was dissolved in 10 ml of 20 % H_2SO_4 solution. This was heated to near boiling and titrated against 0.05 ml $kMnO_4$ to a pink colour which last only for 30 seconds.

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Determination of Hydrogen Cyanide (HCN)

This was determined by alkaline picrate colorimeter method described by Balogopalin *et al*., (1988). 1.0 g of the sample was dispersed in 50 ml of distilled water in a 25 ml conical flask. An alkaline picrate paper was hung over the sample mixture and the blank in their respective flasks. The set-up was incubated overnight and each picrate paper was eluted or dipped into 60 ml distilled water. A standard cyanide solution was prepared and diluted to a required concentration. The absorbance of the eluted sample solution of the stand was measured spectrophotometrically at 540 nm wavelength with the reagent blank at zero. The cyanide content was determined in mg/kg

Proximate Analysis

Moisture Determination

This was done by the use of gravimetric method (AOAC, 1990). A measured weight of the sample (5.0 g) was weighed into a previously weighed moisture can. The sample in the can was dried in the oven at 105°C for 3 hours. It was then returned to the oven for further drying. Drying, cooling and weighing were done repeatedly at 1 hour interval until there were no further diminutions in the weight; that is constant weight was obtained. The weight of the moisture lost was calculated and expressed as a percentage of the weight of sample analyzed.

Determination of Crude Fibre

5 g of the processed sample was boiled in 150 ml of 1.25 % H_2SO_4 solution for 30 minutes under reflux. The boiled sample was washed in several portion of hot water using a two-fold muslin cloth to trap the particles. It was turned back to the flask and boiled again in 150 ml of 1.25 % NaOH for another 30 minutes under same condition. After washing in several portion of hot water, the sample was allowed to drain dry before being transferred quantitatively to a weighed crucible where it was dried in the oven at 105° C to a constant weight. It was transferred into the muffle furnace and ashed for about 2 hours until a whitish grey colour was obtained. It was transferred with a forceps into a dessicator to cool. Amount of fibre in the sample is the loss in weight during incineraton.

Determination of Ash

5g of the processed sample was measured into a previously weighed porcelain crucible. The crucible was then closed and put in a gollen hemp muffle furnace at 550° C. After 2 hours, the furnace was allowed to cool. The crucible was then transferred into a desiccator and allowed to cool before weighing. The ash content was found and expressed in percentage.

Determination of Fat

5g of the sample was wrapped in a porous paper and put in thimble. The thimble was placed in a soxhlet reflux flask and mounted into a weighed extraction flask containing 200ml of petroleum ether. The upper end of the reflux flask was connected to a water condenser. The solvent was heated; it boiled, vapourized and condensed into the reflux flask.

Determination of Protein

This was done by the Kjeldahl method described by Jones (1991). The total N_2 was determined and multiplied with factors 6.25 to obtain their protein content.

Procedure

0.5 g of the sample was mixed with 10ml of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added to it before it was heated under a fume cupboard until a clear solution was obtained. The digest was diluted to 100 ml in a volumetric flask and used for the analysis.

10 ml of the digest was mixed with equal volume of 45 % NaoH solution in a Kjedahl distillation apparatus. The mixture was distilled into 10 ml of 4 % buric acid containing 3 drops of mixed indicator (bromocressol/green/methyl red). A total of 50 ml of distillates was collected and titrated against 0.02 NH_2SO_4. The protein content was determined and calculated in percentage.

Determination of Carbohydrate

It was calculated using the formula below described by James (1995).
% carbohydrate= 100 - % (protein + fat + fibre + ash + moisture content).

Determination of Phosphorus

Phosphorus in the test sample was determined by the molybdo vanadate colorimetric method (James, 1995). A measured volume of the dry ash (5.0 g) digest of the sample was dispensed into 50 ml volumetric flask. The same volume of distilled water and standard P solution was measured into different flask to serve as reagent blank and standard respectively. 2 ml of the phosphorus colour reagent (molybdo vanadate solution) was added to each of the flask and allowed to stand at room temperature for 15 minutes. The content of each flask was diluted to the 50ml mark with distilled water and its absorbance was measured in a spectrometer at a wavelength of 540 nm with the reagent blank at zero. The phosphorus content was found and calculated in mg/ 100g.

Determination of Sodium and Potassium by Flame Photometry

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The instrument, Jaway digital flame photometer was set up according to the manufacturer's instruction. It was switched on and allowed for about 10 to 15 minutes to equilibrate. Meanwhile standard sodium and potassium solution were prepared separately and diluted in series to contain 10,8,6,4, and 2 ppm of Na (sodium) and K (potassium) respectively. After calibrating the instrument, 1 ml of each standard was aspirated into it and sprayed over the non-luminous flame. The optical density of the resulting emission from each standard solution was recorded. Before flaming, the appropriate element filter was put in place with the standards measured. The test sample extracts were measured in time and they were plotted into standard curve which was used to extrapolate the content of each test element and calculated in mg/100g.

Determination of Vitamins

The determination of vitamin A, C, and E in the sample was done using the method of the association of vitamin chemist as described by Kirk and Sawyer (1998).

Determination of Vitamin A

The method of the association of vitamin chemist (Kirk and Sawyer, 1998) was employed. A measured weight (5 g) of the processed sample was dispersed in 30 ml of 5 % KOH solution and boiled under reflux for 30 minutes. After cooling rapidly in running water, 30 ml of distilled water was added to it and mixture was transferred into a separation funnel. Three portions of 50 ml of ether was used to wash the mixture thus extracting the vitamin A, the lower layer (aqueous) was discarded while the vitamin A extract was washed with 50 ml distilled water. Care was taken to avoid formation of emulsion. The extract was then evaporated to dryness and dissolved in 10 ml of isopropyl alcohol and its absorbance of the vitamin A extract was also measured at 325 nm. The vitamin A content was calculated in mg/ 100g.

Determination of Vitamin C

5 g of the sample was dispensed in 50 ml of EDTA/TCA solution and homogenized. The homogenate was filtered with Whitman no 42 filter paper and more of the extractant were used to wash the residue in the filter paper until 50 ml filtrate was obtained. A 20 ml portion of the filtrate was measured into conical flask and 10 ml of 30 % potassium solution was added to it, mixed well and then followed by 1 % starch solution. The mixture was titrated against 0.01 M $CuSO_4$ solutions. A reagent blank was also titrated. The vitamin C content was calculated based on the relationship that 1 ml 0.01 M $CuSO_4$ = 0.88 mg vitamin C.

Results and Discussion

Results of laboratory analysis of the six uncommon vegetables are shown in Tables 1-6 below. Tables 1 show the phytochemical (mostly anti-nutrients) contents while Tables 2 show the proximate composition. Table 3 and 4 show the mineral and vitamin compositions respectively.

Table- 1: Phytochemical content of the six species of neglected vegetables

Sample	*% Alkaloid*	*% Saponin*	*% Flavonoid*	*% Tannins*	*% Phenol*	*HCN mg/kg*	*% Oxalate*
L. ovalifolia	1.18±0.1	0.72±0.02	1.16±0.02	0.24±0.001	0.18±0.002	9.64±0.1	0.09±0.01
C. aconitifolius	4.39±0.03	0.79±0.02	3.07±0.1	0.42±0.002	0.23±0.002	13.69±0.03	0.038±0.01
L. multiflora	2.15±0.04	4.07±0.2	0.93±0.1	0.35±0.001	0.11±0.001	11.59±0.1	0.041±0.01
C. crepidioides	0.69±0.03	0.43±0.02	0.25±0.01	0.46±0.001	0.19±0.01	7.20±0.03	0.052±0.01
T. expansa	0.25±0.03	0.27±0.02	0.17±0.01	0.19±0.001	0.11±0.003	6.64±0.1	0.053±0.01
D. sammatii	0.43±0.03	0.64±0.1	0.41±0.02	0.38±0.002	0.24±0.002	9.08±0.1	0.10±0.01

The results as shown in the table above reveal that the test vegetable samples contain the major phytochemicals of importance. The results show that *C. aconitifolius* has the highest alkaloid content (4.39±0.03%) while the *T. expansa* had the least (0.25±0.03%). Alkaloids are secondary plant metabolites that have wide applications in medicine. Harbone (1973) observed that the wide use of alkaloids in medicine stems from their ability to cause wide range of physiological activity when consumed. Most alkaloids are however toxic and are thus considered to be antinutrients.

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Table- II: Proximate composition of the six species of neglected vegetables

Sample	% Protein	% Fat	% Fibre	% Ash	% CHO	% MC	% Dry Matter
L. ovalifolia	7.76±0.1	5.45±0.03	21.03±0.1	12.61±0.03	53.15±0.02	74.33±0.1	25.67±0.1
C. aconitifolius	12.02±0.1	7.19±0.03	13.69±0.04	14.09±0.1	53.28±0.3	85.26±0.1	14.74±0.1
L. multiflora	13.83±0.2	5.89±0.03	26.01±0.21	12.49±0.03	41.80±0.1	86.94±0.04	13.06±0.04
C. crepidioides	8.52±0.1	6.76±0.1	16.51±0.20	8.09±0.1	60.11±0.1	63.14±1.1	36.86±1.1
T. expansa	5.72±0.1	4.01±0.1	13.88±0.04	11.69±1.0	64.70±1.0	92.47±0.03	7.53±0.03
D. sammatii	13.42±0.1	5.22±0.1	32.66±0.7	9.66±0.10	39.04±1.0	56.91±1.1	43.09±1.1

Table- II: Minerals

Sample	Phosphorus	Calcium	Magnesium	Potassium
L. ovalifolia	367.88 ± 0.24	37.43 ± 2.3	36.48 ± 1.4	285.10 ± 0.23
C. *aconitifolius*	289.65 ± 0.29	25.40 ± 2.3	83.20 ± 2.8	319.00 ± 0.47
L. multiflora	331.56 ± 0.47	55.40 ± 2.3	25.60 ± 1.4	198.80 ± 0.40
C. crepidioides	341.76 ± 0.41	61.50 ± 2.3	20.00 ± 1.4	266.00 ± 0.40
T. expansa	206.12 ± 0.41	14.69 ± 2.3	12.80 ± 1.4	138.00 ± 0.28
D. sammatii	412.92 ± 0.24	27.10 ± 2.3	29.60 ± 1.4	257.07 ± 0.23

Table -IV: Vitamins

Sample	Riboflavin	Vit A IU/100g	Niacin Mg/100g	Thiamine Mg/100g	Vit C Mg/100g
L. ovalifolia	0.236 ± 0.011	-	0.540 ± 0.005	0.142 ± 0.0	13.49 ± 1.02
C. aconitifolius	0.383 ± 0.01	14.46 ± 0.31	2.102 ± 0.010	0.251 ± 0.002	90.35 ± 1.02
L. multiflora	0.131 ± 0.005	-	0.362 ± 0.01	0.109 ± 0.003	15.25 ± 1.02
C. crepidioides	0.131 ± 0.005	-	0.241 ± 0.005	0.129 ± 0.003	20.53 ± 1.02
T. expansa	0.261 ± 0.010	3.48 ± 0.18	0.346 ± 0.010	0.163 ± 0.002	48.11 ± 1.02
D. sammatii	0.136 ± 0.011	4.51 ± 0.17	0.213 ± 0.011	0.091 ± 0.003	11.15 ± 1.02

The vegetables were also found to contain HCN – a hydrolyte of cyanogenic glycoside which is established to be toxic to man and animals. Again comparatively, *C. aconitifolius* has the highest HCN content of 13.69±0.03 mg/kg while *T. expansa* contained the least 6.64±0.1 mg/kg. Notwithstanding the presence of this toxic principle, the level in the vegetables

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was far below the critical dose for man. Onwuka, (2007) reported that HCN in foods are considered lethal at doses of 50 – 60 mg/kg.

Flavonoids are present in all the six (6) vegetables analyzed, *C. aconitifolius* has the highest content of (3.07 ± 0.1 %) while *T. expansa* contained the least (0.17 ± 0.01 %). Flavonoids are not antinutrient per se. Flavonoids are reported to be strong antioxidants and as such can protect consumer from oxidative cell destruction. The above imply that the plants studied have potentials for use in nutritional therapies. Tannins are phenolic compounds and are present in all samples but to varying degrees. The highest concentration of tannin was found in *C. crepidioides* (0.46 %) while the least was found in *T. expansa* (0.19 %).

Similarly, phenols had the highest concentration in *D. sammatii* (0.24 %) while *L multiflora* and *T expansa* contained the least (0.11 %) each. Phenols are used extensively in antiseptic and disinfectants and are known to possess strong antibiotic potential. Although present in very low concentrations, oxalate was found in the vegetables. *D sammatii* contained the highest concentration of 0.1 % while *C. aconitifolus* contained the least 0.038 %. Oxalates, like phytates, are anti-nutrients which interfere with the solubility and absorption of nutritional minerals in the body.

Generally, the test vegetables have been found to contain phytochemicals which are of nutritional as well as pharmaceuticals relevance.

Nutritional (Proximate)

The vegetables were found to contain mainly water with moisture content on fresh basis which ranged from 56.91 ± 1.1% in *D. sammatii* to 92.47 ± 0.03% in *T. expansa*. The high moisture content of these vegetables agrees with the findings of previous workers. It was reported that moisture content of 80% and above in many vegetables including *Amaranthus* species, *Talinium* spp and *Hibiscus* spp.
Expectedly, the vegetables are rich in fibre which makes for good bowel movement as well as aid in digestion process. The leaves were found to be rich in ash. Lienel (2002) observed that ash content is an important tool in evaluating nutritional quality of foods since it indicates the general mineral content of foods. The protein and fat contents were found to be low. The fat content, determined as ether extract, ranged from 4.01% in *T. expansa* to 7.19% in *C. aconitifolius* while the protein content ranged from 5.72% in *T. expansa* to 13.83% in *L. multiflora*. All the vegetables are rich in carbohydrate ranging from 39.04% in *D. sammatii* to 64.70% in *T. expansa*. It was therefore observed that the vegetables contain primary food constituents (protein, fat, carbohydrate, etc) similar to those of the popular conventional vegetables like *Telferia occidentalis* (Ugu) and *Pterocarpus spp* (Oha).

The mineral content of the six (6) uncommon vegetables are shown in table II above. All the vegetables were found to be rich in phosphorus and potassium as well as contain moderate quantity of calcium and magnesium. The phosphorus content ranged from 206.12 ± 0.41 mg/100g in *T. expansa* to 412.92 ± 0.24 mg/100g in *D. sammatii*. The high phosphorus content is nutritionally beneficial. The potassium content which ranged from 138.00 ± 0.28 mg/ 100g in *T. expansa* to 319.00 ± 0.47 mg/100g in *C. aconitifolius*, is high enough. Both phosphorus and potassium are important as they play vital roles in the reputation of body internal environment. On the other hand, calcium content which is relatively lower at a range of 14.69 ± 2.3 mg/100g in *T. expansa* to 61.5 ± 2.3 mg/100g in *C. crepidioides* is nevertheless an important supplement source. Calcium is important in the development and maintenance of bones and teeth.

The result on vitamin content of the vegetable, as shown in table IV above, reveal that most of the vegetables lack vitamin A while those that contain the vitamin had relatively low concentration. The absence of vitamin A (as well as the low level content) was attributed to the equally very low fat (oil) content of the vegetables. Vitamin A is an oil soluble vitamin and does not thrive well in high moisture environment due to its hydrophobic nature. However *C. aconitifolius* contain up to 14 IU/100g while *T. expansa* and *D. sammatii* contain 3.48 and 4.51 IU/100g respectively. In contract, the vegetables contain the water soluble vitamins such as Niacin, Riboflavin and Thiamine as well as ascorbic acid (Vitamin C). *C aconitifolius* and *T expansa* were quite rich in Vitamin C containing 90.35 ± 1.02 and 48.11 ± 1.02 mg/100g respectively. The vegetables represent good sources of these vitamins which together play very important role in overall nutrition of humans and animals.

Conclusion and Recommendation

In conclusion, findings from this work show that the vegetables, though uncommon and unpopular amongst the people, nevertheless are rich nutritionally. The test vegetables were found to contain high fibre, carbohydrate and moisture in addition to appreciable level of fats and protein. Their ash contents were generally high; there were also high moisture, phosphorus and potassium contents.

Also, the phytochemical composition of the vegetables reveals the presence of substances with established medicinal values like flavonoids, alkaloids, phenols, etc. However, some constituents like HCN, tannins, and oxalates were found present in the vegetables. But the levels of these antinutrients were well below critical level and therefore should not be of real concern generally. Besides, these vegetables are not eaten raw traditionally and it was believed that normal food processing techniques like boiling may reduce the levels fitter or even eliminate them completely as reported by previous workers (Arntfield *et al*., 1985). It was therefore

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recommended that the consumption of these uncommon vegetables should be encouraged while the possibility of growing them in organized domestic farms should not be ruled out. This will not only encourage their utilization but also enhance their conversation to escape going extinct.

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