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Nutritional and Bioactive Potentials of an Underutilized Vegetable—*Vitex doniana*

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Abstract

The use of lesser-known plant foods in addressing nutritional deficiencies is gaining popularity particularly in developing countries where malnutrition is endemic. This study investigated the proximate, minerals, vitamins, amino acids, tannins, phenolic acids, alkaloids, caratenoids, phytosterols and glycosides composition of the leaves of *Vitex doniana* using AOAC and gaschromatographic methods. The leaves had high (g/100g) fiber (14.67 - 35.39) and protein (15.46 - 37.30); but poor in lipid (0.80 - 1.93) and carbohydrates (4.02 - 9.70) corresponding to 58.68% - 141.56%, 30.92% - 74.60%, 1.23% - 2.97% and 1.34% - 3.23% daily value. The protein had relatively high level of essential amino acids (40.94). The leaves were rich in vitamins A, C and E; mineral elements, iron, copper, manganese and cobalt. Tannic acid constituted 100% of the tannins; ferulic acid (46.99%) for phenolic compounds; viticin (99.96%) of total alkaloids; lutein (35.62%) for carotenoids; vanillic acid (49.78%) and sitosterol (61.6%) for phytosterols while the most abundant of the glycocides was agnuside (72.64%) in the leaves. This result indicated that *Vitex doniana* leaves are a good source of nutrients and bioactive compounds for better nutrition and general wellbeing.

Keywords

Proximate, Phytochemicals, Leaves, Nutrition, General Wellbeing

1. Introduction

In many African countries the fight against malnutrition and under-nourishment continues to be a basic goal of development and variety of strategies is being applied. Strategies based on nutrient-rich foods like vegetables are considered es-

sential. Vegetables are characterized by high nutritient density with low energy input and contain a variety of nutrients and phytochemicals that make them an important part of the basic diet [1]. Vegetables, especially leafy vegetables are useful source of vitamins, minerals, fibers, and some essential amino acids [2] [3] [4]. Fiber, although not digested, serves a useful purpose in the intestine as roughages, thus promoting normal elimination of waste products. The previous notion that vegetables could only provide several vitamins, minerals essential for human health has been overcome by the assessment that they provide also hundreds of phytochemicals, a heterogeneous group of secondary metabolites with biological activity, they include terpenoids, phenolics, alkaloids, glucosinolates, saponins, allicins [5] [6] [7] These metabolites play vital roles in the human system which include; scavenging oxidative agents, stimulation of the immune system, hormone metabolism, antibacterial and antiviral effects. This work analyzed the nutritional and some bioactive compounds in *Vitex doniana*, an underutilized vegetable with a view of encouraging its use for good nutrition.

2. Materials and Methods

2.1. Collection of Plant Samples

The leaves of *Vitex doniana* used for this study were harvested fresh in the month of January from a farm land at Isulo in Orumba South Local Government Area of Anambra State, South East Nigeria. They were identified and prepared as reported by Ifeanacho *et al.* [7].

2.2. Determination of Nutrient Profile

2.2.1. Determination of Proximate Components

The proximate components were determined in triplicates. The moisture content was determined by AOAC Official Method 967.03 [8], ash by AOAC Official Method 942.05 [8], total lipid by AOAC Official Method 920.39 [8], fibre by AOAC Official Method 973.18 [8], and crude protein (% total nitrogen × 6.25) by AOAC Official Method 2001.11 [8]. Carbohydrate was determined by difference (*i.e.* by subtracting the sum of all the other components from 100 g). The caloric values were calculated with the Atwater factors 4, 9 and 4 for protein, fat and carbohydrate respectively [9].

2.2.2. Determination of Vitamin Profile

The vitamin profiles were analysed by a combination of AOAC official methods 992.03, 992.04 and 992.26 [8]. Chromatographic conditions were similar to that reported by Ikewuchi *et al.* [6], except for the use of HP5 column, and compressed air pressure of 241.32 kPa.

2.2.3. Determination of Mineral Elements

Analysis of the mineral elements was carried out according to FAO fertilizer and plant nutrition bulletin 19 [10]. Phosphorus was determined by vanadium molybdate method [10].

2.2.4. Determination of Percent Daily Value

By comparing to daily values [11], per cent daily values were calculated, as follows:

$$\text{Percent daily value}\,(\%) = \frac{\text{Weight of the particular nutrient in 100 g of sample}}{\text{Daily Value}} \times 100$$

2.2.5. Aminoacid Analysis

The extraction and analysis were carried out following the methods of AOAC Method 982.30 (a, b, c) [8] [12]. The gaschromatograph was fitted with a pulse flamephotometric detector. A split injection (splitratio: 20:1) was adopted, with hydrogen as carrier gas, at flow rate of 1.0 mL/min. AnEZ column (10 m × 0.2 mmi.d. × 0.25 μm film thickness), was used. The inlet and detector temperatures were 250 and 320˚C. The hydrogen and compressed air pressure were 137.90 and 241.32 kPa. The oven was programmed initially at 110˚C, ramped at 7˚C/min to 320˚C; and kept at 320˚C for 5 min.

2.2.6. Evaluating Digestible Indispensable Aminoacid (DIAA) Reference Ratio and DIAA Score

The digestible indispensable aminoacid (DIAA) (IAA) in the test proteins were determined by comparing their aminoacid composition, with WHO reference protein patterns [13], according to the following equation:

$$\text{DIAAS}(\%) = \frac{\left[\text{mg of digestible dietary IAA in 1 g of the dietary test protein}\right]}{\left[\text{mg of the same amino acid in 1 g of the reference protein}\right]} \times 100$$

The DIAA with the least DIAA reference ratio became the limiting amino acid while its ratio was converted to percentage to get the digestible IAA score (DIAAS) (13).

2.3. Evaluation of Phytochemical Profile

2.3.1. General Procedures

The preparation of the standard solutions, as well as the identification and quantification of the component compounds were as earlier reported by Ikewuchi *et al.* [6].

2.3.2. Determinationglycosides, Alkaloids, Carotenoids, Tannins, Phenols and Phytosterols Compositions

The glycosides, alkaloids, carotenoids, tannins, phenols, phytosterols were extracted according to [8] [14] [15] [16] [17] [18] methods respectively. The extracts were subjected to gas chromatography under similar conditions as reported by Ikewuchi *et al.* [6].

2.4. Data Analysis

The experimental results were expressed as means of triplicate determination.

3. Results and Discussion

Table 1 shows the nutrient values of the *Vitex doniana* leaves (g/100g). The leaves were high in protein (15.46 ± 0.01 - 37.30) and fibre (14.67 - 35.39), moderate in ash (6.50 - 15.68) and low in fat (0.8.62 - 1.93), carbohydrate (4.02 - 9.70) and calorie (60.13 - 205.36). Their moisture content (58.55) is low when compared to cocoyam leaf, *Tridaxprocumbens linn* [19], (*Colocasia escculanta*) [20] *and Pandiaka heudelotii* [6]. However, [21] reported higher moisture content in some vegetables like okra leaf (*Abelmeschus escalentus*), pumkin leaf (*Telferia occidentalus*), bitter leaf (*Veronia amydalin*) and water leaf (*Talinum triagulare*). The moderate moisture content of *Vitex doniana* therefore confers on it relatively longer shelf life.

The daily values per 100g of the leaves (Table 1) when compared to [14] will deliver 30.92% - 74.60% of protein, 58.68 - 141.56 of fiber, 1.34 - 3.23 of carbohydrate, 1.23 - 2.97 of fat and 4.26 - 10.27 of calorie.

The results of the amino acid composition and DIAA reference ratios of the leaf protein are presented in Table 2 and Table 3 respectively. They are rich in essential amino acids, 40.94% except for tryptophan that was not detected and can meet the daily requirements [11] for essential amino acids except for lysine. In comparison to the WHO reference protein pattern for infant (birth to 6 months), child (6 months to 3 years) and older child, adolescent, adult [13], the DIAA ratio of the leaf protein were the least, 2.45, 3.00 and 3.50 respectively for methionine though tryptophan was not detected. However, the leaf protein can be used for the supplementation of all the detected essential amino acids except lycine and methionine in all the groups. Every 100 g of the leaf protein contains 32.5 g essential amino acids, 4.5 g sulphur containing amino acids and 7.7 g of aromatic amino acids (Table 2).

The vitamin composition of *Vitex doniana* leaves is presented in Table 4. Eleven vitamins were detected (mg/kg) with the antioxidant vitamins, ascorbic acid (27.56 - 66.50), vitamins E (4.10 - 9.90) and vitamin A (0.89 - 2.14) having

Table 1. Proximate composition of *Vitex doniana* leaves.

Component	Fresh Weight	Dry Weight	% Daily Value Fresh Weight	% Daily Value Dry Weight
Moisture(g)	58.55	0.00	NA	NA
Dry matter	41.45	100	NA	NA
Protein(g)	15.46	37.30	30.92	74.60
Fiber(g)	14.67	35.39	58.68	141.56
Carbohydrate(g)	4.02	9.70	1.34	3.23
Fat (g)	0.80	1.93	1.23	2.97
Ash (g)	6.50	15.68	NA	NA
Calorific Value (kcal/100g)	85.12	205.36	4.26	10.27

Values are means of triplicate determinations. NA-Not applicable.

Table 2. Amino acids composition of *Vitex doniana* leaves.

Amino acid	mg/g protein	mg/100g sample Fresh	mg/100g sample Dry
Glutamate	137.54	2.126	5.130
Aspartate	121.84	1.883	4.545
Leucine*	73.91	1.144	2.757
Proline	69.11	1.070	2.573
Serine	66.31	1.068	2.473
Alanine	61.85	0.957	2.307
Glycine	58.57	0.906	2.185
Arginine	58.53	0.904	2.183
Isoleucine*	52.27	0.809	1.950
Valine*	52.19	0.807	1.947
Threonine*	48.26	0.747	1.800
Phenylalanine*	40.32	0.633	1.504
Tyrosine	36.91	0.570	1.376
Cysteine	35.65	0.511	1.329
Histidine*	29.48	0.456	1.100
Lysine*	20.61	0.319	0.769
Methionine*	08.09	0.125	0.302
Tryptophan*	ND	ND	ND
Total amino acids	**971.44**	15.035	36.230
Total essential amino	**325.13**	6.121	14.834
Total non essential amino	**573.75**	10.036	24.101
Total sulphur-containing amino acids	**44.74**	0.677	1.631
Total aromatic amino acids	**77.23**	1.203	2.880

*Essential amino acids. ND-Not detected.

Table 3. Digestible indispensable amino acid (IAA) reference ratios of proteins from the leaves of *Vitex doniana.*

Amino acids	Digestible Indispensable Amino Acid (IAA) reference ratio			
	Amino acid composition from present study (mg/protein)	Comparison to Infant (birth to 6 months) requirement	Comparison to Infant (6 months to 3 years) requirement	Comparison to older child, adolescent, adult requirement protein pattern
Histidine	29.480	1.404	1.474	2.457
Isoleucine	52.270	0.950	1.633	1.307
Leucine	73.910	0.795	1.120	1.212
Lysine	20.610	0.299	0.362	0.429
Methionine + cysteine	43.740	0.245	0.300	0.352

Continued

Phenylalanine + tyrosine	77.220	1.326	1.620	1.902
Threonine	48.260	1.097	1.557	1.930
Valine	52.190	0.949	1.214	1.305
Tryptophan	ND			

ND-Not detected.

Table 4. Vitamin composition of *Vitex doniana*.

Vitamin	Amount (mg/kg) Fresh	Amount (mg/kg) Dry	%Daily Value/100g Fresh	%Daily Value/100g Dry
Vitamin-C (Ascorbate)	27.56339	66.49793	45.94000	110.8298
Vitamin-E (α-Tocopherol)	4.10291	9.89846	20.39100	82.58
Vitamin-A	0.88551	2.13633	59.03001	142.42
Vitamin-B_3 (Niacin)	0.20428	0.49283	1.02000	2.461
Vitamin-B_2 (Riboflavin)	0.12158	0.29332	7.15000	17.2541
Vitamin-B_1 (Thiamin)	0.001147	0.00277	0.07700	1.8467
Vitamin-B_9 (folic acid)	0.008079	0.01949	2.20000	5.3076
Vitamin-B_6 (Pyridoxine)	0.005076	0.01225	0.26010	1.4475
Vitamin-K	0.00120	0.00289	1.50000	3.6188
Vitamin D (Cholecalciferol)	0.02200	0.05308	22.0000	53.0760

*Percentage is based on component per total extract of the whole vitamins

higher values respectively. The values for vitamin C were higher, those of vitamin E were comparable and those of vitamin A were lower than the values of *Ficus capensis*, *Selenium melongena*, *Solanum nigrum*, *Moringa oleifera lam*, ([22]. However, (Ikewuchi *et al.* 2019 [6], Ifeanacho *et al.* 2019 [23]) reported higher vitamin C and lower vitamins E and A contents in *Pandiaka heudelotii* and *Cnidoscolus aconitifolius* than in *Vitex dodiana*, though. Compared to the daily value [11], 100 g of the leaves of *Vitex dodiana* can contribute 45.94% - 100.82% of daily value for vitamin C, 20.39% - 82.58% of vitamin E and 59.03 - 142.42 of vitamin A.

Mineral composition of the leaves of *Vitex doniana* is represented in **Table 5**. Ten mineral elements, (five macro and five trace elements) were detected. The leaf is a good source of the trace elements iron, copper and manganese. This report is supported by [24]. They have higher percent daily values than the other detected mineral elements. The high iron and copper content of the leaves suggests that the two mineral elements will be well metabolized from the leaf because of the synergistic relationship between the two trace elements. The metabolic fates of copper and iron are intimately related. Systemic copper deficiency generates cellular iron deficiency, which in humans results in diminished work

Table 5. Mineral composition of *Vitex doniana*.

Major elements	mg/kg Fresh	mg/kg Dry	%Daily Value/100g Fresh	%Daily Value/100g Dry
Calcium	73.0	176.12	7.3	17.61
Magnesium	41.0	98.91	10.25	24.73
Potassium	38.0	91.67	1.09	2.62
Sodium	1.8	4.34	0.07	0.18
Phosphorous	51.0	123.04	5.1	12.3
Trace elements				
Iron	24.0	57.90	1333.33	321.67
Copper	1.9	4.58	145.0	229.0
Manganese	1.8	4.34	90.0	217.5
Cobalt	0.001	0.002	16.67	33.33
Selenium	0.004	0.01	5.71	14.29
Sodiun/potassium ratio	0.047^{+}	0.047^{+}	NA	NA
Calcium/phosphorus ratio	1.43^{+}	1.43^{+}	NA	NA

NA-Not applicable, +These have no units.

capacity, reduced intellectual capacity, diminished growth, alterations in bone mineralization, and diminished immune response. Iron is useful in prevention of anaemia and other related diseases [25] [26]. While Copper is a component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin, an iron-oxidizing enzyme in blood [27]. The observation of anaemia in copper deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin [28].

The result indicated that *Vitex doniana* leaves had low sodium/potassium ratio (0.047) and relatively high calcium/phosphorus ratio (1.43). Sodium/potassium ratio is associated with blood pressure (BP) in humans [29] [30] [31] [32]. High sodium and potassium intake are known to be related to high and low blood pressure, respectively [33] [34] [35]. High calcium/phosphorus ratio is vital to bone health and development particularly for infants [36].

The tannins, alkaloids and phenolic acids composition are presented in **Table 6**. Only tannic acid 0.1590 - 0.3440 mg/100g was identified in the *Vitex doniana* leaves. The concentration was slightly lower in fluted pumkin [37]) and slightly higher in *Venonia sp* [38]). Tannic acid or tannin is a bitter tasting substance. The leaf probable owes its strong bitter taste to this compound. It also acts as an astringent when consumed or applied topically, which means it shrinks or constricts the body tissues which may be the reason why the leaf is used for treating wound [39]). It is also believed that the tannin in the leaves is the reason for its use by rural dwellers in traditional medicine for treatment of anaemia with huge success [40] [41] and also its haemopoetic properties [42] [43].

Table 6. Tannin, alkaloid and phenol acids composition of *Vitex doniana* leaves.

Compound	(mg/100g) Fresh	(mg/100g) Dry	% Composition*
Tannin			
Tannic acid	0.1590	0.3840	100
Total	**0.1590**	**0.3840**	**100**
Alkaloids			
Viticin	391.560540	944.657515	99.96
Indicine	0.0175052	.181066	0.019
Dopamine	0.021698	0.052347	0.0055
Tryptamine	0.017472	0.042152	0.0044
4,5-dihydroblumenol A	0.011160	0.026924	0.0028
Scopoletin	0.0015649	0.003732	0.00040
Echinatine	0.0011946	0.002882	0.00030
Intermidine	0.0010031	0.002420	0.00025
Echimidine	0.0008808	0.002125	0.00022
Monocrotalline	0.0002338	0.000564	0.00005
Supinine	0.0001643	0.000396	0.00004
Seneciphylline	0.0000261	0.000204	0.00003
Restrorsine	0.0000603	0. 000146	0.00001
Lycopsamine	0.0000194	0.0000470	0.000004
Total	**391.691168**	**944 97252**	**100**
Phenolic acids			
Vanillic acid	263	634.50	49.78
Ferulic acid	248	598.31	46.99
Ellagic acid	8.44	20.36	1.60
Piperic acid	4.41	10.64	0.84
Rosmarinic acid	2.258	5.45	0.43
Syringic acid	1.713	4.13	0.32
Total	**527.66**	**1273.0039**	**100**

*Percentage is based on the weight of the compound per total extract of its family.

The alkaloid composition of *Vitex doniana* leaves is presented in decreasing order. Alkaloids like tannins are bitter and so also contribute to the bitter taste of the leaf. The leaves have higher total alkaloid content than *Cnidoscolus aconitifolius*, *Tridax procumbens and Pandiaka heudelotii* [6] [23] [44]. Fourteen known alkaloids mainly Viticin (99.96%) were detected and others in very lower concentrations, indicine (0.019%), dopamine (0.006%), tryptamime (0.004%). Viticin is reported to have lactopoietic properties [45]. It aids in initiating, maintaining, and augmenting of adequate milk production. Dopamine is a neu-

rotransmitter that plays several important roles in the brain and body like impact mood regulation, muscle movement, sleep patterns, ability to store and recall memories, concentration, appetite, and ability to express self-control. Tryptamine is an indolamine metabolite of the essential amino acid, tryptophan. In the human gut, symbiotic bacteria convert dietary tryptophan to tryptamine, which activates 5-HT_4 receptors and regulates gastrointestinal motility. [46] [47] [48]. Tryptamine has been shown to activate trace anime-associated receptors expressed in the mammalian brain, and regulates the activity of dopaminergic, serotonergic and glutamatergic systems [49] [50].

Vitex dodiana leaves are rich in phenolic acids (527.66 - 1273.39 mg/100g). Vanillic acid and ferulic acid had the greater percentage of the detected phenolic acids, 49.78% and 46.99% respectively. Vanillic acid has been shown to be protective against cardiac toxicity caused by oxidative stress [51]. Ferulic acid has been reported to have many physiological functions, including antioxidant, antimicrobial, anti-inflammatory, anti-thrombosis, and anti-cancer activities. It also protects against coronary disease, lowers cholesterol and increases sperm viability [52]. Many studies have shown a strong and positive correlation ($p \leq 0.05$) between the phenolic compound contents and the antioxidant potential of fruits and vegetables [53] [54] [55]. This antioxidant mechanism, present in the plants, has an important role in the reduction of lipid oxidation in (plant and animal) tissues, because when incorporated in the human diet, not only it conserves the quality of the food, but it also reduces the risk of developing some diseases [56] [57].

Carotenoid, Phytosterol and glycosides composition of *Vitex dodiana* leaves are presented in **Table 7**. Ten known carotenoids (mg/100g); lutein (63.3581 - 152.854), carotene (41.8094 - 100.867), malvidin, zea-xanthin, viola-xanthin, β-crypto-xanthin, asta-xanthin, neo-anthin, anthera-xanthin (0.0862 - 0.0207) and lycopene (0.0112 - 0.0270) arranged in descending order of quantity in the leaves were identified. The leaf total caratenoid (1778.6 - 4289.22 mg/100g) was higher than Utazi' Gongronema latifolium "Nchanwu"/Scent leaf Occinum gratissmum "Onugbo"/Bitter leaf Vernonia amygdalina "Ugu"/Pumpkin Telferia occidentalis "Ahihara"/Bush Mallow Corchorus olitorius "Nturukpa" Pterocarpus santalinoides "Okazi" Gnetum Africana but lower than "Oha" Pterocarpus mildbreadii. The various antioxidant actions of carotenoids have been reviewed extensively [58] [59] [60] [61] although the existence of a clinical importance of antioxidant effect of these compounds has been questioned by some researchers [62]. However, epidemiological studies have suggested that dietary carotenoids play a role in reducing the risk of cancer [63], cardiovascular disease [64] [65], macular degeneration [66], and cataracts [67] [68]. Although, specific dietary carotenoids may be responsible for different protective effects. β-carotene for instance may be markers for reduced risk of cancer and heart disease [69] [70] in physiological dose, but poses a risk at higher doses. [71] [72]. Both epidemiological and laboratory studies consistently indicate an association between oxygenated carotenoids, lutein and zeaxanthin, and the protection of the retina and retinal

Table 7. Carotenoid, phytosterol and glycosides composition of *Vitex doniana*.

Compound	(mg/100g) Fresh	(mg/100g) Dry	% Composition*
Carotenoid			
Lutein	63.3581	152.854	35.62
Carotene	41.8094	100.867	23.51
Viola-xanthin	27.6530	66.714	15.54
Zea-xanthin	25.0445	60.422	14.08
Asta-xanthin	11.5920	27.966	6.52
β-crypto-xanthin	3.3375	8.053	1.88
Neo-xanthin	2.7655	6.673	1.55
Malvidin	2.2072	5.325	1.24
Anthera-xanthin	0.0862	0.0207	0.05
Lycopene	0.0112	0.0270	0.01
Total	**177.86**	**429.0953**	**100**
Phytosterol			
Sitosterol	8.646.16	20.85887	61.66
Stigmasterol	2.098.97	5.06386	14.97
5Avenasterol	2.016.26	4.86431	14.38
Campesterol	1.259.27	3.03805	8.98
Ergosterol	0.00009950	0.000240	0.71×10^{-3}
Cholestanol	0.00009326	0.000225	0.71×10^{-3}
Cholesterol	0.000000889	0.000002	0.63×10^{-5}
Total	**14.02086**	**33.82557**	**100**
Glycosides			
Agunuside	4.887040	11.7902051	72.64
Aucubin	1.643320	3.9645838	24.42
Vitexicarpin	0.0196966	0.0047519	2.93
Arbutin	0.0000685	0.0001653	0.00101
Costugenin	0.00001467	0.0000354	0.00022
Salicin	0.00001064	0.0000257	0.00016
Amygdalin	0.00000979	0.0000236	0.00010
Quabain	0.00000436	0.0000105	0.000064
Digitoin	0.00000399	0.0000096	0.000059
Digoxin	0.0000000625	0.0000015	0.0000093
Total	**6.55016**	**15.75981**	**100**

*Percentage is based on the weight of the compound per total extract of its family.

pigment epithelium from damage induced by UV light and oxygen [73] [74] [75].

Seven Phytosterols-sitosterol > stigmasterol > 5Avenasterol > campesterol > ergosterol > cholestanol > cholesterol were detected in the leaves. (Ikewuchi *et al.* 20015 [20], ikewuchi *et al.* 2019 [6], Ifeanacho *et al.* 2019) [23] reported lower total pytosterol in *Tridax procumbens*, *Pandiaka heudelotii and Cnidoscolus aconitifolius* than in *Vitex doniana*. Beta-sitosterol possesses analgesic/anti-nociceptive, angiogenic, anthelmintic, anti-atherosclerosis, anti-arthritic, anticancer, anti-diabetic, anti-hyperlipidaemic, anti-inflammatory, antimicrobial, antioxidant, antipyretic and immunomodulatory activities [8] [76] [77]. According Ikewuchi *et al.* [8] and Saeidnia *et al.* [78], stigmasterol has analgesic, anticonvulsant, anti-hypercholesterolemic, anti-inflammatory, anti-osteoarthritic antioxidant, antitumor, hypoglycaemic and memory enhancing activities. Studies have also indicated that a diet high in phytoesterols may inhibit the absorption of cholesterol and lower serum cholesterol levels by competing for intestinal absorption. Stigmasterol stimulates export of H^+ at low concentrations whereas all other steroids act as inhibitors. In animal avenasterol is a natural, non-cholesterol and has hypocholesterolemic activity in the body [79] [80]. Generally, phytosterols have anti inflammatory, anti cancer, hypocholesterolemic, antineoplasic, hypoglycemic, artheroprotective, hepatoprotective, immune modulating and antipyretic activities [81].

Total glycoside detected was 6.727 - 15.760 mg/100g composing of ten known glycosides mainly agnuside, aucubin, vitexicarpin. This range of total glycosides is higher than the level in amaranthus hybridus, curcubita pepo and genetum Africana [82]. Agnuside (AGN), an iridoid glycoside, is the principle active phytoconstituent and a chemotaxonomic marker of the genus Vitex. Agnuside, found in plants helps with many female reproductive issues because of its ability to normalize the amount of progesterone in the body [83]. Progesterone is one of the hormones in the body responsible for stimulating and regulating female reproductive activities such as, monthly menstruation, conception and pregnancy [84]. Aucubin is an iridoid glycoside [85]. Iridoids are commonly found in plants and function as defensive compounds. [85] Aucubin is known to have potent liver-protective activities. Aucubin was found to protect against liver damage induced by carbon tetrachloride or alpha-amanitin in mice and rats when 80 mg/kg was dosed intraperitoneally [86]. Aucubin in this vegetable has been suggested to help in clearing liver toxicity and treatment of jaundice [87].

4. Conclusion

The study has shown that *Vitex doniana* leaves have high nutritional potentials as well as possess some bioactive compounds. Consequently, if the vegetable is consumed in sufficient amount it may help in combating diseases associated with malnutrition as well as maintaining the overall wellbeing. Therefore, *Vitex doniana* plant, deserves protection in the wild and its domestication should be promoted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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