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Evaluation of the Nutritional and Anti-Nutritional Composition of Selected Green Leafy Vegetables Consumed in Ekiti State, Nigeria

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Abstracts: **This study was carried out to evaluate the proximate, mineral, and anti-nutritional composition of selected leafy green vegetables consumed in Nigeria, namely, *Amaranthus hybridus*, *Talinum triagulare*, *Telfairia occidentalis*, *Corchorus olitorius, Vernonia amygdalina and Basella alba.* The vegetables were analyzed using standard methods. Results of the proximate composition of the vegetables show that the moisture content ranged from 75.29% to 81.03%, protein from 3.56% to 6.20%, crude fiber from 2.25% to 5.86%, crude fat from 1.76% to 4.84%, ash content from 2.54% to 3.83% and carbohydrate from 6.40% to 10.25%. The mineral content, namely, calcium ranged from 28.45mg/100g to 43.40mg/100g, magnesium from 188.56mg/100g to 340.10mg/100g, potassium from 52.25mg/100g to 274.10mg/100g, sodium from 22.48mg/100g to 52.25mg/100g, iron from14.22 mg/100g to36.23mg/100g and phosphorus from 16.70mg/100g to 38.40 mg/100g. For the anti-nutrient contents of the vegetables, phytate ranged from 0.45mg/100g to 6.55 mg/100g, tannin from 0.46 mg/100g to 0.81 mg/100g, saponin from 1.84 mg/100g to 2.76 mg/100g and oxalate from 0.53 mg/100g to 1.72 mg/100g. Results obtained from these work show that the analyzed vegetables contain reasonable amount of nutrients required for normal growth and development of the body. The anti-nutritional contents of the vegetables are low, hence they do not pose a threat. These vegetables are good and can contribute qualitatively to the nutritional need of the Nigerian population.**

Keywords: **Leafy green vegetables, Proximate, Anti-nutrient, Phytochemical, Mineral and Vitamin.**

1. INTRODUCTION

Vegetables refers to the edible parts of leaf, stem and roots of plants [1, 2]. Vegetable also include parts used in making soup [3]. They are sometimes accompanied by tender petioles and shoots and are regarded as valuable parts of the dietary regimen of Africans, providing essential minerals and vitamins needed for growth, development and maintenance of optimal health [4]. They are valuable sources of nutrients especially in rural areas where they contribute substantially to protein, minerals, vitamins, fibers and other nutrients which are usually in short supply in daily diets [5].

Generally, green leafy vegetables are good sources of micronutrients, non- volatile acids, organic acids, mineral salts, volatile sulphur compounds and tannins, which impart flavour in diets and antioxidant compounds like polyphenols, flavonoids and arrays of carotenoids especially, β-carotene. The micronutrient content of leafy vegetables can potentially address the problem of micronutrient deficiency among the rural dwellers in Nigeria. In contribution to health, reasonable amount of green vegetables intake have been reported to reduce the risk of degenerative diseases like cancer, diabetes

mellitus and cardiovascular diseases [6]. Vegetables are important food crops as they provide adequate amount of minerals and vitamins for humans consumption [7] as well as important sources of protective food [8]. Vegetables are important as they provide nourishment for more than 900 million people who are undernourished and over two billion people who are afflicted by one or more micronutrients [9]

The uses of vegetables for food security in the nation is something to reckon with, most especially in Nigeria and Sub-Sahara Africa where malnutrition and hunger are threatening millions of people [10]. Leafy vegetables play important roles in human nutrition especially in the aspect of food scarcity and micronutrient deficiencies [11].

Apart from vegetables serving as food, they also serves as medicine to manage various ailments for their therapeutic properties. [12] reported that anti-nutrient substances, which are medicinal, such as phytic acid, flavonoids, tannins, saponins and alkaloids are present in most vegetables. The anti-nutrients present in leafy vegetables make them to act as antioxidants and are responsible for their therapeutic properties [13].

When dietary intake of vegetables is insufficient, they are bound to be micronutrients malnutrition and this is reported to account for about 2.7 million deaths worldwide annually, thus ranking it among the top ten risk factors that contribute to mortality rates around the world [14]. It is estimated on the global scale that about 10.6 million children below five years of age die on an annual basis and malnutrition is seen as the underlying cause of about 50% of these deaths [15]. It was also reported that sub-Saharan African nations which constitutes about 10% of the world's population, carries about 41% of the global mortality burden of children under the age of five [15].

This study was carried out to provide baseline information on the nutrients and anti-nutrient composition of the vegetables grown and consumed in Ekiti State, Nigeria and as well sensitize the populace on the nutritional and medicinal values of the green leafy vegetables. Consequently, the study seeks to explore the possible contribution of green leafy vegetables in solving the problems of micronutrient malnutrition, most especially among the masses as well as create more variety in the nutritious food for the Nigerian populace.

2. MATERIALS AND METHODS

The vegetables used in this study are: *Amaranthus hybridus*, *Talinum triagulare*, *Telfairia occidentalis*, *Corchorius olitorius*, *Vernonia amygdalina* and *Basella alba*. They were purchased from Oba market, Ado Ekiti, Ekiti State, Nigeria. They were identified by the herbarium Curator of the Department of Plant Science and Biotechnology, Ekiti State University, Ado Ekiti, Nigeria.

The vegetable leaves were handpicked to remove unwanted materials. They were washed with clean tap water and were allowed to drip off. The fresh samples were blended and packed inside polythene bags separately and stored in the refrigerator until required for use.

Table 1: Names of Nigeria selected leafy vegetables

Botanical name	Local name	Common name	Part used
Telfairia amydalina	Ugu	Flutted pumpkin	Leaves
A. hybridus	Efo tete	Green amaranth	Leaves
Talinum triangulare	Gbure	Water leaf	Leaves
C. olitorius.	Ewedu	Jute/Jew'smallow	Leaves
V. amygdalina	Ewuro	Bitter leaf	Leaves
B. alba	Efo amununtutu	Malabar spinach	Leaves

PROXIMATE ANALYSIS:

Proximate Analysis

The methods of the Association of Official Analytical chemists were used for the determination of the nutritional composition of the Green leafy vegetables. All the analyses were carried out in triplicates for all the green leafy vegetable samples analyzed.

Moisture content: One hundred grams(100 g) of fresh vegetable leaves samples were weighed in Petri dishes and dried in an oven at 105°C until constant weight was obtained. The loss in weight was expressed as percentage moisture content [16]

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Ash content: The ash content was determined by the incineration of a 2g vegetable leaves sample in a muffle furnace at 500°C for 6 hours until the ash turned white [16]

Fat content: Fat content was determined by petroleum ether at 60-80°C extraction in a Soxhlet apparatus [16]

Fibre content: Fiber content was determined by acid- base digestion using 1.25% H_2SO_4 (v/v) and 1.25% NaOH (w/v) solutions [16]

Protein content: Protein content was estimated by the Kjeldahl method. Total protein was calculated by multiplying the evaluated nitrogen by a factor of 6.25 [16]

Carbohydrates content: Carbohydrae content was estimated using a difference method [17]. This was done by subtracting the sum of the per cent of protein, moisture, fat and ash from 100.

Mineral analysis

The analysis of mineral composition of the leafy vegetables was carried out according to the methods of [18]. One gram (1 g) portion of each sample was measured into a digestion flask, 20 mL of acid mixture (650 mL of conc. HNO_3; 80 mL PCA; 20 mL conc. H_2SO_4) was then added and the flask was heated until a clear digest was obtained. The digest was diluted with distilled water to the 500 mL mark. Appropriate dilution was then made for each element.

Vitamins analysis

Vitamin A content was determined by the method of [19] while thiamine (B1) Riboflavin (B2), Niacin (B3), vitamin E were determined by Spectrophotometric method. These methods are as described by [20]. Ascorbic acid (vitamin C) was determined titremetrically by the method of [21].

Anti-nutrient screening of leafy vegetables

Saponins test (foam test): Two milliliters (2 mL) of extract was dissolved in 3 mL distilled water and shaken vigorously. The formation of a stable layer of form indicated the presence of saponins in the sample.

Tannins test: To 1 ml of the extract, 2 ml of 5% ferric chloride was added. The formation of dark blue or greenish-black indicates the presence of tannins [22].

Flavonoids test: To 2 ml of the extract, 1 ml of 2N sodium hydroxide was added. The yellow color indicates the presence of flavonoids_tannins [22]

Phenol test: A pinch of ferric chloride ($FeCl_3$) was added to 2 mL of the extract and the appearance of green colour indicated the presence of phenol [23]

Alkaloids test: The method of [23] was used. A drop of Mayer's reagent was added by the side of the test tube to a few quantity of the filtrate. A creamy or white precipitate indicates the presence of alkaloid.

Phytic acid: This was carried out using the method of [24]

DATA ANALYSIS

The treatment means were compared by ANOVA one way at 5% level of significance (significant at $p < 0.05$) and the ranking of treatments denoted by letters using the SPSS 20.0 statistical package

3. RESULTS

Table 2: Proximate composition (%) of selected leafy vegetables consumed in Ekiti State, Nigeria

Sample	Moisture	Crude protein	Crude fibre	Crude fat	Ash	CH_2O
T. occidentalis	75.29±2.12^{c}	6.14±0.07^{a}	2.68±0.06^{d}	2.12±0.45^{c}	3.52±0.12^{a}	10.25±0.72^{a}
A. hybridus	76.65±2.24^{b}	4.31±0.63^{c}	5.45±0.14^{a}	2.67±0.07^{c}	3.34±0.56^{a}	7.40±0.23^{c}
T. triangulare	81.03±3.14^{a}	3.56±0.48^{d}	2.25±0.07^{d}	1.76±0.09^{d}	2.54±0.04^{b}	8.86±0.21^{b}
C. olitorius	75.86±2.92^{c}	6.20±0.13^{a}	5.86±0.21^{a}	2.43±0.21^{c}	3.25±0.13^{a}	6.40±0.31^{d}
V. amygdalina	76.86±0.32^{b}	5.22±0.27^{b}	4.15±0.46^{b}	4.84±0.25^{a}	3.83±0.12^{a}	5.10±0.25^{de}
B. alba	80.12±3.63^{a}	6.15±0.48^{a}	3.50±0.34^{c}	3.25±0.16^{b}	2.33±0.12^{b}	4.65±0.81^{e}

Means in the same column followed by the same letter are not significantly different at $p \geq 0.05$

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Table 3: Vitamin composition (mg/100g) selected leafy vegetables consumed in Nigeria

Sample	Vitamin A	Vitamin B_1	Vitamin B_2	Vitamin B_3	Vitamin C
T. occidentalis	4.50±0.63^b	3.60±0.07^b	2.58±0.04^d	1.67±0.02^a	22.25±1.18^c
A. hybridus	3.34±0.15^c	4.67±0.41^a	2.53±0.07^d	0.85±0.02^b	25.33±1.14^b
T. triangulare	2.70±0.16^d	2.25±0.03^c	3.15±0.06^c	1.56±0.05^a	18.25±0.44^d
C. olitorius	5.04±0.15^a	3.18±0.04^b	4.13±0.23^b	1.86±0.23^a	29.25±2.12^a
V. amygdalina	4.15±0.27^b	2.50±0.14^c	3.27±0.21^c	1.10±0.76^a	23.15±1.21^c
B. alba	4.20±0.12^b	3.77±0.15^b	5.50±0.11^a	1.81±0.23^a	26.26±2.08^b

Means in the same column followed by the same letter are not significantly different at $p \geq 0.05$.

Table 4a: Mineral composition (mg/100g) of selected leafy vegetables consumed in Nigeria

Sample	Calcium	Magnesium	Potassium	Sodium
T. occidentalis	43.40±2.11^a	340.10±5^a	67.25±2.64^d	26.50±1.13^e
A. hybridus	38.25±2.19^b	228.38±6.7^c	52.25±2.77^f	22.48±1.13^f
T. triangulare	28.45±1.43^d	234.76±4.2^b	61.37±2.08^e	28.14±1.19^d
C. olitorius	32.25±1.07^c	188.56±1.9^d	274.10±4.6^a	52.25±1.86^a
V. amygdalina	27.15±2.12^c	165.50±1.9^e	234.25±6.42^b	30.36±1.38^c
B. alba	33.25±1.66^c	235.25±4.13^b	74.25±3.42^c	33.24±1.23^b

Means in the same column followed by the same letter are not significantly different at $p \geq 0.05$

Table 4b: Mineral composition (mg/100g) of selected leafy vegetables consumed in Nigeria

Sample	Iron	Phosphorus
T. occidentalis	36.23±1.48^a	38.40±2.23^b
A. hybridus	14.22±0.57^e	32.75±1.13^d
T. triangulare	18.25±0.72^c	42.15±1.17^a
C. olitorius	21.67±0.91^b	16.70±0.72^f
V. amygdalina	16.15±1.08^d	35.50±2.33^c
B. alba	21.50±1.13^b	24.37±1.52^e

Means in the same column followed by the same letter are not significantly different at $p \geq 0.05$

Table 5: Anti-nutrient composition (mg/100g) selected leafy vegetables consumed in Nigeria

Sample	Phytate	Oxalate	Tannins	Saponins
T. occidentalis	1.23±0.02^c	0.56±0.01^c	0.46±0.03e	1.84±0.13^c
A. hybridus	0.45±0.05^d	0.53±0.06^c	0.53±0.16^d	2.72±0.07^a
T. triangulare	6.55±0.14^a	1.72±0.04^a	0.81±0.02^a	2.76±0.21^a
C. olitorius	1.38±0.02^c	0.68±0.07^b	0.62±0.03^c	1.87±0.08c
V. amygdalina	4.50±0.34^b	1.20±0.06^a	0.76±0.04^b	2.25±0.23^b
B. alba	1.57±0.07^c	1.22±0.07^a	0.77±0.04^b	2.25±0.41^b

Means in the same column followed by the same letter are not significantly different at $p \geq 0.05$.

4. RESULTS AND DISCUSSION

The result of the proximate composition of the vegetables is presented in Table 2. Percentage moisture of the fresh samples ranged from 75.29% to 81.03% with the highest value obtained in *T. triangulare* and the least in *T. occidentalis.* This is within reported range (75.4 to 90.3%) obtained in some Nigerian green leafy vegetables. High moisture contents provides for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities of these Leafy Vegetables [25].

Percentage crude protein content ranged from 3.56% to 6.20% with the highest value obtained in *C. olitorius* (6.20%). There was no significant difference (P<0.05) in the protein content of *T. occidentalis* (6.14%), *B. alba* (6.15%) and *C. olitorius* (6.20 %). These values are in accordance with the report of [26] in which the percentage crude protein of *P. guineensis* (6.4%) and *corchorus olitorius* (7.0%). Plant foods that provide more than 12% of their calorific value from protein have been shown to be good source of protein [27]. This shows that all the Leafy Vegetables investigated are low in protein content. Still, the protein content of these vegetables will go a long way in meeting the protein need of the rural poor people who supplement their food with vegetables. Proteins play critical roles in cellular functions, structure and regulations of metabolic activities in all living organisms. Hence, proteins have primary importance in the daily diets of consumers. This is because of their ability to synthesize and accumulative amino acids with the help of abundant source of sunlight, water, oxygen and nitrogen) which is readily available in the atmosphere. Protein nutritional quality is determined by the proportions of essential amino acids, which cannot be synthesized by humans and hence must be provided in the diet [28]

Percentage crude fibre content ranged from 2.25% to 5.86% with the highest value obtained in *C. olitorius.* There was no significant difference (P<0.05) between in the crude fibre content of *A. hybridus* (5.86%) and *C. olitorius* (5.86%). Dietary fiber is important in intestinal health and in prevention of excess cholesterol absorption. Dietary fibre, mainly cellulose and hemicellulose add bulk to the diet, ease waste elimination and prevent absorption of excess starchy diets which protects metabolic conditions against hypercholesterolemia, diabetes mellitus [29] and other related health complications. Green leafy vegetables have been traditionally recognized as good sources of dietary fiber [29]. There are epidemiological evidences that show that dietary fiber is important in preventing several diseases, especially the fiber that is found in leafy vegetables such as celery, cabbage, spinach and lettuce that is characterized by high water content and a high percentage of fiber [30].

Percentage crude fat content ranged from 1.76% to 4.84% with the highest value obtained in *V. amygdalina* (4.84%). There was no significant difference (P<0.05) between in the crude fat content of *T. occidentalis*, (2.12%), *A hybridus* (2.67%) and *C. olitorius (*(2.43%). The percentage fat content are generally low, it ranged from (1.76 - 4.84 %). It is clear that the lipid content of the leafy vegetables under investigation is low. It's vital to remember that one to two percent of calories should come from fat in a diet for humans, as more fat consumption increases the risk of cardiovascular diseases including atherosclerosis, cancer, and aging [31,32]. Therefore, individuals who suffer from obesity may be advised to consume these leafy vegetables in large quantities [33].

The percentage ash content ranged between 2.33% to 3.83%. The ash content is indicative of the mineral content of the leafy vegetables. The analyzed leafy vegetables were found to be rich in ash. [34] observed that ash content is an important tool in evaluating nutritional quality of food since it indicates the general mineral contents of foods. These values indicate that these leafy vegetables species may be considered as good sources of minerals.

Percentage carbohydrate content ranged from 6.40% to 10.25% with the highest value obtained in *T. occidentalis.* Significant differences occur in the carbohydrate contents of the test vegetables**.** Carbohydrate is a source of energy enhances human activities.

The result of the vitamin content (mg/100g) in the test leafy vegetables was presented in Table 3. Vitamin A content ranged from 2.70 mg/100g to 5.04 mg/100g. The highest vitamin A content was recorded in *C. olitorius* (5.04 mg/100g) while the least was recorded in *T. triangulare* (2.70 mg/100g). . Vitamin A as an antioxidant is known to scavenge free radicals in the body and thus prevents cellular damage. It is important in maintenance of healthy eyes and skin, normal growth and reproduction as well as enhancement of immune function (Roth and Townsend 2003). Vitamin A is important for normal vision, gene expression, growth and immune function by its maintenance of epithelial cell functions [35]

The vitamin B_1 content ranged from 2.25 mg/100g to 4.67 mg/100g. The highest vitamin B_1 content was recorded in *A. hybridus* (4.67 mg/100g) (while the least was recorded in *T. triangulare* (2.25%). Vitamin B_1 is required for the maintenance of nerve tissue and for the release of energy from carbohydrate metabolism [36].

The vitamin B_2 content ranged from 2.53 to 5.50 mg/100g. The highest vitamin B_2 content was recorded in *C. olitirius* (5.50 mg/100g) while the least was recorded in *A. hybridus* (2.53 mg/100g)

The vitamin B_3 content ranged from 0.85 to 1.86 mg/100g. The highest vitamin B_3 content was recorded in *C. olitirius* (1.86 mg/100g). There was no significant difference in the in Vitamin B_3 content of *T. occidentalis*, *T. triangulare* and *C. olitirius*, *V. amygdalina* and *B. alba.* The B_1 content of these vegetables ranged from 2.25 mg/100g to 4.67 mg/100g. These values are within the range reported by[37]. Vitamin B_1 is required for the maintenance of nerve tissue and for the release of energy from carbohydrate metabolism [36].

Vitamin C content ranged from 18.25 to 29.25 mg/100g. The highest vitamin content was recorded in *C. olitorius* (18.25 mg/100mg) while the least was recorded in *T. triangulare*. Vitamin C is a potent antioxidant that facilitates the transport and uptake of non-heme iron at the emucosa, the reduction of folic acid intermediates and the synthesis of cortisol. Its deficiency includes fragility to blood capillaries gum decay, scurvy [37, 38]. Vitamin C is essential for healthy teeth, gum and bone. It is also vital for proper functioning of the adrenal and thyroid glands. Scurvy is a deficiency disease of vitamin C and adequate intake of ascorbic acid from these vegetables can be used in the curing of scurvy and also can reduce the formation of carcinogenic nitrosamines [39].

Calcium content ranged from 27.15 mg/100g to 43.40 mg/100g. The highest magnesium content was recorded in *T. occidentalis* (43.40 mg/100g) while the least (27.15 mg/^{100g}) was recorded in *V. amydalina.* Calcium is one of the most essential macro mineral required by the body for strong teeth and bones and its deficiency is more prevalent than any other mineral. Calcium, phosphorus and vitamin D help to eradicate rickets in children and osteomalacia as well as osteoporosis among older people [36].

Magnesium content ranged from 165.50 mg/100g to 340.10 mg/100g. The highest magnesium content was recorded in *T. occidentalis* (340 mg/100g) while the least (165.50 mg/100g) was recorded in *V. amydalina.* The magnesium status of the body is greatly influenced by the health of both the digestive and renal systems. Any disorder of the gastrointestinal tract that impair absorption processes, such as Crohn's disease, can limit magnesium absorption by the body leading to depletion in body magnesium stores which could, in extreme cases, lead to chronic magnesium deficiency which may include symptoms like erythemia, hyperaemia, neuromuscular hyper-irritability which increases if the deficiency is unchecked and may be accompanied by cardiac arrhythmia and generalized tremours [40].

Potassium content ranged from 52.25 mg/100g to 274.10 mg/100g. The highest potassium content was recorded in *V. amygdalina* while the least was recorded in *A. hybridus.* The vegetables are also rich in potassium and sodium. Potassium is an intercellular salt that can combine with sodium to influence osmotic pressure and contributes to normal pH equilibrium in the body [36].

Sodium content ranged from 22.48 mg/100g to 52.25 mg/100g. The highest sodium content (52.25 mg/100g) was recorded in *C. olitorius* while the least (52.25 mg/100g) was recorded in *A. hybridus.* Sodium plays a significant role in the maintenance of osmotic pressure of the body fluids. Sodium is one of the minerals whose absorption is considered a factor in the etiology of hypertension hence, its low availability in these vegetables can lower the incidence of hypertension [36].

Iron content ranged from 14.22 mg/100g to 36.23 mg/100g. The highest iron content (36.23 mg/100g) was recorded in *T. occidentalis* while the least (14.22 mg/100g) was recorded in *A. hybridus.* Iron is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, protein and fats [41]

Phosphorus content ranged from 16.70 mg/100g to 42.15 mg/100g. The highest Phosphorus content (42.15 mg/100g) was recorded in *T. tringulare*, while the least (16.70 mg/100g) was recorded in *C. olitorius***.** For good Ca/P intestinal absorption, Ca/P ratio should be close to unity [42]

The anti-nutrient of the test plant is presented in Table 5. Phytate composition ranged from 0.45 mg/100g to 6.55 mg/100g. The highest phytate content (6.55 mg/100g) was recorded in *T. triangulare*, while the least (0.45 mg/100g) was recorded in *A. hybridus.* Oxalate composition ranged from 0.53 mg/100g to 1.72 mg/100g. Phytate is a strong chelating agent that can form protein and mineral-phytic acid complex, thereby reducing protein and mineral bioavailability while High saponin level has been associated with gastroenteritis manifested by diarrhea and dysentery [43] Saponins are glycosides containing polycyclic aglycone moiety of either C_{27} steroid or C_{30} triterpenoids attached to a carbohydrate. The highest oxalate content (1.72 mg/100g) was recorded in *T. triangulare*, while the least (0.53 mg/100g) was recorded in *A. hybridus.* There was no significant difference in oxalate content of *T. triangulare*, *V. amygdalina* and *B. alba.* Oxalate renders calcium unavailable by binding to the calcium ion complex [44, 45].

Tannins composition ranged from 0.46 mg/100g to 0.81 mg/100g. The highest tannins content was recorded in *T. triangulare*, while the least was recorded in *A. hybridus.* Saponnins composition ranged from 1.84 to 2.76 mg/100g. The highest saponnins (2.76 mg/100g) content was recorded in *T. triangulare*, while the least was recorded in *T. occidentalis.* There was no significant difference ($P<0.05$) saponnins content in *T. triangulare.* Tannins prevent the activities of digestive enzymes such as trypsin, chymotrypsin, amylase and lipase. The tannin-epigallo-catechin- 3-gallate is known to possess hypoglycemic activity [46]. Anti-nutrients limit the use of many plant foods due to their occurrence as natural compounds capable of eliciting deleterious effect in man and animals [47]. However, the values recorded in this study were far below the toxic level and cannot cause harm in the vegetables when consumed.

5. CONCLUSION

The vegetables analyzed in this study; *T. occidentalis, A. hybridus, T. triagulare C. olitorius, V. amygdalina* and *B. alba* were discovered to contain reasonable amount of proximate composition, mineral nutrient and anti-nutrients. The choice of any of the vegetable depends on the types of nutrients deficiency in an individual. Therefore, the vegetables should be incorporated into human and animal diets.

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