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Assessment of Nutritional Value of Selected Underutilized Green Leafy Vegetables in Southwestern Nigeria

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ABSTRACT: The need for underutilized leafy vegetables as food has been greatly emphasized owing to the increase in knowledge of the value of the essential nutrients they can provide. In this study, an assessment of the nutritional value of underutilized leafy vegetables collected in Southwestern Nigeria, and their content for mineral nutrients (K, Na, P, Ca, and Mg), essential vitamins (A, C, and E), and proximate composition was carried out on ten vegetables: *Jatropha tanjorensis, Solanum nigrum, Talinum triangulare, Solanecio biafrae, Vernonia amygdalina, Crassocephalum crepidoides, Telfairea occidentalis, Amaranthus hydridus, Launaea taraxacifolia* and *Solanum macrocarpon*. From this study, it was observed that the ten vegetables provide mineral concentrations exceeding 0.01%, essential vitamins exceeding 0.5%, ash exceeding 5%, moisture exceeding 5% of plant dry matter, crude fiber exceeding 10%, protein, crude fat exceeding 5%, and carbohydrate exceeding 30%. High levels of potassium, vitamin A, vitamin C, crude fat, and carbohydrates were noticed in *Jatropha tanjorensis*. High levels of both sodium and calcium were noticed in *Solanecio biafrae*. *Amaranthus hydridus*, *Vernonia amygdalina*, and *Solanum nigrum* were noted to be good sources of protein. The range of values of mineral nutrients, essential vitamins, proximate composition, and recommended dietary allowances of the studied leafy vegetables are very similar to those obtained in typical conventional edible leafy vegetables. The results therefore provide evidence that these underutilized leafy vegetables are well endowed with essential nutrients and could be important contributors to improving the nutritional content of humans.

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In this study, an assessment of the nutritional value of underutilized leafy vegetables collected in Southwestern Nigeria, and their content for mineral nutrients (K, Na, P, Ca, and Mg), essential vitamins (A, C, and E), and proximate composition was carried out on ten vegetables: *Jatropha tanjorensis*, Solanum nigrum, Talinum triangulare, *Solanecio biafrae*, *Vernonia amygdalina*, *Crassocephalum crepidoides*, *Telfairea occidentalis*, *Amaranthus hydridus*, *Launaea taraxacifolia* and *Solanum macrocarpon*. From this study, it was observed that the ten vegetables provide mineral concentrations exceeding 0.01%, essential vitamins exceeding 0.5%, ash exceeding 5%, moisture exceeding 5% of plant dry matter, crude fiber exceeding 10%, protein, crude fat exceeding 5%, and carbohydrate exceeding 30%. High levels of potassium, vitamin A, vitamin C, crude fat, and carbohydrates were noticed in *Jatropha tanjorensis*. High levels of both sodium and calcium were noticed in *Solanecio biafrae*. *Amaranthus hydridus*, Vernonia amygdalina, and Solanum nigrum were noted to be good sources of protein. The range of values of mineral nutrients, essential vitamins, proximate composition, and recommended dietary allowances of the studied leafy vegetables are very similar to those obtained in typical conventional edible leafy vegetables. The results therefore provide evidence that these underutilized leafy vegetables are well endowed with

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essential nutrients and could be important contributors to improving the nutritional content of humans. *Telfaria occidentalis*, *Cucurbita pepo* and *Corchorus olitorus* are suitable for growing during the rainy season, while others, such as *Pennisetum purpureum, Solanum aethiopicum, Vernonia amygdalina, Vitex doniana and Gnetum africanum* are suitable for growing during the dry season. A good number of these vegetables are indigenous to various zones due to cultural diversities. Leafy vegetables such as *Amaranthus hybridus, Corchorus olitorius, Vernonia amygdalina, Ocimum grattissimum, Ocimum. Basilicum, Telfairea occidentalis* and Solanum macrocarpon are domiciled in the southwestern zone of Nigeria. Traditionally, leafy vegetables of the respective endemic region of a zone are known to make a significant contribution to the diet of rural households, particularly during famine, the dry season, and drought (Agbaire, 2011). These species have genetic diversity and vast indigenous knowledge linked to their nutritional sources. As a food source, leafy vegetables are the best source of vitamins A, C, and many of the B-complex vitamins and also supply good amounts of calcium, potassium, magnesium, iron, folate, and other essential minerals, including beta-carotene, lutein, zeaxanthin, and Omega-3 fatty acids (Deb *et al*., 2018). Likewise, underutilized leafy vegetables are likely to contain a variety of carotenoids, flavonoids, and other powerful antioxidants that have cancer-protective properties. Traditional underutilized leafy vegetables are inexpensive, easy to cook, and packed with phytonutrients, including minerals that are essential for the metabolic processes and protection of the human body (Deb *et al*., 2018; Bhavithra *et al*., 2019). The cultivation of these vegetable crops has a significant effect on food and nutritional protection for children, women, and adults and can also provide income to subsistence farmers by reducing the overreliance on limited crop plants as sources of diet, fuel, and food and by requiring low input in comparison to conventional agriculture systems (Shackleton, 2003; Venter *et al*., 2007). These green leafy vegetables have hidden sources of essential nutrients such as proteins, vitamins, dietary fibers, minerals, and phytonutrients. These are embedded with nutraceutical and pharmaceutical components that are essential for human well-being and are mostly used based on traditional knowledge, social rituals, and folklore (Deb *et al*., 2018). Some of the leafy vegetables are also recognized for their medicinal value (Hamid *et al*., 2008; Deshmukh and Rothe, 2013). Indigenous underutilized vegetables are in danger of being replaced by a few cultivated species (Jansen van Rensburg *et al*., 2004; Rohini *et al*., 2017). The development of modern agricultural practices has further neglected the potential of many of these hidden resources. The underutilization of these leafy vegetables, particularly in Southwestern Nigeria, is due to complex reasons like social, geographical, and economic concerns, geographical isolation, the complete unexplored status of agronomic practices of production, and little institutional interest in these plants. These plants continued to remain underutilized due to a lack of awareness and advertising for their utilization and exploitation. Also, the absence of a popularization program, mobilization of local farmers and consumers towards better utilization of these leafy vegetables, value addition, and lack of information on their nutrient composition and variations are the main reasons why these crops remain underutilized (Jansen van Rensburg *et al*., 2004). Therefore, the performance and variation of nutrients among less familiar green leafy vegetables such as Jatropha tanjorensis, *Solanum nigrum, Talinum triangulare, Solanecio biafrae, Vernonia amygdalina, Crassocephalum crepidoides, Telfairea occidentalis, Amaranthus hydridus, Launaea taraxacifolia* and *Solanum macrocarpon* which are also under exploitation and underutilized, need to be assessed. Hence, the objective of this paper is to assess the nutritional value of selected underutilized green leafy vegetables in Southwestern Nigeria.

MATERIALS AND METHODS

Sample Collection and Sample Preparation: The selected underutilized vegetables were bought from Owode market, Oja Oba market, Sasha market, Igbona market, and their environment in Osogbo, Osun State, Nigeria. The vegetables were identified, authenticated, and deposited in the laboratory of the Department of Plant Biology, Osun State University, Osogbo, Nigeria.

Table 1: List of ten underutilized vegetables with their Local name, English name, scientific name and Family name

Local Name	**English name**	**Scientific name**	**Family**
Iyana Ipaja	Miracle plant	*Jatropha tanjorensis*	*Euphorbiaceae*
Oodu	Glossy Night Shade	*Solanum nigrum*	*Solanaceae*
Gbure	Water leaf	*Talinum triangulare*	*Portulacaceae*
Worowo	Bologi	*Solanecio biafrae*	*Asteraceae*
Ewuro	Bitter leaf	*Vernonia amygdalina*	*Asteraceae*
Ebolo	Fire weed	*Crassocephalum crepidoides*	*Apiaceae*
Ugu	Fluted pumpkin	*Telfairea occidentalis*	*Cucurbitaceae*
Soko	Plumed cockscomb	*Celosia argentea*	*Amaranthaceae*
Yanrin	Wild lettuce	*Launaea taraxacifolia*	*Asteraceae*
Gbagba	Africa eggplant leaf	*Solanum macrocarpon*	*Solanaceae*

[e] *Means with the same letter in columns are not significantly different at p≤0.05, Duncan's multiple range test. Data are means of 3 replicates.*

The samples were properly washed under tap water, oven-dried in an air-circulating oven at 70^0 C, blended into powder, and preserved in tightly sealed containers for mineral analysis. The mineral analyses of potassium (K), phosphorous (P), sodium (Na), calcium (Ca), and magnesium (Mg) were carried out on the ground samples following the methods of AOAC (2005).

Sample Analysis: To determine ash content, a clean, flat-bottomed silica dish was held in a hot burner flame for 1 minute. This was then transferred to a desiccator, cooled, and weighed (W). Two gramme of the pulverized plant sample was weighed into a dish (W1) and heated gently on the Bunsen burner, charred, and later transferred to a muffle furnace at 550 °C and ashed for 6 hours (AOAC, 2000). The heating continued until all the carbon had been burned away and a whitish substance was left. The dish plus ash was then transferred into a desiccator, cooled, and weighed until a constant weight was obtained (W2). The ash content of the sample was calculated using the formula adopted by Chukwuma *et al*. (2016).

$$\% \text{ of Ash} = \ = \frac{W2-W}{W1-W} \times 100$$

For moisture content determination, about 2 g of the sample was weighed into a silica dish previously dried and weighed. The sample was then dried in a conventional oven at 650 °C for 36 h, cooled in a desiccator, and weighed. The drying and weighing continued until a constant weight was achieved. The difference in weight was recorded as the moisture content, while the percentage moisture content was estimated. The crude fiber content of the samples was determined by sequential acid and alkali hydrolysis followed by ignition. One gram (1 g) of a grounded sample was collected in a 1-L beaker covered with a round-bottom flask containing cold water. The system maintained a constant volume during boiling. The contents of the beaker were refluxed to the boiling point with 250 ml of 1.25% H_2SO_4. The beaker was then sealed with cotton, and the mixture was boiled on a heater for 30 minutes. Then, the content was filtered quickly in a Buchner funnel through Whatman No. 1 filter paper and washed to remove the acid. The acid-free residue was refluxed with 200 ml of a 1.25% NaOH solution at boiling point for exactly 30 minutes, maintaining the same constant volume as before. Then, the mixture was filtered as before and washed with water to make the residue alkali-free. The residue was transferred to a crucible and dried in an oven at 105 °C until a constant weight was attained. The sample was then cooled in a desiccator and weighed as W1. The sample was then ignited in a muffle furnace at 5500 °C for 4 hours, after which it was cooled again in a desiccator. The weight of the ignited sample was recorded as W2 after subsequent cooling. The weight loss of the samples after ignition indicated the amount of crude fiber (W2-W1). The percent of crude fiber was calculated using the following formula adopted by Suman *et al*., 2022:

$$\% \text{ of Crude fiber} = \frac{w2-w1}{W1} \times 100$$

For protein determination, 2 g of dried and ground samples were taken in a Kjeldahl flask. 18 ml of H_2SO_4, 1 g of $CuSO_4$ and 20 ml of concentrated H_2SO_4 were added. This was digested in the Kjeldahl digestion unit for 6 hours. The mixture was cooled to room temperature. It was transferred into 50 ml of a 4% boric acid solution in a receiving flask, and 3-5 drops of mixed indicator were added. This was placed under the condenser at Kjeldahl. Distillation unit, making sure that the condenser tube extends beneath the surface of the acid, in the flask. 50 ml of water and 60 ml of a 32% NaOH solution were then added to the Kjeldahl flask and distilled so that a volume of 200^0C was collected in the receiving flask, which was later removed for titration. 0.1 N HCl was taken in a burette, and the content of the flask was titrated against it. The reading was noted, and the percentage of protein was determined following the formula of Chukwuma *et al*. (2016)

$$\% \text{ Protein} = \% \text{ Nitrogen x } 6.25.$$

To determine crude fat content, 2 g of the powder sample was weighed into the thimble with porosity, which permitted rapid passage of the solvent. The thimble was covered with deflated cotton wool. 25 mL of petroleum ether was poured into the flask, and the Soxhlet extractor was fixed. The whole setup was put on an electro mantle, and it was heated to 500 °C, which was extracted for 5 h. The solvent was evaporated until no odour of petroleum ether that was used as a solvent remained. Carbohydrate was obtained by difference methods using the method described by Bryant *et al*. (1988), in which the sum of moisture, fat, crude fiber, protein, and ash is subtracted from 100. This is referred to as "estimated" by the “different method”.

% carbohydrate = 100% - (% Moisture + % Fat + % Fiber + % Protein + % Ash).

Samples were digested as described by the method of Awofolu (2005) for mineral analysis. 0.5 g of powdered samples were weighed into a 100 cm3 beaker. 5 cm^3 of concentrated nitric acid (HNO_3) and

2 cm^3 of perchloric acid ($HClO_4$), together with a few boiling chips, were added. The mixtures were heated at 70 °C for 15 minutes until a light-coloured solution was obtained. The sample was then filtered into a 50cm3 standard flask, and two 5cm^3 portions of distilled water were used to rinse the beaker, and the contents were filtered into the 50ml flask. The filtrate was allowed to cool to room temperature before dilution was made to the mark, and the contents were thoroughly mixed by shaking. The digest was run on atomic absorption spectrometry (Buck Scientific, Norwalk, United Kingdom) for K, P, Na, Ca, and Mg. The contribution to the Recommended Dietary Allowance (CRDA) was calculated as follows: (NRC, 1989),

$$CRDA = \frac{C_E}{RDA}$$

Where C_E = Concentration of Elements and RDA is the Recommended Dietary Allowance.

Vitamin analysis was carried out according to the method documented by Pearson (1976). One gram of the sample was macerated with 30 mL of absolute alcohol. Three milliliters of 50% potassium hydroxide were added. The solution was then boiled for 30 minutes and cooled. Thirty milliliters of distilled water were added. The mixture was transferred to a separating funnel and washed with 10 mL of petroleum ether. The lower layer was discarded, while the upper layer was evaporated to dryness. The residue was dissolved in 10 mL of isopropyl alcohol, and absorbance was taken at 334 nm. Vitamin A content was extrapolated from a vitamin A standard curve. For the determination of vitamin C content, one gram of the sample was macerated with 20 mL of 0.4% oxalic acid. This solution was filtered with Whatman No. 1 filter paper. One milliliter of the filtrate was pipetted out, and 9 mL of indophenol reagent was added to it. The absorbance was read at 520 nm. The vitamin C content was extrapolated from a vitamin C standard curve. One gram of the sample was macerated with 20 mL of ethanol. The solution was filtered with Whatman No. 1 filter paper. One milliliter of the filtrate was pipetted out, and 1 mL of 0.2% ferric chloride in ethanol was added. One milliliter of 0.5% alpha dipyridyl solution was also added. The solution was diluted to 5 mL with water, and the absorbance was read at 520 nm using a digital spectrophotometer (Bibby Scientific Manufacturer, Jenway, Model 6300, Stone, Staffordshire, United Kingdom). The vitamin E content was extrapolated from a vitamin E standard curve.

Data Analysis: The data obtained were subjected to a one-way analysis of variance to determine statistically significant differences in the proximate composition, mineral composition, and vitamin contents of the ten vegetables studied. Means were separated using Duncan's post-hoc test in SPSS (ver. 25.0, SPSS Inc., Chicago, IL).

RESULTS AND DISCUSSION

Mineral nutrients: All the leafy vegetables contained an appreciable amount of K, Na, P, Ca, and Mg. In all, the concentration of K ranged from 0.06 to 2.00 g/mol, Na ranged from 0.03 to 2.04 g/mol, P ranged from 0.02 to 2.01 g/mol, Ca ranged from 0.03 to 2.17 g/mol, and the concentration of Mg ranged from 0.04 to 1.96 g/mol. *Jatropha tanjorensis* was found to contain the highest K concentration, followed by Solanum nigrum while Solanum macrocarpon was found to contain the least K concentration. *Solanecio biafrae* was found to contain the highest concentration of Na, followed by *Amaranthus hydridus* while *Telfairea occidentalis* was found to contain the lowest Na concentration. The concentration of P was found to be highest in Solanum nigrum followed by *Telfairea occidentalis* and lowest in Vernonia amygdalina. The concentration of Ca was found to be highest in Telfairea occidentalis followed by *Solanecio biafrae* and lowest in *Solanum macrocarpon*. Meanwhile, *Crassocephalum crepidoides* was found to contain the highest concentration of Mg, followed by *Jatropha tanjorensis* while *Talinum triangulare* was found to contain the lowest Mg concentration (Table 2). There were variations in the concentration of mineral elements in the leaves of *Jatropha tanjorensis*, *Solanum nigrum*, *Talinum triangulare*, *Solanecio biafrae*, *Vernonia amygdalina*, *Crassocephalum crepidoides*, *Telfairea occidentalis*, *Amaranthus hydridus*, *Launaea taraxacifolia* and *Solanum macrocarpon*. The concentration of K compared to other mineral elements was found to be highest in *Jatropha tanjorensis* and *Talinum triangulare*, Na was found to be highest in *Amaranthus hydridus*, P was found to be highest in *Crassocephalum crepidoides* and Solanum macrocarpon, Ca was found to be highest in *Solanecio biafrae*, *Telfairea occidentalis* and *Launaea taraxacifolia* while the concentration of Mg was found to be highest in *Crassocephalum crepidoides* (Table 2).

Essential Vitamins: The leafy vegetables were found to contain the essential vitamins (A, C, and K) at a considerable level. The concentration of vitamin A in the leafy vegetables ranged from 5.43 to 6.62 g/mol, while the concentration of vitamin C ranged from 8.61 to 6.62 g/mol. The concentration of vitamin E ranged from 0.48 to 0.65 g/mol. Vitamin C contents were found to be higher in *Jatropha tanjorensis*, *Solanum nigrum*, *Talinum triangulare*, *Solanecio biafrae*, Vernonia amygdalina, *Crassocephalum crepidoides*, *Telfairea occidentalis, Amaranthus hydridus, Launaea taraxacifolia*, *Solanum macrocarpon* as compare to Vitamin C and E, while the content of Vitamin E was the lowest. Among the leafy vegetables, the content of vitamins A and E was found to be highest in *Jatropha tanjorensis* followed by Solanum nigrum, and lowest in *Solanecio biafrae* and *Telfairea occidentalis*. Vitamin C content was found to be highest in Solanum macrocarpon followed by *Launaea taraxacifolia* and lowest in *Solanecio biafrae* (Table 3). Proximate Composition. The results indicated that 60% of the vegetables have significant ash, moisture, crude fiber, protein, crude fat, and carbohydrate contents. Ash content ranged from 4.8 to 7.6 kcal/100 g. All the vegetable samples contained moisture contents ranging between 4.5 and 7.0%. Crude fiber content ranged from 14.30 to 24. 35 g/100g

Table 2: Mineral nutrients composition of the ten underutilized vegetables

	K	Na	P	Ca	Mg
Miracle plant	2.00a[a]*	0.076c	0.02f**	0.08d	1.51ab
Glossy Night Shade	1.77a	0.16c	2.01a*	0.10d**	0.11d
Water leaf	0.62b*	0.07c	0.12cd	0.04d**	0.04d**
Bologi	0.14b	2.04a	0.02f**	2.07a*	0.09d
Bitter leaf	0.11b	0.09c	0.01f**	1.16b*	0.75c
Fire weed	0.08b	1.20b	0.07e**	1.17b	1.96a*
Flute pumpkin	0.07b	0.03c**	1.14b	2.17a*	0.05d
Plumed cockscomb	0.06b	1.41b*	0.02f**	1.10b	1.10bc
Wild lettuce	0.06b**	0.09c	0.08de	0.27c*	0.10d
Africa eggplant leaf	0.06b	0.09c	0.15c*	0.03d**	0.06d
$LSD_{0.05}$	0.58	0.20	0.04	0.17	0.49

[a] Means with the same letter in columns are not significantly different at p≤0.05, Duncan's multiple range test. Data are means of 3 replicates.

Table 3: Essential Vitamins in the ten underutilized vegetables

Underutilized plants	Vitamin A	Vitamin C	Vitamin E
Miracle plant	6.62a[a]	9.88bc*	0.64a**
Glossy Night Shade	6.33b	9.17d*	0.65a**
Water leaf	6.20bc	9.79c*	0.51cd**
Bologi	5.57g	8.08f*	0.59b**
Bitter leaf	5.90de	8.61e*	0.56b**
Fire weed	5.84ef	8.74de*	0.59b**
Flute pumpkin	5.43g	9.11d*	0.50de**
Plumed cockscomb	5.63fg	9.74c*	0.48e**
Wild lettuce	5.99cde	10.27b*	0.54c**
Africa eggplant leaf	6.11bcd	11.71a*	0.58b**
$LSD_{0.05}$	0.23	0.47	0.02

[a] Means with the same letter in columns are not significantly different at p≤0.05, Duncan's multiple range test. Data are means of 3 replicates

The fat content of the vegetable species ranged from a low of 7.0 g/100 g (*Talinum triangulare*) to 10.60 g/100 g (*Jatropha tanjorensis*). The carbohydrate content of the leaf samples varied considerably, ranging from 33.45 g/100 g in Vernonia amygdalina to 53.60 g/100 g in *Jatropha tanjorensis. Amaranthus hydridus*, Vernonia amygdalina and Solanum nigrum had the same content of protein (Table 4). There was a slight variation in the ash, moisture, crude fiber, protein, crude fat, and carbohydrate contents of the ten vegetables investigated. The percentage of ash was highest in *Amaranthus hydridus*, followed by *Solanecio biafrae* and lowest in *Solanum nigrum*. Percentage moisture was highest in *Launaea taraxacifolia*, followed by *Vernonia amygdalina* and lowest in *Solanum macrocarpon*, and crude fiber was highest in *Solanecio biafrae*, followed by *Vernonia amygdalina* and lowest in *Crassocephalum crepidoides*. The protein content was highest in *Amaranthus hydridus* and *Solanum nigrum*, followed by *Crassocephalum crepidoides* and lowest in *Jatropha tanjorensis*. Percentages of crude fat and carbohydrate were highest in *Jatropha tanjorensis* and lowest in *Talinum triangulare* and *Amaranthus hydridus* (Table 4). The recommended dietary allowances (RDA) of K in the leafy vegetables ranged from 0.28% in Solanum macrocarpon to 9.98% in *Jatropha tanjorensis*, and Na ranged from 0.5% in *Telfairea occidentalis* to 40.76% in *Solanecio biafrae*. The recommended dietary allowances for Ca varied greatly and ranged from 0.25% in Solanum macrocarpon to 18.12% in *Telfairea occidentalis*. The highest recommended dietary allowances of P were found in Solanum nigrum and the lowest were found in *Vernonia amygdalina*. The leafy vegetable with the highest recommended dietary allowances of magnesium was *Telfairea occidentalis*, and the lowest was *Solanum macrocarpon*. There was no significant difference observed in the recommended dietary allowances of K in *Jatropha tanjorensis* and *Solanum* *nigrum*, as well as in *Talinum triangulare*, *Solanecio biafrae*, *Vernonia amygdalina*, *Crassocephalum crepidoides*, Telfairea occidentalis, *Amaranthus hybridus* and *Launaea taraxacifolia*. This was also the same for Ca in Vernonia amygdalina, *Crassocephalum crepidoides*, Jatropha tanjorensis, Solanum nigrum and *Amaranthus hybridus*, *Talinum triangulare* and *Solanum macrocarpon*. For P, the recommended dietary allowances of *Amaranthus hydridus, Solanecio biafrae*, *Jatropha tanjorensis*, and *Vernonia amygdalina* were not significant.

Leafy vegetables are good sources of minerals like iron, calcium, potassium, and magnesium, as well as vitamins such as C, E, K, and many of the B vitamins. They also provide a variety of phytonutrients such as zeaxanthin, lutein, omega-3 fatty acids, and beta-carotene, which protect cells from damage in elderly individuals with health-related problems (Sreenivasa Rao, 2017). Edelman and Colt (2016) reported that the mineral content of leafy vegetables provides all the essential amino acids that meet the nutritional standards of both young and adults. The results obtained on the mineral content of *Jatropha tanjorensis*, *Solanum nigrum*, *Talinum triangulare*, *Solanecio biafrae*, *Vernonia amygdalina*, *Crassocephalum crepidoides*, *Telfairea occidentalis, Amaranthus hybridus*, *Launaea taraxacifolia, Solanum macrocarpon* in this study revealed that they contain appreciable amounts of macronutrients such as K, Na, P, Ca, and Mg (Afolayan and Jimoh, 2009). These nutrient elements were high in comparison to commonly cultivated vegetables (Schippers, 2000; Nordeid *et al*., 1996; Opabode and Adebooye, 2005). This indicated that they are good dietary sources of minerals. Meanwhile, mineral elements such as K, Na, P, Ca, and Mg are macronutrients that exhibit a wide range of physiological functions such as anti-allergenic, antioxidant, anti-thrombotic, cardioprotective, and vasodilatory effects (Manach *et al*., 2005).

Table 4: Proximate content of the ten underutilized vegetables

	Ash	Moisture	Crude_Fiber	Protein	Crude_Fat	Carbohydrate
Miracle plant	5.55e[e]	6.50c	15.00i	8.75g	10.60a	53.60a
Glossy Night Shade	4.80g	4.90f	21.50e	21.90a	8.95c	37.95g
Water leaf	4.95f	4.50h	23.50d	13.13f	7.05i	46.87b
Bologi	7.50b	4.90f	24.35a	19.69c	7.70g	35.86h
Bitter leaf	4.30h	6.75b	24.10b	21.90a	9.50b	33.45j
Fire weed	7.50b	5.10e	14.30j	21.88b	7.15h	44.07c
Fluted pumpkin	6.50d	6.50c	21.00g	17.50d	7.85f	40.65f
Plumed cockscomb	7.60a	6.35d	20.95h	21.90a	8.05e	35.15i
Wild lettuce	6.80c	7.00a	21.10f	15.31e	8.50d	41.29e
Africa eggplant leaf	6.80c	4.55g	23.75c	15.31e	7.15h	42.44d
$LSD_{0.05}$	59E-9	3E-8	336E-9	0.00	0.00	672E-9

[e] Means with the same letter in columns are not significantly different at $p \leq 0.05$, Duncan's multiple range test. Data are means of 3 replicates.

Table 5: Recommended Dietary Allowance

	K	Na	Ca	P	Mg
Miracle plant	9.98a[a]	1.52c	0.68d	0.13f	2.31d
Glossy Night Shade	8.83a	3.22c	0.85d	16.76a	2.91d
Water leaf	3.08b	1.37c	0.34d	1.03cd	1.17d
Bologi	0.72b	40.76a	17.22a	0.17f	59.04a
Bitter leaf	0.53b	1.70c	9.66b	0.095f	33.13b
Fire weed	0.39b	24.07b	9.71b	0.61e	33.29b
Fluted pumpkin	0.37b	0.50c	18.12a	9.52b	62.11a
Plumed cockscomb	0.29b	28.13b	9.17b	0.19f	31.43b
Wild lettuce	0.29b	1.79c	2.24c	0.67de	7.69c
Africa eggplant leaf	0.28b	1.79c	0.25d	1.21c	0.87d
$LSD_{0.05}$	2.90	4.08	1.38	0.36	4.72

[e] Means with the same letter in columns are not significantly different at $p \leq 0.05$, Duncan's multiple range test. Data are means of 3 replicates.

Calcium, potassium, and magnesium have antioxidant properties that are much stronger than those of vitamins C and E. Therefore, consumption of these leafy vegetables may be helpful in overcoming nutritional deficiencies. There were variations in the mineral nutrients among the vegetables. The amounts of mineral nutrients vary widely from species to species. Some of the mineral elements were higher in one leafy vegetable than in another, while others were lower. These variations might be a result of the individual habits of the plant species. Variations in topography, climatic conditions, and soil factors might have also influenced the chemical composition of the crop species (Gupta *et al*., 2005; Uusiku *et al*., 2010). Leafy vegetables are increasingly recognized as major contributors of both micronutrients and bioactive compounds to diets (Smith and Eyzaguirre, 2007). They also contain nutrients such as vitamins A, B-complex, C, E, and K (Manach *et al*., 2005). Altogether, these compounds act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a healing role in aging and various disease processes (Manach *et al*., 2005). All the leafy vegetables (*Jatropha tanjorensis*, *Solanum nigrum, Talinum triangulare, Solanecio biafrae, Vernonia amygdalina*, *Crassocephalum crepidoides*, *Telfairea occidentalis*, *Amaranthus hybridus*, *Launaea taraxacifolia*, *Solanum macrocarpon*) contain essential vitamins (A, C, and E) ranging from 0.48 to 11.71 mg/g. This range of values is similar to those obtained by Lakshmi and Vimala (2000) on powered leafy vegetables, Unuofin *et al*. (2017) on *Kedrostis africana*, Uusiku, *et al*. (2010) on leafy vegetables of sub-Saharan Africa, and Olawoye *et al*. (2017) on *Amaranthus viridis* seed. Meanwhile, the vitamin C contents in all the leafy vegetables were found to be lower than those of vitamins A and E. This implies that these vegetables are poor sources of vitamin C, which might have health implications for human diets. This is in line with the results obtained by Ogunlesi *et al*. (2010) on tropical leafy vegetables. Moreover, *Jatropha tanjorensis* had the highest content of vitamins A and E, while Solanum macrocarpon had the highest content of vitamin C, while other vegetables have a considerable amount of these vitamins. This implies that *Jatropha tanjorensis* and *Solanum macrocarpon* are rich sources of vitamins A and C, and therefore can serve as important sources for the supplementation of micronutrients in vegetarian diets. From the results obtained on the proximate composition of Jatropha tanjorensis, Solanum nigrum, Talinum triangulare, *Solanecio biafrae*, *Vernonia amygdalina*, *Crassocephalum crepidoides*, *Telfairea occidentalis*, *Amaranthus hydridus*, *Launaea taraxacifolia*, *Solanum macrocarpon*, it was observed that the leafy vegetables contain a significant percentage of ash, moisture, crude fiber, protein, crude fat, and carbohydrates, which are comparable to those obtained in *Kedrostis africana*, leafy vegetables of sub-Saharan Africa, *Amaranthus viridis* seed, and tropical leafy vegetables (Ogunlesi *et al*., 2010; Uusiku *et al*., 2010; Unuofin *et al*., 2017). Consumption of high levels of vegetable fiber can result in a reduced risk of cardiovascular diseases and cancer of the colon (Jenkins, 2001). There were variations in the proximate composition, such as ash, moisture, crude fiber, protein, crude fat, and carbohydrate, among the leafy vegetables. These variations may be attributed to the individual attributes of the plant species. *Jatropha tanjorensis*, *Solanecio biafrae,* and *Launaea taraxacifolia* are mostly aquatic plants with succulent stems and leaves. This might have contributed to their moisture content, crude fiber, and protein. *Solanum nigrum*, *Amaranthus hybridus*, and *Crassocephalum crepidoides*' lower content of moisture, crude fiber, protein, crude fat, and carbohydrates might be a result of their thick and mucilaginous leaves and stems. Meanwhile, these vegetables may have medicinal importance and are ideal for weight management as they are typically low in calories. Nutrient-rich foods are vital for proper growth both in adults and children (Asibey–Berko and Taiye, 1999). Health officers should promote the nutritional values of locally grown and consumed leafy vegetables among people, especially children, as this can contribute substantially to improving their diet

Conclusion: Taking into account the recommended dietary allowance (RDA) for minerals in this study, these underutilized leafy vegetables can provide 10% of the recommended dietary allowance (RDA) for adults and children. It can therefore be ascertained that these vegetables have high nutrient values and thus may be desirable to serve as better supplements for diets. These leafy vegetables being well endowed with the essential nutrients required by man could be important contributors to improving the nutritional content of human diets.

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