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Phytochemical Screening and Nutritional Analysis of Five Common Edible Leafy Vegetables in Southwestern Nigeria

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ABSTRACT

In tropical countries, leafy vegetables are traditionally cooked and eaten as a relish together with starchy staple food. This study examined the nutritional compositions and phytochemicals of *Amaranthus hybridus* ('Efo tete'), *Solanum nigrum* ('Odu'), *Solanecio biafrae* ('Worowo'), *Telfairia occidentalis* ('Ugu'), and *Corchorus olitorius* ('Ewedu'), mostly grown in western Nigeria and used in preparing staple indigenous recipes. Kjehdal method and HPLC were used for proximate composition, amino acid, vitamins and mineral analysis while alkaloids, quinones, flavonoids, tannins, phlobatannins, glycosides, cardiac glycosides, anthraquinone, saponins, terpenoids, steroids, and anthocyanides screening was carried out using standard methods. Results showed significant total soluble carbohydrates in all the leaves, with *Solanum nigrum* having the highest value (55.90 ± 0.10). Protein and crude fibre contents are highest in *Corchorus olitorius* leaves (31.85 ±0.02 and 36.02 ± 0.01 respectively) while fat and ash contents were highest in *Solanum nigrum* leaves (5.71± 0.01) and *Telfairia occidentis* (23.00±0.00), respectively. Essential amino acids such as Leucine, Lysine, Phenylalanine and Histidine were observed in appreciable values. The leaves contain a high amount of vitamin A (≥1714.70) while vitamin E and vitamin B3 are more significant in *Telfairia occidentis* and *Corchorus olitorius,* respectively. All the vegetables contain macronutrients, especially phosphorus and the above listed phytochemicals , suggesting their antioxidant potentials. The results provided evidence of the potential of these vegetables to improve nutritional and health status.

Keywords: Nutritional Status, Macronutrients, Health Benefits, Proximate Composition

INTRODUCTION

Health is inextricably linked to good nutrition, and many diseases result from nutritional imbalances. The body requires not only a certain proportion of carbohydrates, fats, and proteins but also vitamins and minerals to remain healthy. Plants contain all these components (Jansen van Rensburg *et al.*, 2004). In tropical Africa where the daily diet is dominated by starchy staples, leafy vegetables contribute significantly to household food security and add variety to cereal-based staple diets (Van-den-Heever, 2012). Indeed, African Leafy Vegetables (ALVs) are the cheapest and most readily available sources of proteins, vitamins, minerals, and essential amino acids (Martin and Meitner, 2006). Traditionally, leafy vegetables are cooked and eaten as a relish together with starchy staple foods, such as porridge (Vainio-Mattila, 2000). For flavour, taste, colour, and aesthetic appeal, these dishes can be prepared with a single plant species or with a combination of plants (Marshall, 2001; Fasuyi, 2006) to enhance the diet.

Nutritional and non-nutrient bioactive properties of ALVs contribute to their health-promoting and protecting effects. The sources of nutrition have long been reported to contribute significantly to vitamin and mineral consumption of local populations (Nordeide *et al*., 2013). As protective agents against diseases, these micronutrients are necessary for health and growth in humans (Ertan *et al*., 2002; Falade *et al*., 2003). Increasing rates of illness and death caused by infectious diseases and disabilities such as mental impairment are due to an inadequate intake of micronutrients known as "hidden hunger" (Black, 2003). For this reason, leafy vegetables are an excellent strategy for combating poverty, hunger, malnutrition, and undernutrition (Barminas *et al*., 1998). However, Steyn *et al*. (2001) reported that leafy vegetables consumed in Africa contain higher amounts of micronutrients than those found elsewhere.

In spite of the nutritional contribution of ALVs to local diets, and their health maintenance and protective properties, very little concerted effort has been made to exploit these biodiversified and healthy resources to improve the nutritional status of people in West Africa (Kwenin *et al.*, 2011). In southwest Nigeria, most people consume indigenous green leafy vegetables such as *Amaranthus hybridus* ("Efo tete"), *Solanum nigrum* ("Odu"), *Solanecio biafrae* ("Worowo"), *Telfairia occidentalis* ("Ugu"), and *Corchorus olitorius* ("Ewedu") through confectionery soups (CNRA, 2011). Although literature on the nutritive values of these leafy vegetables is abundant, this study provided complementary information on the proximate, nutrient, and phytochemical compositions of these vegetables, consumed locally in Southwest Nigeria, to provide more information about their wider application and contribution to the food security of the local community and beyond.

MATERIALS AND METHODS

Plant Materials

The material was basically plant material constituted of powders of the leaves of *Amaranthus hybridus* ("Efo tete"), *Solanum nigrum (*"Odu"), *Solanecio biafrae (*"Worowo"), *Telfairia occidentalis* ("Ugu") and *Corchorus olitorius* ("Ewedu") collected from Oye-Ekiti town, Oye-Ekiti Local Government, Southwest Nigeria. The samples were identified and authenticated by the Taxonomists at the Department of Plant Science and Biotechnology, Federal University Oye-Ekiti (FUOYE), Ekiti State, Nigeria, and the botanical names confirmed as shown above.

Preparation of the Leave Powders

The leaves of each vegetable were carefully washed with distilled water, dried at laboratory temperature for three weeks, and then pulverized in a mechanical grinder. The powders were then sieved with a stitch sifter of 0.2 mm and stored at laboratory temperature in sterile containers until use (Ugochukwu et al, 2013).

Qualitative Analysis of Phytochemical Constituents

The pulverized samples were subjected to phytochemical analysis for identification of phytoconstituents using standard procedures (Harbone, 1998; Ejikeme *et al*., 2014). This allows the identification of some constituents, such as alkaloids, flavonoids, tannins, glucosides, cardiac glycosides, quinones,

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anthraquinones, saponins, terpenoids, steroids, and anthocyanins

Determination of Proximate and Nutrient Composition

The AOAC (1990) methods were used to determine crude protein, lipids, fiber, and ash (in duplicate), whereas carbohydrate content was determined by subtracting crude protein, crude fat, crude fiber, and ash from total dry matter content (100). To estimate the crude protein content, the micro-Kjeldahl method was used to determine the concentration of milled samples. Using petroleum ether (40-600C) as a solvent in a Soxhlet extractor as a solvent, the lipid content was continuously extracted to determine lipid content. A known weight sample was defatted with petroleum ether to determine crude fiber content. The defatted sample was then boiled with H_2SO_4 under reflux, filtered, and rinsed with boiling water until the filtrates were no longer acidic. The residue was then boiled with NaOH, filtered, and rinsed with boiling water until the filters were no longer basic. Drying in an oven at 100C, cooling in a desiccator, and weighing the residue were followed by incineration at 6000C in a muffle furnace. Additionally, ash content was estimated by heating a known weight of the sample inside a pre-weighted porcelain crucible at 6000 C in a muffle furnace(AOAC (1990).

Determination of Mineral Composition

An acid digest was prepared by oxidizing 0.2 g of each powdered leaf with conc. HCl/conc. nitric acid to form a colorless solution. A certain volume of digests was diluted with distilled water and then heated until a colourless solution was obtained and then filtered with Whatman filter paper No. 1 (110 mm). The filtrate was then made up to 100 ml with distilled water. Afterward, the aliquot was analyzed using the Atomic Absorption Spectrophotometer (AAS), as described in the official method of the Association of Official Analytical Chemists (Achikanu *et al*., 2013). The blank and working standards were first, followed by the samples. Each sample was analyzed twice, and the data were reported as a mean of the analyzed samples in mg/100g.

Determination of Vitamin Composition

The vitamins in the leafy vegetables were determined by the official methods of the Association of Official Analytical Chemists (AOAC, 1990).

Determination of Amino Acid Composition

The amino acid profiles of the vegetable leaves were determined using the method of (AOAC, 2006). The vegetable leaves were dried to constant weight and defatted using chloroform and methanol of ratio 2:1. They were evaporated in a rotary evaporator and loaded into the Applied Bio-Systems, PTH Amino Acid Analyzer. The tryptophan in the samples was hydrolyzed using 4.2 N sodium hydroxide.

Statistical Analysis

Appropriate quality assurance procedures and precautions were carried out to ensure reliability of the data. All the experiments were carried out in duplicates and the results were presented as mean ± standard deviation. Data was analysed using Statistical Product for Service Solution (SPSS) version 2.0. Group mean differences and values at $P < 0.05$ were considered significantly different..

RESULTS AND DISCUSSION

Phytochemical analysis is of great importance in identifying new sources of nutrients and medicinal properties. Based on Table 1, alkaloids, flavonoids, tannins, phlobatannins, glycosides, cardiac glycosides, quinones, anthocyanins, anthraquinone, saponins, terpenoids, and steroids were found. The result showed that alkaloids and tannins are present in the five leafy vegetables. These compounds are biologically active in protecting plants against infection and are beneficial for both humans and animals (Webb, 2013). Alkaloids have been found to have microbiocidal effects, with the main antidiarrheal effects probably due to their effects on the small intestine, as well as antihypertensive, antifungal, anti-inflammatory, antimalarial, antiasthma, anticancer, antiarrhythmic, analgesic, antispasmodics, antibacterial, antihyperglycemic and antifibrogenic properties (Kurek, 2019). Tannins are useful in promoting wound healing, while steroids are used to treat inflammatory conditions such as systemic vasculitis (inflammation of blood vessels) and myositis (inflammation of muscles) (Orlowski *et al*, 2018). Tannins have also been proven to have antiviral and anticancer properties (Narayanan *et al*, 1999). Flavonoids are a large class of polyphenolic plant compounds found throughout the plant kingdom. Besides acting as an antimalarial, anti-inflammatory, and antioxidant (Liu, 2013), and many other pharmacological activities, they are also known to exhibit antiviral and anticancer properties. Cardiac glycosides have a strong and direct effect on the heart and help to support strength and contraction when the heart fails (Jing *et al*, 2019). Other phytochemicals identified in the leaves such as saponins, terpenoids, phlobalatannins, and quinones play roles as anticarcinogenic, hypocholesterolemic, immunostimulatory, antioxidant, anti-inflammatory as well as anti-aging and wound-healing properties (Zulkefli *et al*, 2023, Gemede and Ratta, 2014, Rao and Koratkar, 1997).

Table 1: Phytochemical composition of the leafy vegetables

Constituents	**Plant samples**				
	Senecio biafrae	***Telfairia occidentalis***	***Amaranthus hybridus***	***Corchorus olitorius***	***Solanum nigrum***
Alkaloids	+	+	+	+	+
Flavonoids	-	+	-	+	-
Tannins	+	+	+	+	+
Phlobatannins	-	+	-	+	-
Glycosides	+	-	+	+	+
Cardiac glycosides	-	-	-	+	+
Quinones	+	-	+	+	+
Anthraquinone	-	-	-	-	-
Saponins	-	-	-	+	-
Terpenoids	-	-	-	+	-
Steroids	+	-	-	-	-
Anthocyanins	+	+	+	-	+

(+) = Present; (-) = Absent.

Proximate analysis is conventionally used for assessing the food value of feed substance (AOAC, 2000). Table 2 summarizes the proximate composition of the different leafy vegetables. Overall, their proximate constituents are within standard recommendations, especially, with respect to protein, crude fibre, and soluble carbohydrates. However, there are significant differences ($P< 0.05$) in proximate values of the leaves in all the indices evaluated. Specifically, *Amaranthus hybridus* has the highest value of crude protein (33.42±0.17), followed by *Corchorus olitorius* (31.85±0.02), while *Telfairia occidentalis* has the lowest crude protein content (3.55±0.10). The crude protein value of 31.85±0.02 in *C. olitorius* shows that the vegetable can be considered a high-protein vegetable (Agbaire, 2012; Soetan and Aiyelaagbe, 2016). The crude protein value here differs from Daniel (2014), who had 24.14±0.21% crude protein. Their high protein content and good sources of indispensable (essential) amino acids (Table 5), indicate that they are good sources of protein required to compensate for low-quality protein that is affecting human and animal populations in developing countries (Soetan and Aiyelaagbe, 2016). Further, it may provide rural populations with a significant source of cheap and affordable protein (Ndlovu and Afolayan, 2008). Crude fibre values are significantly different ($p < 0.05$) but highest in *C. olitorius* leaves (36.02 ± 0.01%). However, the result of *C. olitorius* does not agree with Daniel (2014) who had 6.64±0.01%, and Onwordi *et al.* (2009) who reported 6.70±1.40% as crude fibre content. This significant difference may be a result of environmental or soil factors in which the vegetables grow. Dietary fibre promotes growth and protects beneficial intestinal flora. A high intake of fiber has been shown to reduce colon cancer risk (Gemede *et al.,* 2015). A study has indicated that plants with high fiber content can be used to treat obesity, diabetes, cancer, and digestive disorders (Ibironke, 2013).

The results (Table 2) show that *Telfairia occidentalis* has the highest ash content (23.00±00), while *Senecio biafrae* has the least value (7.91±0.02). The ash content of a plant reflects its mineral elements, which indicates the presence of inorganic elements. The high levels of ash in all the leaves studied indicate that the vegetable is rich in vital nutrients such as potassium, calcium, sodium, magnesium, phosphorus, zinc, copper, iron, and selenium. In humans and animals, minerals play an important role in nutritional development in many ways (Rahman *et al*., 2014). The ash content result of this work is different from Onwordi *et al*. (2009) who had 21.20±0.80% ash content of *C olitorius (*10.60±0.01). The difference may be caused by processing, soil conditions, or climate.

The moisture content of the dried leaves is highest in *Senecio biafrae* and *Amaranthus hybridus* (11.34±0.01%) but lowest in *Telfairia occidentalis (*7.10±0.01). Moisture content is an integral part of proximate composition analysis of food (Gemede *et al*., 2015). It is an indication of its water activity and is used as a measure of stability and susceptibility to microbial contamination (Uyoh *et al*., 2013). In accordance with Rishi *et al*. (2012), it is estimated that 6% to 15% of moisture is required for most vegetables. As a result, leaves can be stored easily, and their moisture content contributes to slowing down microorganism growth, hindering the hydrolysis of plant components (Ngaha *et al*., 2016), as well as hindering the growth of microorganisms.

Minor difference in crude fat value is noticed but highest in *Solanum nigrum* (5.71±0.01). According to the present study, Amaranthus spp. contains low fat (4.36%). This agrees with the report of Akubugwo *et al*., (2007) who reported crude fat values ranging from 4.65%. Food providing 1 – 2% of fat is sufficient for healthy humans as excess fat consumption has implications and may lead to certain cardiovascular disorders (Antia *et al*,2006). As part of food nutrients, fats contain more energy per gram than carbohydrates (Ilodibia, *et al.*, 2014). Additionally, they act as solvents for fat-soluble vitamins and are important as food ingredients not only because of their energy value but also because they enhance the palatability of food by absorbing and retaining flavors (Antia *et al*., 2006; Ilodibia *et al*., 2014). Since *C. olitorius* leaves have relatively low levels of fat, they can be recommended as part of a weight-reducing diet for weight loss. Hence, there is no risk of cardiovascular disease, obesity, or other related diseases from consuming large amounts of the leaf (Okon *et al*., 2017).

Carbohydrates constitute a major class of naturally occurring organic compounds that are essential for the safeguarding and nourishment of the life of plants and animals and provide raw materials for many industries (Ebunoluwa and Alade 2007). The samples contain a significant amount of carbohydrates considered as an important source of energy. *Telfairia occidentalis* has the highest carbohydrate value (51.63±0.01), while *Corchorus olitorius has* the lowest value (8.38±0.02). All the vegetables meet the recommended dietary allowance (RDA) values (FND, 2002). This high carbohydrate content agrees with the report given by Usunobun *et al*., 2016. The amount of carbohydrate determined for *C. olitoriu*s (8.38±0.02 mg/100g) was lower than that found by Yekeen *et al*., 2013 (48.17 ±0.12 mg/100g), Idirs *et al*., 2009 (19.58 ±0.05 mg/100g) and Ndlovu and Afolayan, 2008 (69.5 ±0.02 mg/100g). In line with Ijeomah *et al*. (2012), vegetables do not provide good sources of carbs as they contain substantial amounts, ranging from 5.69 - 10.38 mg/100g, but they can also serve as good sources since the RDA for this class of food is 7.0 - 100 mg/g. The above proximate composition result slightly agrees with Ajiboye *et al*., (2013). There may be differences due to the types of plants or soil in which the vegetable grows as well as environmental factors.

Table 2: Result of proximate composition of the leafy vegetables

	Crude protein	Crude fiber	Ash	Moisture content	Fat	Carbohydrate
Senecio biafrae	19.54±0.26^{c}	8.48±0.01^{a}	7.91±0.02^{a}	11.34±0.01^{d}	4.26±0.16^{a}	48.47±0.12^{c}
Telfairia occidentalis	3.55±0.10^{a}	10.46±0.01^{b}	23.00±0.00^{d}	7.10±0.01^{a}	5.162±0.01^{b}	51.63±0.01^{d}
Amaranthus hybridus	33.42±0.17^{e}	8.45±0.01^{a}	13.11±0.01^{c}	11.34±0.01^{d}	4.36± 0.07^{a}	29.32± 0.22^{b}
Corchorus olitorius	31.85±0.02^{d}	36.02±0.01^{c}	10.60±0.01^{b}	8.22±0.02^{b}	5.55±0.01^{c}	8.38±0.02^{a}
Solanum nigrum	9.22±0.10^{b}	8.78±0.01^{a}	10.58±0.01^{b}	9.81±0.20^{c}	5.71±0.01^{c}	55.90 ±0.10^{e}

Values are presented as Mean ± standard deviations of the duplicate (n=2) determination; Mean values of different superscript in the same column are significant at p<0.05.

Micro and macrominerals contribute to a host of physiological and metabolic processes (Murray *et al*., 2000). In Table 3, essential minerals in the vegetable leaves studied show significant differences (P < 0.05) in values and distribution patterns. *Telfairia occidentali* had the highest values of magnesium and calcium (7.85±0.01and 16.33±0.04), respectively, while *Senecio biafra* showed the least value of the two nutrients. The presence of magnesium in a diet is essential for decreasing blood sugar in animals, as it activates many enzyme systems and maintains nerve electrical potential (Balogun and Olatidoye, 2012); It is also important for maintaining acid balance in the body, producing enzymes, and so on (Usunobun and Okolie, 2016). Calcium plays a critical role in the growth and development of bones and teeth, coagulation of blood, contraction of muscles, and the normal function of the heart and nervous system (Murray *et al*, 2011).

A 100g/day consumption of *Corchorus olitorius,* for instance, will provide about 9% of daily calcium requirements. Dietary deficiencies of magnesium which is linked with ischemic heart disease could be prevented by regular consumption of these vegetables in the indigenous diet since the consumption of 100 g of *C olitorius* will contribute 124.68±1.07% of the daily requirement of the element (Ogbuagu *et al*., 2011). *Telfairia occidentali* has the highest value of iron (7.62±0.05), while *Solanum nigrum* has the lowest value (3.41 ± 0.08). The iron in the body has several biochemical functions, including bonding oxygen with hemoglobin and acting as a catalytic center in many enzymes (Oulai *et al*., 2014). In addition to hemoglobin formation, iron is essential for the normal functioning of the central nervous system, as well as the oxidation of carbohydrates, protein, and fat (Adeyeye *et al*., 2011). Among the samples, iron content is 5.18±0.03 for C. *olitorius.* Infants, convalescents, and the elderly are all at risk of iron deficiency if they do not consume enough iron in their diets (Barminas *et al*., 1998).

Consuming 100 g of *C. olitorius* will contribute 163.73±2.8 or 273.25± 5.94% of the RDA of this element, making it a good source of the element although the latter contributes a greater contribution. All the leaves have phosphorus content above 22.68 ± 0.09 (*Solanum nigrum*), being the least. *Amaranthus hybridus* has the highest (3518± 0.04). All tissues and cells require phosphorus for growth, maintenance, and repair, as well as for the production of genetic building blocks, DNA and RNA. It is an essential component of bone mineral. A phosphorous and calcium deficiency can cause osteoporosis, arthritis, rickets, pyorrhea, and tooth decay. The body needs a balance of calcium and phosphorous. The presence of potassium in the extracellular body fluid plays a vital role in the body system, such as improving insulin functions (Igbakin & Oloyede, 2009), and sugar and fat metabolism. All of the plants have significant and appreciable Na and K values, with *Telfairia occidentalis* and *Solanum nigrum* recording the highest values (7.51±0.02, 10.80±0.02, 7.85 ± 0.09 and 10.87 ± 0.10 respectively).

Sodium and potassium are two important intracellular and extracellular cations (Akpanyung, 2005) and both play a role in controlling plasma volume, acid-base balance, nerve and muscle contractions. Sodium remains a major electrolyte in the blood. In order to meet adequate sodium intake recommendations for both males and females between 9 and 50 years, 1500 milligrams are recommended, while 1300 milligrams are recommended after the age of 50 years old. In other words, 100g of either of these plants would provide approximately 6 and 7% of the recommended sodium intakes for the respective age groups if eaten. Potassium intake helps maintain blood pressure in healthy individuals and prevents high blood pressure in people who suffer from protein deficiency (Ogbuagu *et al*., 2011). *Telfairia Occidentali* has the highest value of Zinc (0.19±0.02) while *Senecio biafrae* and *Solanum nigrum* have the least value (0.05 ± 0.01). Zinc plays a crucial role in maintaining a healthy immune system, and its deficiency is possible when not enough of it is consumed from diet or supplementation (Haase and Schomburg, 2019)**.** The zinc in the body plays an important role in the immune system, and it forms the basis for over 50 enzymes (Okeke *et al*., 2006). As well as stimulating vitamin activity, zinc stimulates the formation of red and white blood cells (Igbakin and Oloyede, 2009).

In addition to being an integral part of many enzymes in the body, zinc also plays an important role in the proper functioning of immunity (Igbakin and Oloyede, 2009). As part of nerve transmission, sodium plays a crucial role. In addition to wound healing and taste and smell, zinc is essential to the body. Zinc content in the analyzed samples of vegetables was lower than that reported by

Kadiri (Kadiri, 2014), who reported a mean value of 2.79 mg/kg in leaf of long-Fruited Jute (Corchorus olitorius). Consuming these vegetables regularly may help prevent the adverse effects of zinc deficiencies, which result in retarded growth and delayed sexual maturation (Barminas *et al*., 1998). Zinc levels in this study are below 9.94 mg/kg, which is the maximum limit for zinc in vegetables. However, despite the fact that zinc is essential for the maintenance of the sense of smell, the building of proteins, the activation of enzymes, and the function as a neurotransmitter in the body, the United States Food, Drug and Agriculture (USDA) (2010) recommends that zinc be consumed in small quantities as it disrupts copper and iron absorption (Otemuyiwa *et al*, 2021, Murray *et al.*, 2000). The difference could be attributed to the fact that many soils are geographically deficient in certain minerals, which means foods grown in them lack those minerals. An overabundance of soil can also contribute to such problems. According to Joseph (1997), this variation could be explained by differences in plant types, ages, and environmental conditions in which the crops were grown.

Table 3: Result of mineral composition of the leafy vegetables.

	Mg	Fe	P	Na	K	Ca	Zn
Senecio biafrae	1.87 ± 0.04^{a}	5.41 ± 0.08^{b}	28.47 ± 0.82^{b}	4.83 ± 0.04^{a}	6.78 ± 0.03^{a}	3.84 ± 0.02^{a}	0.05 ± 0.02^{a}
Telfairia Occidentalis	7.85 ± 0.01^{e}	7.62 ± 0.05^{c}	28.36 ± 0.02^{b}	7.51 ± 0.02^{d}	10.80 ± 0.02^{c}	16.33 ± 0.04^{e}	0.19 ± 0.02^{c}
Amaranthus hybridus	2.52 ± 0.04^{b}	5.36 ± 0.02^{b}	35.18 ± 0.04^{d}	6.54 ± 0.06^{c}	6.78 ± 0.03^{a}	5.31 ± 0.04^{b}	0.15 ± 0.02^{b}
Corchorus olitorius	4.77 ± 0.04^{d}	5.18 ± 0.03^{b}	33.20 ± 0.07^{c}	5.48 ± 0.04^{b}	7.23 ± 0.06^{b}	10.22 ± 0.56^{d}	0.15 ± 0.03^{b}
Solanum nigrum	3.84 ± 0.12^{c}	3.41 ± 0.08^{a}	22.68 ± 0.09^{a}	7.85 ± 0.09^{d}	10.87 ± 0.10^{c}	8.50 ± 0.11^{c}	0.05 ± 0.01^{a}

Values are presented as Mean ± standard deviations of the duplicate (n=2) determination; Mean values of different superscript in the same column are significant at $p<0.05$.

The presence of antioxidant vitamins such as vitamins A, C and E, which are free radical scavengers, makes them useful in the management of diabetes mellitus. They also serve as immune system boosters (Sarubin and Thomson, 2007). Our bodies require vitamins to maintain functions such as immunity and metabolism. Among vitamins found in the leaves, as shown in Table 4, the highest levels were those of vitamin A and vitamin C, with the highest vitamin A values noted in *Senecio biafrae* (1755.67±0.86) and vitamin C in *Amaranthus hybridus* (133.33 ±0.00) *and Corchorus olitorius* (133.33). There are also appreciable values of vitamin B1, B2, B3 and E as shown Table 4. Many biological functions are impacted by these vitamins, including growth, development of the skeleton, function, and maintenance (transformation and utilization of macronutrients), vision, and normal muscle, nervous, and immune function. The vitamin composition values of Amaranthus hybridus.leaves in this study (Table 4) is higher than the values of it (carotene (3.29), thiamine (2.75), riboflavin (4.24), niacin (1.54), ascorbic acids (25.40) and -tocopherol (0.50).) as reported by Akubugwo *et al.*,2007. This difference may be due to comparative environmental and edaphic factors between the two regions under review.

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Table 4: Result of vitamin composition of the leafy vegetables.

	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. E	Vit. C
Senecio biafrae	0.42±0.01[c]	2.22±0.08[b]	1.91±0.50[a]	1755.67±0.86[d]	10.71±0.14[c]	10.71±0.14[a]
Telfairia Occidentalis	0.32±0.01[b]	2.08±0.00[b]	37.34±4.41[d]	1714.70±3.45[a]	10.81±1.12[c]	95.23±0.00[c]
Amaranthus hybridus	0.19±0.01[a]	2.48±0.10[c]	4.35±0.73[b]	1714.70±3.45[a]	7.94±0.89[b]	133.33 ±0.00[d]
Corchorus olitorius	0.587±0.06[d]	2.82±0.01[d]	39.4±0.17[d]	1734.27±20.7[b]	6.36±0.67[a]	133.33±26.94[d]
Solanum nigrum	0.22±0.02[a]	1.71±0.01[a]	10.29±0.50[c]	1742.83±0[c]	6.44±0.69[a]	56.25 ± 0.00[b]

Values are presented as Mean ± standard deviations of the duplicate (n=2) determination; Mean values of different superscript in the same column are significant at $p<0.05$.

The amino acid composition of the leafy vegetables is presented in Table 5. Among the 18 amino acids observed, 10 were essential (lysine, histidine, arginine, threonine, valine, methionine, isoleucine, leucine, tryptophan, and phenylalanine) and most of them are within FAO/WHO (1990) daily intake reference values. A variety of other cellular products, including hormones, enzymes, and pigments, are synthesized from amino acids. Additionally, many of these amino acids play an important role in cellular metabolism (Murray *et al*., 2000). According to the results, non-essential amino acids (histidine, alanine, arginine, aspartic acid, glutamic acid, glycine, proline, and serine) have higher concentrations than amino acids that are essential (isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine, tryptophan, and valine). Aremu *et al*. (2006) and Hassan and Umar (2006) have reported similar observations It is observed that glutamic acid and aspartic acid are the most abundant non-essential amino acids, having the highest values in *Senecio biafrae* (15.43± 0.80 and 7.62 ± 0.04, respectively) while leucine and phenylalanine were the most abundant essential amino acid, with highest values in *Corchorus olitorius* (7.77±0.05 and 5.43±0.05) respectively in leaves. the leucine content of *Corchorus olitorius* is higher (1.14g) (Umedum *et al*., 2014). Therefore, glutamic acid and leucine had the highest concentration among their groups. Glutamic acid assists the nerve cells in the brain and sends and receives information. Many organisms rely heavily on it for nitrogen assimilation, amino acid biosynthesis, and cofactor synthesis. Leucine is an essential amino acid for protein synthesis. It is used in conjunction with insulin to signal the availability of energy, which stimulates muscle protein synthesis. In addition, leucine's carbon skeleton is used to generate ATP, just like other amino acids. As well as regulating protein synthesis, tissue regeneration, and metabolism, leucine can regulate other cellular processes as well. Methionine and cysteine, both sulphur-containing amino acids, are present in small quantities in all vegetables, but methionine is the least concentrated, with a value of 1.71±0.04 in *Corchorus olitorius*. Mammals require methionine to regulate metabolic processes, the innate immune system, and digestion. Histidine is also found in all vegetables, but in small amounts, with the highest concentration occurring in *Corchorus olitorius* (2.82±0.04). It can be shown that it has the highest quality of amino acids.

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Table 5: Result of amino acid composition of the leafy vegetables.

Amino Acids	*Senecio biafrae*	*Telfairia Occidentalis*	*Amaranthus hybridus*	*Corchorus olitorius*	*Solanum nigrum*	FAO/WHO (1990)
Glycine	4.56± 0.05^{a}	5.10±0.05^{b}	4.65± 0.05^{a}	4.90±0.05^{a}	4.71± 0.02^{a}	2.2
Alanine	2.89± 0.04^{a}	4.45±0.21^{bc}	4.75± 0.03^{c}	4.33±0.06^{b}	4.51 ± 0.08^{c}	6.1
Serine	3.14 ± 0.03^{a}	4.37±0.22^{c}	3.86± 0.08^{b}	3.49±0.01^{b}	4.04 ± 0.06^{c}	7.7
Proline	2.49 ± 0.04^{a}	4.40±0.14^{c}	3.37± 0.02^{b}	4.78±0.06^{c}	3.50 ± 0.09^{b}	10.7
Valine	4.10 ± 0.01^{b}	3.80±0.14^{a}	5.52± 0.02^{d}	5.10±0.05^{c}	5.93 ± 0.08	5.0
Threonine	2.94 ± 0.14^{a}	4.79±0.24^{d}	3.86± 0.15^{b}	4.26±0.06^{c}	3.94 ± 0.08^{b}	3.4
Isoleucine	3.69 ± 0.05^{bc}	1.19±0.09^{a}	4.08± 0.01^{c}	3.03±0.04^{b}	4.45 ± 0.07^{c}	2.8
Leucine	6.59 ± 0.02^{b}	6.52±0.24^{b}	6.54 ± 0.12^{b}	7.77±0.05^{c}	6.02 ± 0.09^{a}	6.6
Aspartate	7.62 ± 0.04^{c}	7.53±0.16^{b}	5.96 ± 0.10^{a}	7.30±0.05^{b}	7.60 ± 0.09^{c}	7.7
Lysine	5.18 ± 0.02^{c}	5.20±0.08^{c}	4.84± 0.14^{b}	4.30±0.03^{a}	5.48 ± 0.10^{c}	5.8
Methionine	1.25 ± 0.02^{a}	1.50±0.29^{b}	1.29± 0.03^{a}	1.71±0.04^{b}	1.53 ± 0.04^{b}	2.5
Glutamate	5.43± 0.80^{a}	15.09±0.09^{d}	13.78± 0.04^{c}	14.46±0.05^{d}	12.65 ± 0.08^{b}	14.7
Phenylalanine	4.15 ± 0.28^{a}	5.05±0.06^{b}	4.99± 0.16^{b}	5.43±0.05^{c}	5.36 ± 0.06^{c}	6.30
Histidine	2.67 ± 0.03^{c}	2.72±0.30^{c}	1.37± 0.02^{a}	2.82±0.04^{c}	2.30 ± 0.07^{b}	2.5
Arginine	6.27 ± 0.01^{b}	7.00±0.11^{c}	5.42± 0.02^{a}	5.44±0.06^{a}	7.32 ± 0.07^{c}	5.2
Tyrosine	3.26 ± 0.02^{c}	1.32±0.24^{a}	4.61± 0.02^{d}	2.52±0.04^{b}	1.94 ± 0.08^{a}	1.10
Tryptophan	1.66 ± 0.01^{c}	0.85±0.07^{a}	1.32± 0.02^{b}	0.81±0.03^{a}	9.35 ± 0.08^{d}	1.2
Cysteine	1.26 ± 0.02 ^{a}	1.11±0.09^{a}	1.22± 0.05^{a}	1.20±0.05^{a}	9.35 ± 0.08^{b}	3.0

Values are presented as Mean ± standard deviations of the duplicate (n=2) determination; Mean values of different superscript in the same row are significant at $p<0.05$.

CONCLUSION

In recognition of the nutritional contribution of African leafy vegetables(ALVs) to local diets, and their health maintenance and protective properties, a concerted effort has been made in this study to exploit these biodiversified and healthy resources to improve the nutritional status of people in Southwest Nigeria and beyond. Specifically, indigenous green leafy vegetables such as *Amaranthus hybridus* ("Efo tete"), *Solanum nigrum* ("Odu"), *Solanecio biafrae* ("Worowo"), *Telfairia occidentalis* ("Ugu"), and *Corchorus olitorius* ("Ewedu") which most people consume in this locality through confectionery soups have proximate constituents which are within standard recommendations, especially, with respect to protein, crude fibre, and soluble carbohydrates. In addition, among 18 amino acids observed, 10 were essential (lysine, histidine, arginine, threonine, valine, methionine, isoleucine, leucine, tryptophan, and phenylalanine) and most of them are within FAO/WHO. The results revealed that the vegetables also contain significant amounts of bioactive substances, including vitamins, mineral salts, and phytochemical compounds whose antioxidant constituents may be beneficial in the management of degenerative diseases. These essential nutrients needed in the diet can be used as energy sources, bodybuilders, regulators, and protectors. Therefore, this study provided complementary information on the proximate, nutrient, and phytochemical compositions of these vegetables, consumed locally in Southwest Nigeria, and consequently provided more information about their wider application and contribution to the food security of the local community and beyond.

REFERENCES

Achikanu, C.E., Eze-Steven, P.E., Ude, C.M. & Ugwuokolie, O.C. (2013). Determination of the vitamin and mineral composition of common leafy vegetables in southeastern Nigeria *Int. J. Curr.Microbiol.App.Sci* (2013)2(11): 348-350.

DOI: 10.56892/bima.v8i3.757

Adeyeye E.I. & Omolayo, F. O.(2011). Chemical composition and functional properties of leaf protein concentrate of *Amaranthus hybridal* and *Telfairia occidentalis*. *Agric. Biol. J. N. Am*.;2(3):499-511.

Agbaire P. O. (2012). Levels of anti-nutritional factors in some common leafy edible vegetables of southern Nigeria. *Afr. J. Food Sci. Tech*., 394: 99-101.

Ajiboye, B.O., Ibukun, E.O., Edobora, G., Ojo, A.O. & Onikanni, S.A. (2013). Chemical composition of *Senecio biafrae* leaf. *Scientific Journal of Biological Sciences:* 2(8) 153-158.

Akpanyung, E. O. (2005). Proximate and mineral composition of bouillon cubes produced in Nigeria. Pak. *J. Nutr*. 49(5):327-329.

Akubugwo, I.E.,Obasi, N.A.,Chinyere, G.C. & Ugbogu, A.E. (2007).Nutritional and chemical value of *Amaranthus hybridu*s L.leaves from Afikpo, Nigeria.*African Journal of Biotechnology* .6(24)pp. 2833-2839,17 Dec 2007.

Antia, B. S, Akpan, E. J, Okon P. A. & Umoren, I. U. (2006). Nutritive and anti-nutritive evaluation of sweet potatoes (Ipomoea batatas) leaves. *Pakistan J. Nutri*., 5: 166-168. DOI: http://dx.doi.org/10.3923/pjn..166.168.

AOAC.1990. Official methods of food analysis (15th edition). Williams. (ed). Association of Official Analytical Chemists, Washington D.C.pp.152-164.

AOAC (2000) Official Methods of Analysis. 17th Edition, The Association of Official Analytical Chemists, Gaithersburg, MD, USA. Methods 925.10, 65.17, 974.24, 992.16.

AOAC (2006). Official Method of Analysis of the Association of Official Analytical Chemists, Washington, D.C. 18th Edition. 2006;810- 931.

Aremu, M.O., Olaofe, O. & Akintayo, T.E. (2006). Comparative study on the chemical and amino acid composition of some Nigerian underutilized legume flours. *Pak. J. Nut*., 5, 34-38

Barminas, J.T., Charles, M. & Emmanuel, D. (1998). Mineral composition of non-conventional leafy vegetables. *Plant Foods Hum Nutr*. 53(1):29-36. doi: 10.1023/a:1008084007189. PMID: 10890755.

Black, R. (2003). Micronutrient deficiency-an underlying cause of morbidity and mortality. Bulletin of World Health Organization, 81: 79-83.

CNRA. (2011). Socio-economical importance of leafy vegetables for the urban populations of Côte d'Ivoire, CNRA Ed.

Daniel, K. (2014). Comparison of Nutritive Values of the Leaves and Stems of Long fruited Jute (Corchorus olitorius) and Local Garden Egg (*Solanum macrocarpon*). *Sci. J. Agri. Res. Manag.*, : 3.DOI: 10.7237/sjarm/129.

Ebunoluwa. Alade, A. S. (2007). Nutritional potential of Berlandier Nettle Spurge. *Food Chem*. 68: 359-367.

Ejikeme, C, M., Ezeonu, C. S. & Eboatu, A. N. (2014). Determination of physical and phytochemical constituents of some tropical timbers indigenous to Niger Delta Area of Nigeria," *European Scientific Journal:*10, (18). pp. 247–270, 2014.

Ertan, P., Yereli, K., Kurt, O., Balcioglu, I.C. & Onag, A. (2002). Serological levels of zinc, copper and iron element among Giadia lamblia injected children in Turkey. *Pediatrics International*, 44: 286-288.

Falade, O.S., Sowunmi, O.R, Oladipo, A., Tubosun, A. & Adewusi, S.R.A. (2003). The level of organic acids in some Nigerian fruits and their effects on mineral availability in composite diets. *Pakistan Journal of Nutrition*, 2: 82- 88.

FAO/WHO., 1990. Protein quality evaluation,In: Report of A joint FAO/WHO Expert Consultations FAO of the United Nations, Rome. Pp., 40.

Fasuyi, O.A.(2006). Nutritional potentials of some tropical vegetable leaf meals: chemical characterization and functional properties. *African Journal of Biotechnology*, 5: 49- 53.

FND.(2002). Food and Nutrition Board, Institute of Medicine national Academy of Sciences. Dietary Reference Intake for Energy, Carbohydrate, Fibre, Fat, Fatty Acids, Cholesterol, Protein and Amino Acid (Micronutrients).

Gemede, H. F. & Ratta, N. (2014). Antinutritional factors in plant foods: Potential health benefits and adverse effects. *Int. J. Nutri. Food Sci*., 3(4): 284-289. DOI: 10.11648/j.ijnfs.20140304.18.

Gemede, H. F. & Ratta N. (2015). Antinutritional factors in plant foods: Potential health benefits and adverse effects. *Int. J. Nutri. Food Sci.*, 3(4): 284-289. DOI: 10.11648/j.ijnfs.20140304.18

Harbone, J.B.(1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis (3rd Edition). Chapman & Hall. London, UK. pp. 40 - 96.

Haase, H., & Schomburg, L. (2019). You'd Better Zinc-Trace Element Homeostasis in Infection and Inflammation. *Nutrients*.3;11(9):2078. doi: 10.3390/nu11092078. PMID: 31484386; PMCID: PMC6770902.

Hassan, L. G. & Umar, K. J. (2006). Nutritional value of Balsam Apple (Momordi cabalsamina L.) leaves. *Pak. J. Nutr*. 5(6): 522-529.

Ibironke, A. A, & Olusola, O. O. (2013). Phytochemical screening, Proximate Analysis and Antimicrobial Activity of aqueous extract of Megaphrynium macrostachchyum seeds. *Int. J. Engin. Res*., Tech., 2: 2123-2131.

Idirs, S., Yisa, J. & Ndamitso, M.M. (2009). Nutritional composition of Corchorus olitorius leaves. *Anim. Prod. Res.Adv*., 5: 83-87.

Igbakin, A.P., & Oloyede, O.B. (2009). Comparative studies on the hypoglycaemic, hypoproteinaemic, hypocholesterolaemic and hypolipidaemic properties of ethanolic and normal saline extracts of the root of Vernoniaamygdalina in diabetic rats. *Adv. Environ. Biol*., 3; 33-38.

Ijeomah, A.U., Ugwona, F.U. & Ibrahim, Y. (2012): Nutrient composition of three commonly consumed indigenous vegetables of North-Central Nigeria. *Nigerian Journal Agricultural Environment*, 8(1), 17 – 21.

Ilodibia, C. V., Ugwu, R. U., Okeke, C. U., Azeabara, C. A, Okeke, N. F, Akachukwu, E. E. & Aziagba, B. O. (2014). Determination of Proximate Composition of various parts of Dracaena Species. *Int. J. Botany*, 10(1): 37-41.

Jansen-Van-Rensberg, W.S., Venter, S.L., Netshiluvhi, R., Van-Den-Heever, E., Voster, H.J. & De-Ronde, J.A. (2004). Role of indigenous leafy vegetables in combating hunger and malnutrition. *South African Journal of Botany*, 70: 52–59.

Jing, F., Zhongyuan,W. &, Lijuan, Z. (2019). Chapter Twenty - Clinical applications of the naturally occurring or synthetic glycosylated low molecular weight drugs, (Ed). Progress in Molecular Biology and Translational Science, Academic Press (163). Pp 487-522. ISSN 1877-173,

Joseph, F. Z. (1997). Functionality of Proteins in Food. Springer Science & Business Media, Germany.1st ed. Springer, pp. 57-63.

Kadiri, D. (2014). Comparison of Nutritive Values of the Leaves and Stems of Long-Fruited Jute (Corchorus olitorius) and Local Garden Egg (Solanum macrocarpon).

Science Journal of Agricultural Research and Management, 129, 1-3.

Kurek, J. (2019). Introductory Chapter: Alkaloids - Their Importance in Nature and for Human Life. IntechOpen. doi: 10.5772/intechopen.85400.

Kwenin, W.K.J., Wolli, M. & Dzomeku, B.M. (2011). Assessing the nutritional value of some African indigenous green leafy vegetables in Ghana. *Journal of Animal and Plant Science*s, 10: 1300-1305.

Liu, R. H. (2003). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *The Amer. J. of Clin. Nutr*., 78(3):5175-5205. DOI:10.1093/ajcn/78.3.517S.

Marshall, F. (2001). Agriculture and use of wild and weedy greens by the piik Ap Oom Okiek of Kenya . *Economic Botany*,55:32-46.

Martin, F.W. & Meitier, L.S. (2006). Edible leaves of the tropic, educational concerns for hunger organization. Inc. North Fort Myers, Florida. *Science and Education*.

Murray, R.K., Granner, D.K, Mayes, P.A. and Rodwell, V.W. (2000) Harper's Biochemistry. 25th Edition, McGraw-Hill, Health Profession Division, New York, 225.

Narayanan, B.A., Geoffrey, O., Willingham, M.C.& Nixon, D.W. (1999). Expression and its possible role in GI arrest and apoptosis in allergic acid treated cancer cells. *Cancer Letters*, 136(2); 215 – 21

Ndlovu J. & Afolavan A.J. (2008). Nutritional analysis of the South African wild vegetable Corchorus olitorius L. *Asian Journal of Plant Science*, 7:615–618.

Ngaha, N.M.I., Dahlan, I., Massoma, S.H., Mandengue, S.H. & Yusuf, A.A. (2016). Com[parative Proximate Analysis of Leaves and Bark of Alchornea Cordifolia (Euphorbiaceae). *Journal of Agriculture and Environmental Sciences*. 5(1).pp. 200 - 206.

Nordeide, M.B., Hatloy, A., Folling, M.,Lied, E. Oshaug, A.(2013). Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in Southern Mali. *International Journal of Food Science and Nutrition*, 45: 455-468.

Ogbuagu, M. N., Odoemelam, S. A. & Ano, A. O. (2011). Chemical composition of an under utilized tropical African seed: Adenantherapavonina. *J. Chem. Soc. Nig*., 36(1):23-28.

Okeke, C.V. & Elekwa, I. (2006). Proximate and preliminary phytochemical analyses of avocado pear persea gratissima Gatertn. F. (Family lauraceae). Niger. *J. Bot*., 19: 156-162.

Okon, W. I., Ogri, A. I., Igile G. O. & Atangwho, I. J. (2017). Nutritional quality of raw and processed unripe Carica papaya fruit pulp and its contribution to dietary diversity and food security in some peasant communities in Nigeria. *Int. J. Biol. Chem. Sci.*, 11(3): 1000-1011. DOI: https://dx.doi/10.4314/ijbcs.v11i3.5.

Onwordi, C. T., Ogungbade, A. M. & Wusu, A. D. (2009). The proximate and mineral composition of three leafy vegetables commonly consumed in Lagos, Nigeria. *Afri. J. Pure and Appl. Chem*., 3(6): 102-107.

Orlowski, P., Zmigrodzka, M., Tomaszewska, E., Ranoszek-Soliwoda, K., Czupryn, M., Antos-Bielska, M., Szemraj, J., Celichowski, G., Grobelny, J., Krzyzowska, M. (2018). Tannic acid-modified silver nanoparticles for wound healing: the importance of size. *Int J Nanomedicine*. 13:991-1007 https://doi.org/10.2147/IJN.S154797

Otemuyiwa, I.O., Akinbola, B.W., Akinyemi, I.O., Bamiro, C.O & Akingbade, A.A. (2021). Nutritional value and antioxidant activity of some reintroduced underutilized vegetables in Nigeria. *The Journal of Applied Science.* Vol 20, 58-59.

Oulai, P., Lessoy, Z., Rose-Monde, M., Ryta, D. & Sébastien N. (2014). Proximate Composition and Nutitive Value of Leafy Vegetables Consumed in Northern Cote D'ivoire. *European Scientific Journal*, 10(6):213-214.

Rahman, S.S; Khatun, A., Azhar, B.S., Rahman, H. & Hossain, S. (2014). A Study on the Relationship between Nutritional Status and Prevalence of Pneumonia and Diarrhoea among Preschool Children in Kushtia," *Pediatrics Research International Journa*l, Vol. 2014(2014), Article ID 805309, DOI: 10.5171/2014.805309. http://www.ibimapublishing.com/journals/PRIJ/prij.html

Rao, A.V. and Koratkar, R. (1997). Anticarcinogenic Effects of Saponins and Phytosterols. *ACS Symposium Series* Vol. 662 ISBN13: 9780841234987eISBN: 9780841216150. DOI: 10.1021/bk-1997-0662.ch018. pp 313-324.

Rishi, K. S., Deepak, P., Anirudh, P. & Abba, S. (2012). Proximate analysis, nutritive value, total phenolic content and antioxidant activity of Litchi chinensis. *Indian J. of Nat. Products*, 5: 361-369.

Sarubin, F.A. & Thomson, C. (2007). The Health Professional's Guide to Popular Dietary Supplements. 3rd ed. Chicago.IL. American Dietetic Association.

Soetan, K. O. & Aiyelaagbe, O. O. (2016). Proximate analysis, Minerals and Anti-nutritional factors of Moringa oleifera leaves. *Annals of Food Sci. Techno.*, 17(1): 253-256.

Steyn, N.P., Olivier, J., Winter, P., Burger, S. & Nesamvuni, C. (2001). A survey of wild, green, leafy vegetables and their potential in combating micronutrient deficiencies in rural populations. *South African Journal of Scienc*e, 97: 276– 278.

Ugochukwu, C.S., Arukwe, U.I. & Onuoha, I. (2013). Preliminary phytochemical screening of different solvent extracts of stems bark and roots of Dennetia tripetala @https://www.researchgate.net/publication/305113922_Preliminary_phytochemical_screening_of_different_solvent_extracts_of_stems_bark_and_roots_of_Dennetia_tripetala

Umedum, N.L., Nwosu, C.C., Udeozo I.P. & Igwemmar, N.C. (2014), "Amino Acid and Heavy Metal Composition of Afzelia africana Leaves". *World Journal of Nutrition and Health* 2(2), 17-20.

US Department of Agriculture and US Department of Health and Human Services Dietary Guidelines for Americans (2010).

Usunobun, U., & Okolie, P.N. (2016). Phytochemical analysis and proximate composition of Vernonia amygdalina, *International Journal of Scientific World*, 4(1) 11-14

Uyoh, E. A., Ita, E. E. & Nwofia, G. E. (2013). Evaluation of the Chemical Composition of Tetrapleura tetrapter Schum and Thonn) Tuap. Accessions from Cross River State, Nigeria. *Int. J. Med. Aromatic Plants*, 3: 386 394.http://www.openaccessscience.com.

Van-der-Heever, E. (2012). The use and conservation of indigenous leafy vegetables in South Africa.

Vainio-Mattila, K. (2000). Wild vegetables used by the Sambaa in the Usambara Mountains Tanzania. *Annales Botanci Fennici*, 37: 57-67.

Velavan, S. (2015). Phytochemical Techniques - A Review World Journal of Science and Research 1(2): 80-91.

Webb, D. (2013. Phytochemicals' Role in Good Health. Today's Dietitian, 15(9): 70.

Wikipedia the free encyclopedia. (2019). Corchorus oliterius. Wikipedia.

Yekeen, T.A., Akintaro, O.I., Akinboro, A. & Azeez, M.A.(2013). Evaluation of cytogenotoxic and nutrient composition of three commonly consumed vegetables in South West Nigeria. *African Journal of Food ,Agriculture and Development*:13(2): 7452-7466

Zulkefli, N; Che Zahari, C.N.M; Sayuti,N. H; Kamarudin, A. A; Saad, N., Hamezah, H. S; Bunawan, H; Baharum, S.N; Mediani, A; Ahmed, Q. U; Ismail, A.F.H. & Sarian, M.N.(2023). Flavonoids as Potential Wound-Healing Molecules: Emphasis on Pathways Perspective. *Int. J. Mol Sci*. 24(5):4607. doi: 10.3390/ijms24054607. PMID: 36902038; PMCID: PMC10003005.