Plant Archives Volume 21, No 1, 2021 pp. 32-39 *e-ISSN:2581-6063 (online), ISSN:0972-5210*

Plant Archives

Journal home page: www.plantarchives.org

DOI Url: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.005

UNDERUTILIZED LEAFY VEGETABLES IN WESTERN GHATS REGION FOR NUTRITIONAL SECURITY

P. Bhavithra[1], R. Balakumbahan[1*], P. Kannan[2] and V. Sivakumar[3]

[1]Horticultural College and Research Institute (TNAU), Periyakulam. Tamil Nadu, India
[2]Agricultural College and Research Institute (TNAU), Madurai. Tamil Nadu, India
[3]Coconut Research Station (TNAU), Aliyar Nagar. Tamil Nadu, India
E-mail: hortibala@gmail.com

(Date of Receiving-09-09-2020 ; Date of Acceptance-27-11-2020)

ABSTRACT

An Investigation on "Evaluation of underutilized leafy vegetables for yield and nutritional value" was conducted at Horticultural College and Research Institute, Periyakulam, TNAU during 2018- 2019 to determine the performance of underutilized leafy vegetables for growth, foliage yield and their nutritional content. Fifteen underutilized green vegetables used by the native people were collected and studied for their development, yield, and nutritional parameters. The results showed significant variations for different characters. The highest fresh foliage yield was registered in the *Alternanthera bettzickiana*. Ascorbic acid content was highest in *Acalypha indica* with lower fiber content. Carotenoid content and sodium content were recorded maximum in *Hibiscus cannabinus*. Total phenolic content was detected highest in G_{13} *Sauropus androgynus*. Potassium and copper content was showed a maximum in *Cardiospermum halicacabu*. Magnesium and manganese content was noticed highest in *Talinum fruticosum*. Zinc and calcium content was registered maximum in G_{15} *Solanum trilobatum*. Iron content was observed maximum in *Alternanthera sessilis*

Keywords: Underutilized, Leafy Vegetable, Western Ghats, Vitamins and Minerals

INTRODUCTION

Vegetables are well-known for their higher nutritional, mineral, vitamins, and therapeutical content and play an immense role in the human diet throughout the world. India is well known for its vegetable wealth and being the second-largest producer of vegetables next to China. The per capita vegetable consumption of an Indian citizen is only 175g against 300g of vegetables per day recommended by the World Health Organization. A regular supply of fresh, frozen, or canned vegetables should be an essential part of good living and good feeding as they add to the elegance and attractiveness of a meal. In developing countries, the consumption of vegetables for health reasons is all the more critical. Besides primary vegetables, Green Leafy Vegetables (GLV) also have a vital role in Indian cuisine due to higher nutritional, vitamins, mineral, and dietary fiber content, and some leafy vegetables are also recognized for their medicinal value. Kearney 2010, reported that 18.4 percent of the total iron intake and 38.3 per cents of pro-vitamin A consumption has been meeting out by leafy vegetables in the human diet.

In general, edible green leafy vegetables appear to be under-utilized or utilized by regional-specific peoples or throughout the world and may in some areas even be diminished in use. For example, *Trichopus zeylanicus* locally called Arogyapacha by Kani tribes of the Kanyakumari region. The stimulant effect of the plant is comparable to that of the famous food or drug ginseng. Arogyapacha enters modern pharmacopeia as a safe, anti-stress, anti-fatigue, appetite promoting, and restorative tonic (Mathew, 2013).

Nutritionally leafy vegetables are prominent sources of carotene, folate, niacin, iron, vitamin C, and calcium. These are of immense importance in preventing avitaminosis A, a significant cause of blindness in young children (Cooper *et al.*, 1992). Green leafy vegetables are good protein sources, especially lysine and tryptophan, vitamins, and minerals (Lovell, 1989, Shukla *et al.*, 2003 Arasaretnam *et al.*, 2018). Besides, leafy vegetables are potent Antioxidants scavenge free oxygen radicals in the body and protect against many diseases, including cardiac, cancer, inflammatory diseases (Law-Ogbomo *et al.*, 2009). Leaf protein concentrate (LPC) has become an alternative to milk protein (50-74 percent more of milk protein) to counteract protein malnutrition in children of rural areas (Guilbert, 2006).

In India, some common leafy vegetables viz., palak *(Beta vugaris var bengalensis)*, lettuce (*Lactuca sativa),* spinach (*Spinacia olerecea*), moringa (*Moringa oleifera),* etc., are being consumed by many people. Besides these common leafy vegetables, some of the green vegetables are commonly recognized at the local level and underexploited. Although they can be raised reasonably at lower management cost and on poor marginal soil, they have remained underutilized due to unawareness of their nutritional values (Chewya and Eyzaguirre, 1999, Odhav *et al.*, 2007). In view of this, a survey was conducted at local vegetable markets of the Theni district of Tamil Nadu for selecting the underexploited leafy vegetables to document the nutritional profile of selected underutilized leafy vegetables.

MATERIALS AND METHODS

Research Location: Investigation on the evaluation of underutilized leafy vegetables of Theni district for yield and the nutritional value was carried out at Department of Vegetable Science, Horticultural College, and Research Institute, Tamil Nadu Agricultural University, Periyakulam during the period from July 2018 to March 2019 situated at 10.126' North latitude, 77.58 East longitude, 426.76 m above MSL. The research location's soil type is sandy loam soil with pH and electric conductivity of 6.8 and 0.23 $dSm^{-1,}$ respectively.

Planting materials: Based on the survey conducted, fifteen diverse types of underutilized greens were collected from different places of the Theni district of Tamil Nadu and used as planting materials for this study. The details of the leafy vegetables utilized for the study are furnished below.

Experimental design: The field was ploughed three times, and the soil was brought to a slight tilt. Farm Yard Manure @ 20 tonnes per ha, *Pseudomonas fluorescens* @ 2 kg per ha was incorporated before the last ploughing. Raised beds of 20 cm height and 1.2 m width were prepared at a spacing of 60 cm between the beds. The plots were randomized as per Randomized Block Design, and the plants were planted as per the treatments with three replications each. In all plots, the selected planting materials *viz.,* seeds or cuttings were planted at 60 x 60 cm spacing. Irrigation was provided over the drip irrigation system immediately after sowing or transplanting and after as and when required. Inorganic nutrients in the forms of water-soluble fertilizers were applied to the plants through the fertigation system. The research plots were kept weed-free by hand weeding at consistent intervals.

Yield estimation: Green leaves were harvested with secateurs at 30 days intervals starting from 30 days after planting, and yield was expressed on grams per plant basis.

Nutrients content estimation: Leaf samples were collected from five tagged plants are pooled and dried. The leaf samples were dried in the shade and then in stainless steel hot air oven and then ground to a fine powder in an electric stainless steel grinder to pass through a 2 mm sieve. The ground leaf powder was stored after labeling in airtight plastic bags at room temperature and used for further analysis.

RESULTS AND DISCUSSION

Biomass yield: Out of fifteen green leafy vegetable species evaluated, ten species had come to the harvestable stage 30 days after planting (DAP) except *Chenopodium album*, *Centella asiatica*, *Pisonia alba*, *Sauropus androgynu*, *Solanum trilobatum* because of their slow growth characters in early stages. At 30 days after planting, 58.56 g of leaf per plant was recorded in Ceylon spinach, followed by 53.66 g per plant in *Alternanthera bettzickiana*. The highest leaf yield in the early stages of growth in cyclone spinach might be due to its succulent herbaceous nature (Nya and Eka, 2015) and spreading character with more number leaves in *Alternanthera bettzickiana* (Firoj *et al.* 2012)

Further, harvests during the study period high leaf biomass were observed in *Alternanthera bettzickiana and Alternanthera brasiliana*. The higher biomass in this species is mainly because; they are herbaceous perennial plants with more leaves (Firoj *et al.* 2012). But there are more possibilities to obtain higher leaf yield in Chekurmanis and *Pisonia* in the later stage of plant growth since both the plants are luxuriant shrubby perennial in nature (Sankri *et al*.,2012).

Proximate nutrient composition: Carbohydrate content was observed at the highest value in *Centella asiatica* in all the three growth phases of the plants tested, followed by *Hibiscus cannabinus.* The high carbohydrate levels recorded in these plants could mean the vegetable may provide high energy, which could be useful for vegetable consumers (Abugre, 2011). The highest carbohydrate content in *Centella Asiatica* was also reported by Topno Monica and Verma Anisha, 2018.

Although greens were not considered a good protein source, the crude protein content in green leaves is another essential quality trait in vegetable crops. Natural protein content was found to be maximum in *Coccinia grandis*. The higher crude protein content of these leafy vegetables suggests their richness in essential amino acids. The amino acids served as alternative energy sources when carbohydrate metabolism was impaired via gluconeogenesis (Iheanacho and Udebuani, 2009). Similar findings were in consonance with (Yadav and Sehgal, 2003) in leafy vegetables.

The low crude fiber content has a positive influence on improving the keeping quality of vegetable crops. Besides, the natural fiber content is one of the most important that affects the palatability and taste of greens (Asha and Geetakumari, 2001). In this study, the low fiber content was found in the green leafy vegetables like *Acalypha indica* L., *Alternanthera brasiliana* L., *Alternanthera bettzickiana* Regol., *Centella asiatica L., Coccinia grandis L.,* and *Hibiscus cannabinus L.*

Phenolic compounds are nonnutritive secondary metabolites that are beneficial to humans to prevent oxidative stress to muscles. Among the leafy vegetables tested, maximum total phenolic content was recorded in *Sauropus androgynus* followed by *Alternanthera sessilis.* The highest phenolic content in multivitamin green was also reported by Petrus (2013).

Table 1. Details of the underutilized greens

Botanical name	**Common name**	**Native / Tamil name**	**Family**	**Source**
Acalypha indica L.	Indian copperleaf	Kuppaimeni	Euphorbiaceae	Kamatchipuram
Alternanthera brasiliana L.	Brazilian joy weed	Siggapu Ponnanganni	Amaranthaceae	Endapuli
Alternanthera bettzickiana Regol.	Red calico plant	Pacchai Ponnanganni	Amaranthaceae	Farmer's Market, Theni
Alternanthera sessilis L.	Sessile joy weed	Vayakattu Ponnanganni	Amaranthaceae	Farmer's Market, Theni
Cardiospermum halicacabum L.	Balloon vine	Mudakathan	Sapindaceae	Vaduga pati
Celosia argentea L.	Cock's comb	Magili keerai (Pannai keerai)	Amaranthaceae	Kamatchipuram
Chenopodium album L.	Common lambs quarter	Chakkaravarthy keerai	Chenopodiaceae	Kamatchipuram
Centella asiatica L.	Asiatic pennywort	Vallarai Keerai	Apiaceae	Cumbum
Coccinia grandis L.	Ivy gourd	Kovaithalai	Cucurbitaceae	Theni
Hibiscus cannabinus L.	Deccan hemp	Pulicha keerai	Malvaceae	Thevaram
Ipomoea aquatica Forssk.	Water spinach	Valla keerai	Covolvulaceae	Seelaiyampatti
Pisonia alba Span.	Bird lime tree	Lachakottai keerai	Nyctaginaceae	Kadamalai kundu
Sauropus androgynus L.	Sweet leaf / Chekkurmanis	Thavasi Keerai	Phyllanthaceae	Kandamanur
Talinum fruticosum L.	Ceylon spinach	Nandukal Pasalai	Talinaceae	Allinagaram
Solanum trilobatum L.	Purple fruited pea eggplant	Thuthuvalai	Solanaceae	Allinagaram

Table 2. Nutrients, Vitamins and minerals analysis methods

S. No	Nutrient/ vitamin/mineral	Unit	Method of Estimation
1	Carbohydrate	Percent	Hedge and Hofreiter, 1962.
2	Crude protein	Percent	AOAC, 1990
3	Crude fiber	Percent	Maynard, 1970
4	Moisture content	Percent	AOAC, 1990
5	Total Phenolic Content	Mg g^{-1}	Bray and Thorpe, 1954.
6	Ascorbic Acid	mg $100g^{-1}$	AOAC, 1990
7	Carotenoid content	mg g^{-1}	Arnon, 1949
8	Phosphorus	Percent	AOAC, 1990
9	Potassium	Percent	AOAC, 1990
10	Calcium	Percent	Jackson, 1973
11	Sodium	Percent	
12	Magnesium	Percent	
13	Iron	Ppm	
14	Copper	Ppm	
15	Zinc	Ppm	
16	Manganese	Ppm	

Statistical Analysis: The data recorded in triplicate were subjected to statistical analysis as per the method suggested by Panse and Sukhatme (1967).

Table 3. Proximate composition of underutilized green leafy vegetable

Greens	Carbohydrate (%)	Crude protein (%)	Crude fiber content (%)	Total phenolic (mg g-1)
G_1	13.00	23.91	31.10	7.00
G_2	18.40	4.85	38.76	8.93
G_3	42.24	4.62	38.10	5.00
G_4	35.16	4.15	57.50	10.65
G_5	60.50	9.90	47.20	4.75
G_6	45.37	5.38	67.32	6.13
G_7	41.04	7.95	45.88	7.45
G_8	82.97	19.65	38.18	12.38
G_9	34.19	30.37	34.95	5.68
G_{10}	78.50	17.33	34.40	6.00
G_{11}	53.85	6.44	42.60	9.38
G_{12}	26.21	4.61	49.38	6.95
G_{13}	65.92	4.28	46.34	16.38
G_{14}	34.86	21.70	37.00	5.63
G_{15}	26.28	5.70	50.55	5.08
S Ed	0.89	0.35	1.13	0.18
Cd (0.05)	1.82	0.70	2.32	0.37

Table 4. Ascorbic acid and carotenoid content of underutilized green leafy vegetable

Greens	Ascorbic acid	Carotenoid
G_1	32.65	0.46
G_2	12.93	0.18
G_3	9.44	0.27
G_4	10.16	0.37
G_5	15.90	0.01
G_6	20.32	0.32
G_7	13.45	0.46
G_8	25.14	0.38
G_9	13.81	0.16
G_{10}	16.30	0.49
G_{11}	13.85	0.24
G_{12}	8.27	0.20
G_{13}	23.98	0.38
G_{14}	17.39	0.28
G_{15}	17.55	0.32
S Ed	0.39	0.01
Cd (0.05)	0.82	0.02

Table 5. Macro elements content of underutilized green leafy vegetables

Greens	Phosphorus (%)	Potassium (%)	Sodium (%)	Calcium (%)	Magnesium (%)
G_1	0.44	4.68	0.48	7.62	6.38
G_2	**0.64**	5.47	**0.72**	6.86	7.93
G_3	0.25	4.88	0.45	2.26	4.66
G_4	0.34	3.97	0.43	3.27	2.65
G_5	0.15	**7.39**	0.59	4.65	3.64
G_6	0.06	5.68	0.48	4.89	3.52
G_7	0.04	3.01	0.63	3.63	4.14
G_8	0.20	5.03	**0.67**	5.10	2.98
G_9	0.14	3.96	0.52	3.92	4.55
G_{10}	0.19	**6.73**	**1.84**	3.30	**8.97**
G_{11}	**1.60**	5.43	0.80	2.53	2.48
G_{12}	0.41	**6.01**	**1.51**	**10.57**	**9.47**
G_{13}	**0.50**	3.71	0.61	**8.06**	6.71
G_{14}	0.22	**6.69**	0.59	**7.67**	**9.85**
G_{15}	0.15	**6.30**	**0.67**	**14.45**	**11.86**
S Ed	0.01	0.12	0.02	0.10	0.19
Cd (0.05)	0.02	0.25	0.03	0.21	0.39

Table 6. Trace elements content of underutilized green leafy vegetables

Greens	Zinc (ppm)	Copper (ppm)	Iron (ppm)	Manganese (ppm)
G_1	0.151	0.066	5.001	0.253
G_2	0.258	0.106	19.969	0.412
G_3	0.233	0.110	8.985	0.490
G_4	0.166	0.099	25.679	0.231
G_5	0.263	0.330	9.845	0.471
G_6	0.231	0.114	19.995	0.293
G_7	0.142	0.076	3.199	0.341
G_8	0.270	0.239	11.421	0.349
G_9	0.169	0.159	16.599	0.366
G_{10}	0.257	0.079	8.812	0.311
G_{11}	0.205	0.083	12.989	0.428
G_{12}	0.332	0.171	2.940	0.294
G_{13}	0.192	0.118	10.262	0.449
G_{14}	0.292	0.181	10.460	0.559
G_{15}	0.407	0.236	3.876	0.236
S Ed	0.005	0.003	0.28	0.007
Cd (0.05)	0.010	0.007	0.57	0.015

Vitamin content

Ascorbic acid is an essential vitamin that plays a crucial role in maintaining a healthy lifestyle and preventing many diseases. It was maximum in *Acalypha indica* among the fifteen underutilized leafy vegetables evaluated in this experiment. Most of the green leafy vegetables are rich in ascorbic acid, were reported earlier by (Misra and Misra, 2014, Bharathi and Umamaheshwari, 2001) in different leafy vegetables.

Similarly, carotenoids, the precursor of vitamin A are also crucial for a human being to have a healthy vision and growth regulation. In dark green leafy vegetables, carotenoids are masked with the presence of chlorophyll. Therefore, these leafy vegetables can serve as a potential source of pro-vitamin A to the population (Alka *et al.*, 2010). Among the green vegetables examined carotenoid content was recorded supreme in *Hibiscus cannabinus*.

Minerals content

Minerals are the important elements for the human body for several biological and metabolic activities *viz.,* bone strengthening, blood thinning, muscle growth, etc., the major minerals like phosphorous, potassium, calcium, sodium, Magnesium, and micro or trace elements like iron, copper-zinc and manganese are estimated in the underutilized leafy vegetables. Phosphorous is one of the key components for the formation of bone and teeth and also protein production in the human body. In this study, underutilized green leafy vegetables viz., *Ipomoea aquatica* Forssk., *Alternanthera brasiliana* L., *Sauropus androgynus* L. are having a fair amount of P in descending order. The right amount of P in leafy vegetables was also reported by Snehalatha Reddy and Bhatt (2001).

Potassium is an essential element for human health that facilitates blood thinning capacity. In the present study, the potassium content was found to be maximum in *Cardiospermum halicacabum* followed by *Hibiscus cannabinus* L., *Talinum fruticosum* L., and *Solanum trilobatum* L. The high amount of potassium increases iron utilization and also beneficial to the people taking diuretics to control hypertension (Archana *et al*., 2012).

Calcium is one of the significant nutrient constituents to have a healthy bone system in the human body. Green vegetables, including amaranth, are one of the significant sources of calcium in the diet. The maximum calcium content was obtained in *Solanum trilobatum* followed by *Pisonia alba* Span and *Sauropus androgynus* L. In general Solanaceae family had more calcium content, as reported by (Odhav *et al.*, 2007). A similar trend was witnessed by (Kamga *et al.*, 2013) in *Solanum scabrum*.

Magnesium is an essential mineral in human nutrition that is involved in many biological functions, *viz.,* protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Magnesium can compete with calcium for binding sites on proteins and membranes. Magnesium was significantly highest in *Solanum trilobatum., Talinum fruticosum,* and *Pisonia alba* Span. With regard to Sodium, *Hibiscus cannabinus* registered *the* highest value, followed by *Pisonia alba* Span. This was found to agree with the result reported by (Patricia *et al.*, 2014) in the different leafy vegetables.

Trace elements

Zinc is an essential component for a large number (>300) of enzymes participating in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids as well as in the metabolism of other micronutrients. Zinc stabilizes the molecular structure of cellular components and membranes and contributes to the maintenance of cell and organ integrity. Its involvement in such fundamental activities probably accounts for zinc's essentiality for all life forms (Otitoju *et al.*, 2014). Zinc content was registered maximum in *Solanum trilobatum* and *Pisonia alba* Span. Copper was the element found to a trace extent in all wild and traditional vegetables. The vegetable samples Copper contents are generally the lowest compared to iron and zinc (Amos-Tautua *et al.*, 2013). Copper content showed significant variation in *Cardiospermum halicacabum*, *Centella asiatica* L., and *Solanum trilobatum* L.. The variation in copper and zinc content could be attributed to one or more factors of the genetic, environmental or growth stage of the vegetable during collection (Getachew *et al.*, 2013). Copper and zinc concentrations are found to be higher in green leafy vegetables than in most other vegetables (Atukorala and Waidyanatha, 1987).

Iron plays an imperative role in growth characters, being a component of ferredoxin, an electron transport protein, and is associated with chloroplast and also helps in photosynthesis in plants. It is an essential mineral and dynamic component of proteins (Haemoglobin) involved in oxygen transport, acts as a cofactor in neurotransmitter synthesis in the human body (Borah *et al.*, 2009). Iron content was observed maximum in *Alternanthera sessilis*. Oluyemi *et al.*, 2005 also reported that *Alternenthera sessilis* have higher iron content.

Manganese plays an essential role in the metabolism of protein, carbohydrate, lipid molecules. Manganese is part of the enzyme involved in urea formation, pyruvate metabolism, and the galactosyltransferase of connective tissue biosynthesis (Chandra and Kumar, 1990). A substantial quality of manganese content was registered in *Talinum fruticosum*. The variation in the manganese content of plants can be attributed to the stage of maturity of the plant, conditions of growth, fertilization, and the nature of the soil reported by (Gupta *et al.*, 2005).

REFERENCES

Abugre, C., (2011). Assessment of some traditional leafy vegetables of the upper east region and influence of stage of harvest and drying method on nutrients content of spider flower (*Cleome gynandra* L.). M.Sc., Thesis, Kwamen Krumah University of Science and Technology, Kumasi.

Alka, G., Neelam, Y., Vandana, V (2010). Nutrition profile of underutilized Lahsua (Digera arvensis) and Pakar (Ficus infectoria) leaves incorporated traditional recipies. *Food Science Research Journal,* 1: 107-110.

Amos-Tautua, Martin, W.B., Onigbinde, Adebayo, O (2013). Estimation of Iron, Copper and Zinc in Some Vegetables Commonly Consumed in Amassoma, Niger Delta, Nigeria.

AOAC, 1990. Official Methods of Analysis: Changes in Official Methods of Analysis Made at the Annual Meeting. Supplement:15.

Archana, G.N., Pradeesh, S., Chinmayee, M.D., Mini, I., Swapna, T (2012). Diplazium esculentum: a wild nutrient-rich leafy vegetable from Western Ghats. *Prospects in Bioscience: Addressing the Issues. Springer*: 293-301.

Arnon, D.I (1949). Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris. *Plant physiology*, 24(1).

Asha, K., Geetakumari, V (2001). Effect of organic manures and Azospirillum inoculation on yield and quality of okra. *Veg. Sci*, 28: 179-181.

Atukorala, T., Waidyanatha, U (1987). Zinc and copper content of some common foods. *Journal of the National Science Council of Sri Lanka* 15:61-69.

Bharathi, R., Umamaheshwari, K (2001). Proximate composition of non-traditional leafy vegetables in Nellore and Prakasam districts of Andhra Pradesh. *Journal of Food Science and Technology*, 38: 534-536.

Borah, S., Baruah, A.M., Das, A.K., Borah, J (2009). Determination of mineral content in commonly consumed leafy vegetables. *Food Analytical Methods,* 2: 226-230.

Bray, H., Thorpe, W (1954). Analysis of phenolic compounds of interest in metabolism. Methods of biochemical analysis, : 27-52.

Chandra, Kumar, R., 1990. Micronutrients and immune functions. *Annals of the New York Academy of Sciences*, 587: 9-16.

Chweya, J.A., Mnzava, N.A. (1997). Cat's Whiskers, Cleome Gynandra L. *Bioversity International.*

Cooper, C., Campion, G., Melton, L. (1992). Hip fractures in the elderly: a world-wide projection. *Osteoporosis International*, 2: 285-289.

Firoj Alam, Nitin Kumar, Khatoon, A. (2012). Phytopharmacology of Alternanthera brasiliana (Amaranthaceae): A Brazilin plant. *The Journal of Phytopharmacology,* 1 (3): 81-88

Getachew, G.A., Asfaw, Z., Singh, V., Woldu, Z., Baidu-Forson, J.J., Bhattacharya, S. (2013). Dietary values of wild and semi-wild edible plants in Southern Ethiopia. *African Journal of Food, Agriculture, Nutrition Development,* 13(2):7485-7503.

Guilbert, J. (2006). The World Health Report 2006: working together for health. Education for health: 385.

Gupta, S., Lakshmi, A.J., Manjunath, M., Prakash, Jamuna (2005). Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. *Food Science and Technology*, 38: 339-345.

Hedge, J., Hofreiter, B.J.N.Y (1962). In carbohydrate chemistry 17 (Eds whistler RL and Be Millee, JN) Academic press.

Iheanacho, K.M., Udebuani, A.C. (2009). Nutritional composition of some leafy vegetables consumed in Imo State, Nigeria. *J. Appl. Sci. Environ. Manage,* 13(3) : 35 - 38.

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, : 183-204.

Kamga, R.T., Kouamé, C., Atangana, A., Chagomoka, T., Ndango, R., 2013. Nutritional evaluation of five African indigenous vegetables. *J. Hort. Res*, 21:99-106.

Kearney, J. (2010) Food Consumption Trends and Drivers. Philosophical Transactions of the Royal Society *B: Biological Sciences*, 365: 2793-2807. https://doi.org/10.1098/rstb.2010.0149

Law-ogbomo, K. E., & Ajayi, S. O. (2009). Growth and Yield Performance of Amaranthus cruentus Influenced by Planting Density and Poultry Manure Application. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 37 (2):195-199.

Lovell, R.T. (1989) Nutrition and Feeding of Fish. Van Nostrand Reinhold, New York. http://dx.doi.org/10.1007/978-1-4757-1174-5

Mathew, B (2013). Traditional Knowledge Protection and Documenting: Critical Study on Traditional Knowledge Database and Registry. *International Journal of Social Sciences & Inter disciplinary Research* 2 (11):183-189.

Maynard, A.J. (1970) Methods in Food Analysis: Physical, Chemical and Instrumental Methods of Analysis. 2nd Edition, Academic Press, San Francisco, London,:845.

Misra, S., Misra, M.K (2014). Nutritional evaluation of some leafy vegetable used by the tribal and rural people of south Odisha, India. *Journal of Natural Product & Plant Resources*, 4(1): 23-28.

Nya, E. J. and Eka, M. J (2015). Morphological Characterization and Hybridization of Talinum Triangulare Land Races for Desirable Metric Characters in South Eastern Nigeria. *The International Journal of Science & Technoledge*, 3 (7): 192-197

Odhav, B., Beekrum, S., Akula, U., Baijnath, H (2007). Preliminary assessment of nutritional value of traditional leafy vegetables *Journal of Food Composition and Analysis*, 20: 430-435.

Oluyemi, E., Akinlua, A., Adenuga, A., Adebajo, M (2005). Mineral contents of some commonly consumed Nigerian foods. *Eur J Sci Res,* 6: 11-15.

Otitoju, G., Ene-Obong, H., Otitoju, O (2014). Macro and micronutrient composition of some indigenous green leafy vegetables in south-east zone nigeria*. J Food Process Technol*, 5: 389.

Panse, V., Sukhatme, P. (1967). Statistical methods for research workers. ICAR, New Delhi, 220-240.

Patricia, O., Zoue, L., Megnanou, R.-M., Doue, R., Niamke, S. (2014). Proximate composition and nutritive value of leafy vegetables consumed in Northern Côte d'Ivoire. *European Scientific Journal,* 10 (6):212-227.

Petrus, A.J.A (2013). Sauropus androgynus (L.)Merill – A potentially nutritive functional Leafy – Vegetable. *Asian Journal of Chemistry,* 25(17): 9425-9433.

S. Arasaretnam, A. Kiruthika and T. Mahendran (2018). Nutritional and mineral composition of selected green leafy vegetables. *Ceylon Journal of Science*,47(1):35-41

Sankari, A., Anand, M. and Arulmozhiyan, R (2012). Multivitamin greens- Chekurmanis. *Rashtriya Krishi*, 7 (2) : 77

Shukla, S., Pandey, V., Pachauri, G., Dixit, B., Banerji, R., Singh, S (2003). Nutritional contents of different foliage cuttings of vegetable amaranth. *Plant Foods Hum Nutr*, 58: 1-8.

Snehalatha Reddy, N., Bhatt, G (2001). Contents of minerals in green leafy vegetables cultivated in soil fortified with different chemical fertilizers. *Plant Foods Hum Nutr*, 56:1–6.

Topno Monica and Verma Anisha (2018). Nutritional analysisi of paratha prepared from dehydrated brahmi (centella asiatica). *International journal of advances in agriculture and technology,* 5 (11):6-15

Yadav, S., Sehgal, S (2002). Effect of domestic processing and cooking methods on total, HCl extractable iron and *in vitro* availability of iron in spinach and amaranth leaves. *Nutrition and health* ,16: 113-120.