Nutritional Composition of Species in the *vernonia hymenolepis* Complex in Kenya

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Abstract- *Vernonia hymenolepis* species is a weed that is found in various parts of Africa and has traditionally been used as a vegetable because of its nutritional and medicinal value. The species complex in the genus *Vernonia* Schreber in Tropical East Africa were collected from Mt. Elgon (K3), Kakamega (K5) & Narok (K6) in Kenya and investigated to establish their proximate and micronutrient composition using traditional methods. Results revealed a high quality and quantity of nutritional elements. The leaves had a vitamin C content of up to 1.6g/100g and a mean content of 303.2mg, 242.3mg, 19.6g, 1.2g, 430.8mg and 133.8mg per 100g dry weight (d.w) of Na, K, Cu, Fe, Mn and Zn respectively. Protein levels in the leaves ranged from 11.2-18.1g/100g d.w whereas P and N were found to be 190-390 mg/100g d.w and 21.1-57.9g/100g d.w respectively. Both proximate and elemental significant differences were shown in species from K3 & K5 at $P<0.05$, except in moisture, N, proteins and Vit C. It is evident from othe nutritional analysis that *Vernonia hymenolepis* species are highly packed with essential nutrients for good nutrition and can therefore contribute to dietary diversity to help curb malnutrition in the different regions where they grow and thus the need to domesticate them.

Index Terms- vernonia hymenolepis, nutritional analysis, Kenya

I. Introduction

1.1 *Background*

Vernonia Shreber (Ironweeds) is a core genus in the tribe Vernonieae which is one of the major tribes of the Asteraceae (Jeffrey& Beentje, 2000; Dematteis, 2002; Keeley, Forsman & Chan, 2007). It comprises about 1000 species (Robinson, 1999a; Robinson, 1999b; Robinson, 2007; Yeap *et al.,* 2010) which are known for being mostly perennial herbs or shrubs with intense purple flowers.

The distribution of *V. hymenolepis* ranges from Kenya into Uganda (Jeffrey & Beentje, 2000) and extends into Ethiopia (Smith, 1971; Jeffrey & Beentje, 2000), Cameroon and Sudan (Isawumi *et al*., 1996; Jeffrey &Beentje, 2000). The species flower between December and July (Smith, 1971; Hyde, Wursten, Ballings & Dondeyne, 2012). Several species of *Vernonia* are eaten as leafy vegetables (Afui, Tonjock, & Ndam, 2008). *Vernonia hymenolepis* is especially appreciated in Cameroon, where it is known as *bayangi* bitterleaf or *ndole* (Schippers, 2000, 2002; Ucheck Fomum, 2004). It is a vegetable which not only plays an important role in nutrition because of its quality and quantity of organic and inorganic elements, but also possesses medicinal value (Schippers, 2000, 2002). It is commonly cultivated by resource poor farmers in Cameroon and other parts of West and Central Africa where it is cherished for its leafy shoots (Gockowski & Moulende, 2003; Afui *et al*., 2008).

In East Africa, Vernonia is found in the wild and in Kenya it occurs in many parts of Western, Nyanza and Rift Valley Provinces. It is used as medicine for both human and livestock and locally is referred to as *musululitsa/luvilukitsa/ivindisi/shisavakwa/nandavulwa* (Luhya: Tiriki, Maragoli and Bukusu) respectively, mucatha (Kikuyu), chesoliet (Sabaot) and ormojase/ormosakwa (Maasai). The Maasai boil the roots in soup for preventive and curative medicinal purposes. Leaf decoctions and root extracts are used to treat fever, malaria, diarrhea, dysentery, typhoid, eye defects, cough, headache, stomach-ache, gastrointestinal dis-orders, sexually transmitted infections (e.g. gonorrhea and syphilis) and as a fertility inducer (Pers. Comm. with locals).

It forms a rich herbal flora of highland Kenya. It has also been documented as a potential tumor inhibitor (Kupchan, Hemingway, Werner, Karim, McPhail & Sim, 1968). *Vernonia calvoana* in Cameroon and Nigeria plays an important role in human nutrition, because of its high mineral content and it is also important medicinally (Fube & Djonga, 1987). However it is often confused with *V. hymenolepis* (Jeffrey, 1988) and sometimes treated as its synonym (Ucheck Fomum, 2004). The aim of this study was to determine the nutritional value of *Vernonia hymenolepis*. The use of local biodiversity to meet our food and nutritional needs requires not only accurate information on the identities of the plants that have the potential of being used as foods but also reliable and accessible data on their nutritional composition.

Generally there is still a dearth of information on their nutritional composition which has hindered their use as food and thus production. The removal of any hindrances to the exploitation of the entities in this species complex as vegetables will not only increase the range of foods available for use locally but will also offer new sources of nutrition especially for the rural poor and thus help mitigate against chronic under nutrition that is known to affect a huge proportion of the population in Sub-Sahara Africa.

1.2 *Nutritional composition of Vernonia*

Many studies on the nutritional composition of *Vernonia* have, to a large extent, been limited to *Vernonia amygdalina* Del. (Faboya, 1990). Leung, Busson and Jardin (1968) showed that 100g edible portion of the leaves of of *V. amygdalina* contained a

substantial amount of water, energy, protein, fat, carbohydrate, fibre, ascorbic acid and minerals. Fube and Djonga (1987) in their study of *V. hymenolepis* and three other species of *Vernonia* revealed that the leaves of these species contained 22-27mg crude fibre, 15-20 mg ash, 10-13 mg cellulose and 15-885 ppm minerals such as iron, copper, zinc, manganese in 100g dry matter. They also reported that the quantity of protein in the four species of *Vernonia* eaten in Cameroon (i.e. *Vernonia colorata*, *V. calvoana*, *V. hymenolepis* and *V. amygdalina*) varied from 22.75–26.50 mg/100 of dry weight which indicated that it was a significant source of protein especially in the villages where children suffered from acute malnutrition. *Vernonia calvoana* was also found to be rich in minerals, particularly Iron and Manganese, and in cellulose. Faboya (1990) demonstrated that ascorbic acid decreased with storage time in *V. amygdalina* while Oshodi (1992) found that the dried leaves of *V. amygdalina* were rich in minerals, especially in phosphorus, and that the content of ascorbic acid was temperature dependent. Maundu, Ngugi and Kabuye (1999) documented the nutritional composition of *V. cinerea* and also noted that *V. amygadlina* was used as a vegetable in western Kenya where it is very common but not under cultivation. They further noted that *V. poskeana* Vatke and Hildebrandt, *V. appendiculata* Less, *V. colorata* and *V. perrottetii* Walp were also being used as vegetables. Ejoh, Tanya, Djuikwo and Mbofung (2005) determined the effect of processing and preserving Vitamin C and total carotenoid in the leaves of *V. calvoana* and other species of *Vernonia*.

1.2 *Study area*

This encompassed the *Vernonia hymenolepis* complex as occurring in three selected regions in Kenya (Mt. Elgon (K3), Narok (K6) and Kakamega (K5) where a substantial amount of flora was identified.

II. MATERIALS AND METHODS

2.1 *Nutritional composition*

Various analytical methods were used to investigate the moisture, ash, protein and mineral content of the leaves of *V. hymenolepis*.

2.1.1 *Moisture*

Ten grams of shredded fresh leaves was dried in a Memmert thermostatically controlled ventilated oven at 105ºC for two hours to constant weight. The loss in weight was recorded as moisture content (AOAC, 1990; Okalebo, Gathua & Woomer, 2002).

2.1.2 *Sample preparation for protein, ash and mineral analysis*

Leaves were cut into tiny pieces and dried in a Memmert ventilated oven at 60ºC for 5 days to constant weight. The dried leaves were then ground into powder and stored in airtight bottles for analysis (Okalebo *et al*., 2002).

2.1.3 *Crude protein*

Crude protein content was determined using the Kjeldahl method. 0.2g of dried and pulverised leaf material was digested in 4.4 ml of a digestion mixture consisting of 2ml concentrated Sulphuric (VI) acid, Selenium catalyst, Lithium and Hydrogen peroxide until a clear digest was obtained (AOAC, 1984). The nitrogen content of diluted digest was determined colorimetrically at 630nm according to Charlot (1964). The Kjeldahl digestion converts organic Nitrogen compounds in the plant tissue to the ammonium form, which is then determined colorimetrically. 0.20 ml of each standard sample digest and the blanks were transferred into clearly labelled test tubes using a micropipette. Five millilitres of reagent N1 (i.e. 34g Sodium salicylate, 25g Sodium citrate, 25g Sodium tartrate and 0.12g Sodium nitroprusside) was added to each test tube using a 5 ml dispenser and mixed well using a vortex mixer. Five millilitres of reagent N2 (i.e. 30g Sodium hydroxide and 10ml Sodium hypochlorite) was added to each test tube and vortexed. The mixture was left to stand for 2 hours for full colour development and absorbency measured at 650nm using a spectrophotometer. Protein was calculated as: Nitrogen content x 6.25 ((AOAC, 1990).

2.1.4: *Fibre Content*

Each of *V. hymenelopis* samples (5g) and 200 ml of 1.25 % H2SO4 were heated for 30 min and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid free. 200 ml of 1.25% NaOH was used to boil the residue 30 min, it was filtered and washed several times with distilled water until it was alkaline free. It was then rinsed once with 10% HCl and twice with ethanol. Finally it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105oC in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550oC for 90 minutes to obtain the weight of the ash.

2.1.5 *Ash content*

Ten grams of dried pulverised leaves were ignited slowly to a final temperature of 550ºC for three hours in an ALPHA 1 Phoenix muffle furnace after being pre-ashed on a hot plate for 2 hours. The crucible containing the grey ash was removed, cooled in a desiccator and weighed. Ash content was determined by calculating the difference in weight of the crucibles before and after combustion (Okalebo *et al*., 2002)

2.1.6 *Minerals*

The content of Sodium, Potassium, Copper, Iron, Phosphorus, Manganese, Zinc, in the leaves was determined using the dry ashing procedure as described by Association of Agricultural Chemists (AOAC, 1990). About 2 g of the dried and ground sample was pre-ashed in a crucible for about 2 hours until the sample was completely charred. The pre-ashed sample was then placed on a muffle furnace and ashed at 550°C for about 3 hours or until the ash was white. After ashing the sample was cooled and weighed. The ash was then dissolved in 10ml of 30% HCl and filtered through acid washed Whatman No. 541 filter paper into a 100ml volumetric flask. The filtrate was made up to the mark with deionised water. The solution was then used for individual mineral determination using VARIAN SPECTRA AA-200 atomic absorption spectrophotomer (Copper, Iron, Manganese, Zinc) and JENWAY PFP 7 flame photometer (Sodium and Potassium) (Okalebo *et al*., 2002; Oboh & Masodje, 2009; Yeap *et al*., 2010). Absorbance and concentration of the minerals was determined at 324.8nm, 213.9nm, 279.5nm, 248.3nm, 766.5nm wavelength for Copper, Zinc, Manganese, Iron and Potassium respectively. Flame type used was Air/Acetylene and Air/butane for atomic absoption spectrophotomer and flame photometer respectively.

Phosphorus content was determined using the Kjeldahl method. Dried and pulverised leaf material (0.2g) was digested in 2ml concentrated sulphuric (VI) acid in the presence of Selenium catalyst, until a clear digest was obtained (AOAC, 1990).

Five millilitres of the supernatant clear wet-ashed digest solution was pipetted into a 50ml volumetric flask. Twenty millilitres of distilled water and 10ml of Ascobic acid reducing agent were added to each flask, beginning with the standards. The mixture was then made up to 50ml with water and left to stand for 1 hour for colour to develop fully. The Phosphorus content of the standards and diluted digest was determined at 880nm using a spectrophotometer (Okalebo *et al*., 2002).

2.1.7 *Vitamin C*

Twenty five millilitres of Ascorbic acid standard solution was placed in a 125ml conical flask and 10 drops of 1% starch solution added to it. This solution was then titrated with iodine until a dark blue colour, signifying the end point of the reaction, was attained (the dark blue colour was supposed to persist for 20 seconds while swirling the solution).

A hundered gram of leaf sample was then ground with 50ml distilled water and the mixture strained. The filtrate was then made upto 100ml in a volumetric flask by adding distilled water. The sample was titrated in the same way as the ascorbic acid sample described above (Fankhauser, 2009).

III. RESULTS

3.1 *Proximate composition*

The proximate composition of *Vernonia hymenolepis* leaves is shown in Table 1. The moisture content of the leaves ranged between 53.2% and 81.0% while that of proteins was on average 11.162±2.719g in 100g dry weight of leaves. The results also revealed a low ash (1.1658±1.842mg) & fibre (2.13±2.23) content (Table 1).

3.2 *Vitamins and minerals*

The Vitamin C content of the leaves ranged from 6.715mg-15.852mg/100g of raw sample and a mean of 11.204mg/100g dry weight. The mean mineral content was also noted as 0.303mg, 0.242mg, 0.0019mg, 1.207mg, 0.432mg and 0.0134mg/100g dry weight for Na, K, Cu, Fe, Mn and Zn respectively.

Table 1. Nutritional composition of *Vernonia hymenolepis* leaves (100g).

Variable	Range	Min.	Max.	Mean	Std. Dev(±)	RDA (#)
Moisture (%)	27.8	53.2	81.0	73.4	7.2	0.7-0.8*; 1,3-1.7** ; 2.7-3.7***(L/D)
Proteins(g)	11.490	6.604	18.090	11.162	2.7195	9.1*; 13-19**; 34-56*** (g/d)
Ash(g)	0.632	0.8760	1.5080	1.1658	1.842	
Fibre(g)	2.50	2.44	1.45	2.13	2.22	19-25**; 21-38***(g/d)
Phosphorus (mg)	0.200	0.190	0.390	0.284	0.061	380-405**; 580-1055***(mg/d)
Sodium (mg)	0.533	0.087	0.621	0.303	0.191	1.5-2.3**;2.3-3.6***(g/d)
Potassium (mg)	0.231	0.146	0.312	0.243	0.046	0.4-0.7*; 3.0-4.5**; 4.7***
Copper (mg)	0.0025	0.0056	0.0031	0.0019	0.0072	0.2-0.44*; 0.7-0.89**; 0.9***(mg/d)
Iron (mg)	2.030	2.21	3.301	1.207	1.262	0.27-11*; 8-15**; 10*** (mg/d)
Manganese (mg)	1.188	0.12	1.199	0.432	0.334	0.003-15*; 800**; 1200***
Zinc(mg)	0.0505	0.016	0.0521	0.0134	0.0153	2-5*; 11**; 15***(mg/d)
Vit C(mg)	91.37	67.15	158.52	112.04	2.745	40-50*; 15-25**; 45-90***(mg/d)

Values are expressed as mean ± SEM for 18 varieties
 # Cited from the United States Department of Agriculture (assessed via http://www.nap.edu)
∗Infants; ∗∗children; ∗∗∗adults

3.3 *Comparison of the nutritional composition of V. hymenolepis leaves from different regions in Kenya*

When compared, populations of *V. hymenolepis* from different regions in Kenya viz., Mt. Elgon, K3 (Bungoma, Trans Nzoia and Mt. Elgon), Kakamega, K5 (Kakamega, Vihiga and Kakamega-Nyanza, Kapsabet, Nabkoi and Nandi) and Narok, K6 (Nasampolai, Saktik and Bomet) showed differences in their nutritional composition. Populations from Mt. Elgon had the highest amount of ash (1.2645/100g d.w) while those from Kakamega had the highest amount of copper (0.0023/100g d.w) and Iron (1.472/100g d.w). The Kakamega populations also gave the highest amount of protein (13.036/100g d.w) and potassium (0.248/100g d.w) while those from Narok had the highest quantities of moisture (77.3%), phosphorus (3.0238mg/100g d.w), sodium (0.5641mg/100g d.w), manganese (0.0687mg/100g d.w) and vitamin C (11.59mg/100g d.w) (see Table 2).

Table 2. Comparison of the nutritive composition of *Vernonia hymenolepis* from three regions in Kenya.

Variable	Mt. Elgon (K3)	Kakamega (K5)	Narok (K6)
Moisture (%)	77.07	65.98	77.26
Ash(g)	1.2645	1.1206	1.0360
Proteins(g)	9.290	13.036	12.093
Fibre(g)	2.205	2.163	1.956
Sodium(mg)	0.224	0.233	0.564
Potassium(mg)	0.241	0.248	0.235
Copper(mg)	0.0019	0.0023	0.0013
Iron(mg)	1.330	1.472	0.565
Manganese(mg)	0.0454	0.0232	0.0687
Zinc(mg)	0.0115	0.057	0.0284
Phosphorus(mg)	2.891	2.652	3.0238
Vit C(mg)	10.30	11.40	11.59

At $p < 0.05$ there were no significant differences in the moisture, ash, phosphorus, potassium, copper, iron, manganese and zinc content of leaves from the Mt. Elgon (K3) and Narok (K6) populations and in ash, potassium, copper and iron content of the leaves from the Kakamega (K5) and Narok (K5) populations. There were significant statistical difference in all the variables investigated in the leaves from the Mt. Elgon (K3) and Kakamega (K5) populations except in moisture, nitrogen, proteins and Vitamin C content at $P<0.05$ (see Table 3).

Table 3. Comparison of the nutritional composition of *Vernonia hymenolepis* leaves from three regions in Kenya.

Variable	K3(Mt Elgon)		K5(Kakamega)		K6(Narok)	
	Mean (N=8)	Std. Dev ±	Mean N=6	Std. Dev ±	Mean N=4	Std. Dev ±
Moisture (%)	0.509 [a]	0.340	1.035	1.110	0.534 [a]	0.361
Ash(g)	0.536 [a b]	1.164	0.245 [a c]	0.544	0.705 [b c]	0.679
Fibre (g)	1.674 [a]	1.030	1.450 [a]	1.104	1.256. [b c]	0.679
Phosphorus(mg)	0.082 [a b]	1.128	0.307 [a]	1.018	0.298 [b]	0.802
Nitrogen(mg)	0.688	0.871	0.690	0.945	0.342	0.200
Sodium(mg)	0.410 [a]	0.714	0.363 [a]	0.850	1.366	0.264
Potassium(mg)	0.024 [a b]	1.210	0.133 [a c]	0.919	0.151 [b c]	0.879
Copper(mg)	0.004 [a b]	0.932	0.532 [a c]	0.685	0.790 [b c]	1.208
Iron(mg)	0.098 [a b]	0.950	0.209 [a c]	1.358	0.509 [b c]	0.155
Manganese (mg)	0.066 [a b]	0.971	0.598 [a]	1.074	0.765 [b]	0.190
Zinc(mg)	0.117 [a]	1.161	0.501	0.447	0.985 [a]	0.601
Proteins(g)	0.688	0.870	0.689	0.946	0.343	0.200
Vitamin C(mg)	0.319	0.340	0.075	0.000	0.141	1.366

Means sharing a common superscript are not significantly different at $P<0.05$
Values are expressed as mean ± SEM. Different superscripts (a,b and c) along the rows are significantly different fromeach other at _ <0.05.

IV. DISCUSSION & CONCLUSION

The nutritional analysis of *V. hymenolepis* revealed notable amounts of vitamins, ash, moisture, proteins, nitrogen, phosphorus and minerals making it a potential vegetable for dietery diversity. Although *V. hymenolepis* has a lower quantity of protein and other nutrients, it contributes to nutrition in rural diets where people suffer from acute malnutrition due to lack of sufficient nutrients. Generally, green leafy vegetables have low amount of proteins and

are usually taken with other foods. *Vernonia hymenolepis* can be a good source of Vitamin C when fresh rather than processed since vitamins are easily degraded (Ejoh *et al*., 2005). However, its high moisture content (73.4%) may make it vulnerable to spoilage (Numfor, 1997; Fidelia., 2000). It is rich in proteins although less than what was noted in. *V. calvoana* (22.75–26.50 mg/100 of d.w (Fube & Djonga, 1978; Ejoh, Nkonga, Inocent & Moses, 2007). The vegetable has substantial amount of fibre and ash and consequently high mineral content, particularly iron and manganese. The few differences noted in a few elements from populations in different regions could be as a result of differences in physiological state before analysis as they were collected at different times and also due to differences in physiological state of plants before harvesting, habitats, edaphic and climatic conditions and human practices (Mbinglo, 1998; Ejoh *et al*., 2007. Most of the collections were wild from roadsides, forest margins or disturbed environment. Pollution probably affects the nutritive composition of the plant. Fube and Djonga (1987) observed that propagation by seeds gave better results than stem-cuttings in *Vernonia calvoana*. Planting of the vegetables under similar conditions and harvesting them at the same time using the same method could realize more controlled environment and thus viable results in nutritional analysis.

There is therefore need to domesticate *V. hymenolepis* so as to provide cheap but nutritious indigenous vegetable options for rural population that can be adopted in family agricultural systems as a substitute vegetable. This could give the resource poor populations an alternative livelihood.

REFERENCES

[1] [1]Abukutsa-Onyango, M.O. (2008). African indigenous vegetables in Kenya: Strategic repositioning in the horticulture sector. A Research project (Ph. D). Maseno University.

[2] [2]Association of Official Analytical Chemists (1984). *Official methods of analysis* (14th ed.). AOAC. Washington, DC.

[3] [3]Association of Official Analytical Chemists (1990): *Official methods of analysis* (15th ed.). Washington, DC.

[4] [4]Bentham, G. & Hooker, J. D. (1873). *Vernonia*. In: *Genera Plantarum*, 2(1), 227-231 L. Reeve & Co. -Williams & Norgate: London.

[5] [5]Burkill, H. M. (1985). The useful plants of West Africa (2nd ed.) Royal Botanical Garden (Kew) UK 1, 960. www.nhbs.com/useful-plants-of-West-Africa

[6] [6]Charlot G. (1964). Colorimetric determination of elements. Principles and methods. Elsevier Co., London, Dietary Reference Intakes Tables and Application. (2010) Institute of Medicine of the National Academy of Sciences.

[7] [7]Ejoh, A. R, Nkonga, V. D, Inocent, G. & Moses, C. M. (2007). Nutritional Components of Some non-conventional leafy vegetables consumed in Cameroon. *Pakistan Journal of Nutrition*, 6 (6), 712-717.

[8] [8]Ejoh, A. R., Djuikwo, V. N., Gouado, I. & Mbofung, C. M. (2009). Effect of different postharvest treatments on antinutritional factors in some commonly consumed leafy vegetables in Cameroon. *Journal of Food Processing and Preservation*, 33 (1), 161–174, Retrieved 28 August 2012 from DOI: 10.1111/j.1745-4549.2008.00290.x

[9] [9]Ejoh, A. R., Tanya, A. N., Djuikwo, N. V. & Mbofung, C. M. (2005). Effect of processing and preservation methods on vitamin C and total carotenoid levels of some *Vernonia* (bitter leaf) species. *African Journal of Food Agriculture Nutrition and Development*, 5 (2), 320-322. Elsevier Publishing Company.

[10] [10]Faboya, O. (1990). The effect of process handling condition on the ascorbic acid content of green leafy vegetables. *Food chemistry*, 38, 297-303.

[11] [11]Fankhauser, B. D. (2009). Vitamin C titration protocol. http://biology.clc.uc.edu/fankhauser/labs/anatomy_&_physiology/a&p203/titrations/vitc_protocol/vitc_protocol.html

[12] [12]Fube, H. N. & Djonga, B. (1987). Tropical vegetables in human nutrition: A case of ndolé (bitterleaf) *Vernonia calvoana* Hook. *Acta Horticulturae*, 198, 199–206

[13] [13]Gockowski, J. G. & Moulende, T.F. (2003). African traditional leafy vegetables and the urban and peri-urban poor. *Food policy*, 28, 221-235.

[14] [14]Mbinglo, S. B., (1998). Survey on the production of bitterleaf *Vernonia* spp. in Bamenda, N. W. Cameroon. Student project report for Natural Resource Institute, Chatham, United Kingdom/Dschang University Cameroon.

[15] [15]Mensah, J. K., Okoli R. I, Ohaju-Obodo J. O & Eifediyi, K, (2008). Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. *Afracan. Journal of Biotechnology*, 7: 2304-2309.

[16] [16]National Nutrient Database for Standard Reference Release 26 Software v.1.4. The National Agricultural Library. http://ndb.nal.usda.gov/ndb/foods?format=&count=&max=25&sort=&fg=Vegetables+and+Vegetable+Products&man=&lfacet=&qlookup=&offset=50

[17] [17]Oboh, F. O. J & Masodje, H. I. (2009). Nutritional and antimicrobial properties of *Vernonia amygdalina* leaves. *International Journal of Biomedical and Health Sciences*, 5(2). Nigeria.

[18] [18]Oboh, G. Heike, R., Thomas, H. (2008). Antioxidant properties of polar and non-polar extracts of some tropical green leafy vegetables. *Journal of the Science of food and Agriculture*. http://scholar.qsensei.com/content/b2ydh.

[19] [19]Okalebo, R, Gathua, K. and Woomer, P. (2002). Laboratory methods of soil and plant Analysis. *A working manual* (2nd Ed). Nairobi. Kenya.

[20] [20]Oshodi, A. A. (1992). Comparison of proteins, minerals and vitamin C content of some dried leafy vegetables. *Pakistan Journal of Scientific and Industrial Research*, 35, 267-269.

[21] [21]Smith F. I. & Eyzaguirre, P. (2007). African leafy vegetables: Their role in the World Health Organization's global fruit and vegetables initiative. *African Journal of Food Agriculture Nutrition and Development*, 7, 3

[22] [22]Ucheck Fomum. (2004). *Vernonia hymenolepis* A.Rich. In: G. J. H. Grubben & O. A. Denton, (Eds.). *PROTA 2: Vegetables/Légumes*. [CD-Rom]. PROTA, Wageningen, Netherlands.

[23] [23]Varalakshim, B. 2001. Characterization and Preliminary Evaluation of vegetable amaranth (*Amaranthus* spp) germplasm short communication. *Journal of Human Agricultural Sciences.* 49-54.

[24] [24]Yeap, S. K. Ho, W. Y., Beh, K. B., Liang, W.S., Ky, H., Hadi, A. *et al*., (2010). *Vernonia amygdalina*, an ethnoveterinary and ethnomedical used green vegetable with multiple bioactivities. *Journal of medicinal plants research*. 4 (25), 2787-2812

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Photographs showing *vernonia hymenolepis.*