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Nutritional composition of the leaves of *Vernonia amygdalina*

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Abstract

The analyses of the nutritional component of the leaves of *Vernonia amygdalina* were carried out using standard methods of food analysis. The results of proximate composition showed that the leaves contained 86.13 ± 1.22% moisture, 15.20 ± 0.04% ash, 12.53 ± 0.13% Crude protein, 11.33 ± 0.58% Crude lipid and 28.51 ± 0.21% available carbohydrate. The leaves also had high energy value of 227.19 ± 0.02 kca/100g respectively. Mineral analysis indicated that Potassium (2569.45 ± 0.02 mg/100g) and Magnesium (74.92 ± 0.08 mg/100g) were the dominant elements. The leaves also contained appreciable concentration of Na (43.95 ± 0.68 mg/100g), Ca (48.91± 0.01 mg/100g), P (6.33 ± 0.01 mg/100g), Cu (2.52 ± 0.03 mg/100g), Fe (10.49 ± 0.15 mg/100g), Mn (10.25 ± 0.09 mg/100g) and Zn (2.61 ± 0.01 mg/100g). Comparing the mineral content with recommended dietary allowance, it was revealed that the plant leaves are good sources of K, Cu, Fe and Mn for all categories of people. From the analysis, it can be concluded that the leaves of *Vernonia amygdalina* could be used for nutritional purposes, due to the amount and diversity of nutrients it contains.

Keywords: *Vernonia amygdalina, Proximate, Mineral elements, Medicinal Plant, Leafy Vegetable*

Introduction

Vernonia amygdalina also called Bitter leaf is a shrub or small tree that grows up to 23 feet tall with gray or brown bark that is rough and flaked. It is known as Mujonso in Tanzania. The vernacular names include Shiwaka (Hausa), Olubo (Igbo), Tsula (Nupe) and Ewuro(Yoruba) (Abdullahi *et al.,* 2003). The leaves of *Vernonia amygdalina* are green and oblong and the flowers are white, small, thistly, and clustered. The pith, leaf, and root have the medicinal qualities. In many parts of Africa, the leaves of *Vernonia amygdalina* is prepared and eaten like spinach. The root and twigs are chewed as appetizers. *Vernonia amygdalina* is believed to have tonic, anti-parasitic, anti-tumor, and anti-bacterial properties. *Vernonia amygdalina* is one of the most widely consumed leaf vegetables of Cameroon, where they are a key ingredient of ndole stew (obtained in Cameroon) . The leaves of *Vernonia amygdalina* have a sweet and bitter taste. They are sold fresh or dried, and are a typical ingredient in egusi soup. *Vernonia amygdalina* is well known as a medicinal plant with several uses attributed to it, including for diabetes, fever reduction, and recently a non-pharmaceutical solution to persistent fever, headache and joint pain associated with AIDS (an infusion of the plant is taken as needed). The roots have been used for gingivitis and toothache due to its proven antimicrobial activity.

Animals' studies have shown that chimpanzees chew the pith for its anti-parasitic properties, but it is also used in Africa to treat intestinal parasite infestation in human as well. It is also used to treat schistosomiasis, a disease caused by parasitic worms, but also works well in treating diarrhea and malaise. The African people also use it to treat other intestinal complaints, malaria, and to help restore stamina (Vernonia, 2008). In view of the potential beneficial attributes of leafy vegetables, there is need to comprehensively establish the nutritional properties before advocating their increased utilization.

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The purpose of this study was to conduct an investigation of the nutritional composition in this leafy vegetable in order to ascertain its suitability for use in human diets, as animal feed or medicinal purposes.

Materials and methods

Sample collection and sample treatment

The sample of *Vernonia amygdalina* used in this study was collected from a farm site at Barkin-Saleh in Minna town, Niger state, Nigeria. The chemicals used were manufactured by M & B and BDH chemicals of England. Prior to analysis, the leaves were separated from the stalk and washed with distilled water. The residual moisture was evaporated at room temperature thereafter the leaves were wrapped in large paper envelopes and oven dried at 60^0C until constant weight was obtained (Fasakin, 2004). The dried leaves were then ground in porcelain mortar, sieved through 2 mm mesh sieve and stored in plastic container (Umar *et al.,* 2007). The powdered sample was used for both proximate and mineral analysis. Moisture content was however, evaluated using fresh leaves.

Proximate analysis

The moisture content of the leaves were determined by drying 5 g of the leaves (in triplicate) in a Gallenkamp oven at 105^0C until constant weight was attained (AOAC, 1990). Ash content was determined according to the method described by Ceirwyn (1998), which involves dry ashing in Lenton muffle furnace at 600^0C until grayish white ash was obtained. Crude protein content was calculated by multiplying the value obtained from Kjeldahl's nitrogen by a protein factor of 5.3, a factor recommended for vegetable analysis (Bernice and Merril, 1975). Crude lipid was quantified by the method describe by AOAC (1990) using the soxhlet apparatus and n-hexane as a solvent. Available carbohydrate was determined by Clegg Anthrone method using Jenway 6100 spectrophotometer at 625 nm with glucose and maltose as the standard (Idris *et al.,* 2009). The sample calorific value was estimated (in Kcal) according to the formula, (Asibey – Berko and Taiye, 1999).

Energy = (g crude protein x 2.44) + (g crude lipid x 8.37) + (g available carbohydrate x 3.57)

Samples preparation

Six (6) gram of the powdered sample was weighed into a crucible and gently heated over a Bunsen burner until it charred. The charred sample with the crucible was transferred into a Lento muffle furnace at about 600^0C and the content was ashed until grayish white ash was obtained. It was cooled first at room temperature and then in a desiccator. 5 cm^3 of concentrated HCl was added and heated for 5 minutes on a hot plate in a fume cupboard. The mixture was then transfer into a beaker and the crucible washed several times with distilled water. The mixture was made up to 40 cm^3 and boiled for 10 minutes over a Bunsen burner. This mixture was then cooled, filtered into a 100 cm^3 of volumetric flask and distilled water was used to rinse the beaker into the volumetric flask and solution made up the volume to 100 cm^3 (Ceirwyn, 1998). The solutions were prepared in triplicates.

Mineral quantification

Sodium (Na) and Potassium (K) were analyzed by flame atomic emission spectrophotometer, using Anarlar grade of NaCl and KCl to prepare the standards. Phosphorus (P) was determined with Jenway 6100 spectrophotometer at 420 nm using vanadium phosphomolybdate (vanadate) colorimetric method with KH_2P0_4 as the standard (Ceirwyn, 1998). The concentrations of calcium (Ca), magnesium (Mg), copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the solutions were determined with a Unicam 969 model atomic absorption spectrophotometer, with standard air – acetylene flame (AOAC, 1990). $CaCl_2$, Mg metal, Cu metal, Fe granules, $MnCl_2.4H_20$ and Zn metal were used to prepare the standards.

Data Analysis

Data were generated in triplicates and the mean standard deviation determined according to Steel and Torrie (1980).

Results and discussion

Proximate composition:

The proximate composition of the leaves of *Vernonia amygdalina* was presented in Table 1. As with most fresh leafy vegetables, the leaves have high moisture content (86.13 ± 1.22%). This value agrees with the 58.0 – 90.64% found in some Nigerian green leafy vegetables (Ladan *et al.*, 1996; Tomori and obijole, 2000) and 83.7 – 87.1% recorded for sweet potato (*Ipomoea batatas)* leaves (Asibey – Berko and Taiye, 1999; Ishida *et al.*, 2000) but higher than 72.83 ± 0.29% indicated in water spinach (*Ipomoea aquqtica Forsk*) leaves (Umar *et al., 2007).*

The ash content of the leaves was found to be 15.20 ± 0.04%. This is an indication that the leaves contain important mineral elements. This value is within the range of 9.2 ± 1.5 to 28.0 ± 1.1% showed in green leafy vegetables of Nigeria (Ifon and Bassir, 1980; Ladan *et al.*, 1996) but high compared to 10.83 ± 0.80 % reported for water spinach (*Ipomoea aquatica* Forsk) leaves (Umar *et al.*, 2007).

Table 1: Proximate composition of the leaves of *Vernonia amygdalina*

Parameter	Concentration (% Dry weight)
Moisture content [a]	86.13 ± 1.22
Ash	15.20 ± 0.04
Crude protein	12.53 ± 0.13
Crude lipid	11.33 ±0.58
Available carbohydrate	28.51 ± 0.21
Calorific Value (k cal/100g)	227.19 ± 0.02

The data are mean value ± standard deviation (SD) of triplicate determinations; [a]value expressed as % wet weight.

The crude protein content of the leaves of *Vernonia amygdalina* (12.53 ± 0.13% dry weight) agreed with the protein content of 11.67 – 18.00% indicated in *Ipomoea batatas* leaves (Ishida *et al.*, 2000). The value is high compared to 6.30 ± 0.27% recorded in *Ipomoea aquatica* leaves (Umar *et al.*, 2007) and the 4.25% dry weight in *Ipomoea aquatica* leaves grown in Vietnam (Ogle *et al.*, 2001). Furthermore, the protein content of this plant leaves can make significant contribution to dietary intake especially during pre – harvest period when domesticated food are in short supply. The sample crude lipid content (11.33 ± 0.58%) is very high when compared with the values of 0.74% (Asibey – Berko and Taiye, 1999) and 2.56 – 6.82% dry weight (Ishida *et al.*, 2000) reported in *Ipomoea batatas* leaves, but within the range (8.5 – 27.0%) reported in some wild green leafy vegetables of Nigeria and Niger Republic (Ifon and Bassir, 1980; Sena *et al.*, 1998).

Carbohydrates provide the body with a source of fuel and energy that is required to carry out daily activities and exercise. Carbohydrates are also important for the correct functioning of vital physiological systems of the body. The available carbohydrate content in the leaves of *Vernonia amygdalina* was 28.51 ± 0.21% dry weight. This is low compared to the 51.8% reported for *Moringa Stenopetala* leaves (Abuye *et al.*, 2003), the 52.85% (dry weight) found in *Bauhenia purpurea* (Raghuvanshi *et al.*, 2001) and 82.8% in *Ipomoea batatas* leaves (Asibey – Berko and Taiye, 1999). According to Isong *et al.* (1999), calorific value of most vegetables is low (30 – 50 kcal/100g) however, the value of 227.19 ± 0.02 k cal/100g obtained in the leaves of *Vernonia amygdalina* was high but lower than the 248.8 – 307.1 k cal/100g reported in some Nigerian green leafy vegetables (Isong *et al.*, 1999).

Mineral content

Table 2 shows the mineral content of the leaves of *Vernonia amygdalina.* The potassium content (2569.45 ± 0.02 mg/100g dry matter) in the leaves of *Vernonia amygdalina* is higher than 220 mg/100g in the leaves of *Tribulus terrestris* (Hassan *et al.,* 2005) and the values in some green leafy vegetables consumed in Sokoto (Ladan *et al.,* 1996; Faruq *et al.,* 2002). The result indicated that the leaves of *Vernonia amygdalina* are useful sources of potassium. Sodium, in combination with potassium in the body is involved in maintaining proper acid – base balance and proper nerve transmissions (Setiawan, 1996). The sodium concentration was 43.95 ± 0.68 mg/100g dry matter, and is low compared to the 45 mg/100g reported for *Senna obtusifolia* (Faruq *et al.,* 2002) and 195.0 mg/100g in *Hibiscus sabdariffa* (Ladan *et al.,* 1996). From the result, it was observed that the concentration of potassium was far greater than that of sodium. The high concentration of potassium may be due to its abundance in Nigerian soil (Oshodi *et al.,* 1999). The K/Na ratio was also high (58.46). This is advantageous as potassium is only taken from diet unlike sodium which is added during cooking. Furthermore, taken into consideration that potassium depresses while sodium enhances blood pressure, thus, high amount could be an important factor in prevention of hypertension and atherosclerosis (Yoshimura *et al.,* 1991).

Table 2: Mineral composition of the leaves of *Vernonia amygdalina*

Mineral element	Concentration (mg/100g dry matter)
K	2569.45 ± 0.02
Na	43.95 ± 0.68
Ca	48.91 ± 0.01
P	6.33 ± 0.01
Mg	74.92 ±0.08
Cu	2.52 ± 0.03
Fe	10.49 ± 0.15
Mn	10.25 ± 0.09
Zn	2.61 ± 0.01
K/Na	58.46
Ca/P	7.73

The data are mean value ± standard deviation (SD) of triplicate determinations.

Calcium content was found to be 48.91 ± 0.01 mg/100g. This is high compared to the 33 and 38 mg/100g reported in lettuce and sickle pod respectively (Faruq *et al.,* 2002). Calcium is important for bone and teeth formation, the transmission of nerve impulses, for muscle contraction and blood clothing. The Phosphorus content of the leaves of *Vernonia amygdalina* was 6.33 ± 0.01 mg/100g. This value was low when compared to the 23.83 ±0.9mg/100g in *Tribulus terrestris* (Hassan *et al.,* 2005) and the 166.0 – 640.0 mg/100g reported in some green leafy vegetables consumed in Sokoto (Ladan *et al.,* 1996). Phosphorus is important for healthy bones and teeth. It is important for the utilization of nutrient in the body and in order to release energy inside the cells. According to Guil – Guerreo *et al.* (1998), for good Calcium and Phosphorus intestinal utilization, Ca/P ratio must be close to unity. The leaves of *Vernonia amygdalina* had a high ration (7.73), indicating that diet based on this leaves required to be supplemented in favor of phosphorus.

Magnesium is an important mineral in connection with circulatory diseases such as ischemic heart diseases and calcium metabolism in bone (Ishida *et al.,* 2000). The magnesium content of the leaves of *Vernonia amygdalina* appeared to be high (74.92 ± 0.08 mg/100g), when compared to the 19 mg/100g in *Senna obtusifolia* leaves (Faruq *et al.,* 2002) and other cultivated green leafy vegetables such as cabbage (4

mg/100g) and lettuce (6 mg/100g) (Turan *et al.,* 2003). High magnesium concentration in these leaves is expected since magnesium is a component of leaves chlorophyll (Dosunmu, 1997; Akwaowo *et al.,* 2000)

Copper is known for the role it plays in hemoglobin formation and also contribution to iron and energy metabolism (Cabrera *et al.,* 1996; Adeyeye, 2002). The concentration of copper in the leaves of *Vernonia amygdalina* was found to be 2.52 ± 0.03 mg/100g. The value reported was higher than 0.1 mg /100g in *Lesianthera africana* leaves (Isong and Idiong, 1997) and *Ipomoea batatas* leaves (Ishida *et al.,* 2000). From the result, the leaves of Vernonia *amygdalina* have good amount of copper relative to its recommended dietary allowance (RDA) of 1.5-3 mg/day for adult male and female, pregnant and lactating mothers and 1-3 mg/day for children (7-10years) set by the United States of America National Research Council, NRC (1989). Iron is required for hemoglobin formation and its deficiency leads to anemia (Turan *et al.,* 2003). The assay indicated that the leaves of *Vernonia amygdalina* contain 10.49 ± 0.15 mg /100g of iron. This value is higher compared to 2.8 mg/100g in *Tribulus terrestris* leaves (Hassan *et al* .,2005), 1.6 mg/100g in spinach, 0.7 mg /100g in lettuce and 0.3 mg/100g in cabbage (Turan *et al.,* 2003). When comparing with the RDA for iron which is 10-15 mg/day (NRC,1989), it can be concluded that the leaves *Vernonia amygdalina* are good source of iron.

Manganese is a mineral element that is nutritionally essential. The manganese content of the leaves of *Vernonia amygdalina* was 10.25 ± 0.09 mg/day. This value is high compared to 2.14± 0.22 mg /100g reported in *Ipomoea aquatica* Forsk leaves (Umar *et al.,*2007) and 4.83-10.03 mg/100g in *Ipomoea batatas* leaves (Ishida *et al.,* 2000). The RDA for manganese are 2-5 mg/day for adult male and female, pregnant and lactating mother, 2-3 mg/day for children (7-10 years) (NRC,1989), based on the RDA, it is clearly revealed that the leaves of *Vernonia amygdalina* are good sources of manganese. Zinc is known to play a role in gene expression, regulation of cellular growth and participates as a co-factor of enzymes responsible for carbohydrates, proteins and nucleic acid metabolism (Camara and Amaro, 2003). The concentration of this element was found to be 2.61 ± 0.01 mg/100g which is high compared to 0.1 mg/100g in *Tribulus terrestris* (Hassan *et al.,* 2005) and 1.75 – 2.58 mg/100g reported in some famine foods of republic of Niger (Sena *et al.,* 1998). This shows that the leaves of *Vernonia amygdalina* are moderate source of this mineral element compared to the zinc RDA of 12-15 mg/day (NRC, 1989).

The contribution of the leaves of V*ernonia amygdalina* to the dietary intake of essential elements was evaluated as follows (Hassan *et al.,* 2005);

$$Contribution\ to\ RDA(\%) = \frac{Concentration\ of\ the\ element}{RDA} \times 100 \qquad (1)$$

where, RDA = recommended dietary allowance (NRC, 1989).

The data are presented in Table 3. The leaves were rich sources of iron, copper, potassium and manganese, moderate source of zinc and magnesium and poor source of phosphorus, sodium and calcium when compared with their respective recommended dietary allowances (RDA). This indicated that the leaves supplement other dietary sources of copper, iron, manganese, potassium and magnesium.

Table 3: Contribution to the dietary intake to some mineral element by the leaves of *Vernonia amygdalina*

Minerals	RDA (mg)	Contribution to RDA (%)
K	2000	128
Na	500	9
Ca	1200	4
P	1200	1
Mg	350	21
Cu	1.5 – 3	84 – 168
Fe	10 – 15	70 – 105
Mn	2 – 5	205 – 513
Zn	12 – 19	14 - 22

Conclusion

The result of the nutritional analysis revealed that the leaves of *Vernonia amygdalina* are good source of carbohydrate, energy and minerals such as iron, potassium, copper, manganese and zinc which meet the recommended daily allowances. The results suggests that the plant leaves if consumed in sufficient amount could contribute greatly towards meeting human nutritional requirement for normal body growth and adequate protection against diseases arising from malnutrition.

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