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Effects of Vegetative Zones on the Nutritional Composition of *Vernonia Amygdalina* Leaves in Ekiti State

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Abstract— *The study was carried out to determine the effects of vegetative zones (location) on the nutritional compositions of Vernonia amygdalina leaves in Ekiti State, Nigeria. Across locations (in each vegetative zones), A total land area of 9 m x 18 m was acquired and soil samples were randomly collected to determine the physical and chemical composition of the soils. The growth of Vernonia amygdalina (stem) with a spacing of 1 m x 1 m between rows was determined. Harvested fresh leaves of the plant were analyzed for nutritional composition using standard methods. Nutritional and mineral compositions were observed at different proportions in the leaves of the investigated plant. Higher proximate composition in the leaves of Vernonia amygdalina was also recorded in terms of Moisture (Efon; 11.34%) and protein (Ikere; 22.46 %,) in the rainforest. However, higher Fat (Otun; 4.58 %), Crude fiber (Omuo; 16.08 %), Ash (Omuo; 14.69%) and Carbohydrate (Otun; 38.68 %) was found in Vernonia amygdalina grown in the Derived Savannah area. Similarly, the Mineral element compositions in the leaves of Vernonia amygdalina were found to be higher in plant from the rainforest area than the derived savannah area of Ekiti State*

except sodium and iron, which were higher in Vernonia amygdalina grown in the Derived Savannah area. However, the significant differences recorded between the nutritional components on the studied medicinal plant reveals the potentiality of the influence of soil factor and different climatic conditions of the study areas.

***Keywords*— Mineral elements, Nutritional composition, Standard methods, Vegetative zones, Vernonia amygdalina.**

I. INTRODUCTION

Nigeria is rich in nutritionally and medicinally important flora and there are a series of plants for bio-prospecting [1]. They are recognized to contain substances that could be useful for the treatment of ailments directly or be used as a basis to produce drugs. Many of these plants are known to alleviate symptoms of illnesses and have been screened to have medicinal importance. Thus, *Vernonia amygdalina* is one of them. *Vernonia amygdalina*, commonly known as bitter leaf in the English language [2], is a member of the Asteraceae family, a small evergreen shrub of the tropical region, especially in West Africa [3]. It is usually used for dietary purposes, especially after washing the leaves to remove the bitter taste [4]. In ethno-medicine practice, the roots and leaves are used to treat fever, kidney problems, hiccups, and stomach discomfort, and they have also been reportedly used in the treatment of toothaches and fertility problems [5]. The nutritional composition of *V. amygdalina* reveals the presence of proximate (protein, crude fiber, fat, ash, crude carbohydrate) and minerals (zinc, calcium, manganese, chromium, copper, phosphorus, sodium, and magnesium) in an appreciable proportion [6].

It is therefore evident from available literature that limited studies have examined the influence of vegetation on the genetic make-up and nutritional quality of medicinal plants. Thus, the need for the research is evident, as the environment (location) affects the quality and characteristics of medicinal plants irrespective of the medicinal plant species [7]. Incidentally, it has also been reported that climatic factors such as rainfall, temperature, light, relative humidity, and stage of maturity have an influence on the growth and development of plants, and these could cause variation in the distribution of the nutritional contents in them [8]. It is therefore imperative to evaluate the nutritional compositions of the leaves of *Vernonia amygdalina* grown in different vegetations of Ekiti State, thereby justifying whether different vegetative areas have effects on the nutritive values of the plants.

II. METHODOLOGY

2.1 Description of the study area

The research was conducted in two different vegetations of Ekiti state.The vegetation was made up of the tropical rain forest of the state that is made up of two towns each, named Efon-Alaaye Ekiti and Ikere Ekiti, and the derived savannah areas that comprise Omuo-Ekiti and Otun-Ekiti, respectively. Efon-Alaaye is located at 7.70^{o}N and 4.96^{o}E of the Greenwich meridian, with an annual temperature of 24.6oC and precipitation of 1361 mm). Ikere-Ekiti is located at 7.50^{o}N and 5.21^{o}E of the Greenwich meridian, with an annual temperature of 25.4^{o}C and precipitation of 1355 mm. Otun-Ekiti is located at 7.98 ^{o}N and 5.11^{o}E, with an annual temperature of 24.7^{o}C and a precipitation of 1292 mm.Omuo-Ekiti is located at 7.76^{o}N and 5.72^{o}E, with an annual temperature of 24.3^{o}C and precipitation of 1296mm [9]

2.2 Land Preparation, Soil Analysis and Seed Sowing

A total land area of 9 m x 18 m was used for the study in each location. Soil samples were collected randomly from the upper layer to a depth of 1 to 15 cm from each of the study locations and transported to the laboratory to determine the physical and chemical compositions of the soil. The land was cleared manually using a machete. Heaps were made after packing the refuse with a spacing of 1 m x 1 m between rows. Viable stems of *Vernonia amygdalina* were collected for planting and were taken to the Department of Plant Science and Biotechnology Herbarium, Ekiti State University, Ado-Ekiti, for authentication. One stem cutting of *Vernonia amygdalina* was planted per heap at a depth of 2-3 cm per heap. Cultural practices such as weeding, pruning, and thinning were involved for a period of 90 days in both planting

periods across the locations in the studied vegetative zones.

2.3 Collection and Preparation of the Plant Sample for Nutritional Analyses

The fresh leaves of the studied plant (*Vernonia amygdalina)* were collected (after 90 days of planting) and washed under running water, drained and air-dried for two weeks to avoid volatilization. The air-dried leaf samples were ground into powder using an electric blender before subjecting them to nutritional analysis.

2.4 Proximate analysis

The standard methods were used for the determination of moisture, ash, crude fiber, carbohydrate, proteins, and fat content in the leaves of *Vernonia amygdalina* [10, 11, 12].

2.5 Mineral Composition

The mineral contents were determined on aliquots of the solution of the dried leaf powdered sample by UV/visible and atomic absorption spectrophotometers [12]. 1 g of the powdered sample was weighed into a pyrex beaker and 10 mL of the concentrated HNO_3 was added and allowed to soak for 30 min. Then, 3 mL of 60% perchloric acid was added. The sample was placed on a hot plate and heated at 3500 C until the frothing stopped and the HNO_3 almost evaporated. Then, a watch glass was placed on the beaker and heating continued until the sample turned light straw in colour. This was then removed from the hot plate and cooled. The watch plate was then rinsed into the sample, and the sample was filtered into a 100 mL volumetric flask and made up to the mark with distilled water. This was analyzed using a flame photometer for sodium and potassium and an AAS for other minerals.

2.6 Data Analysis

The results obtained from nutritional (proximate and mineral) analyses were subjected to an Analysis of Variance (ANOVA). The mean values obtained from samples across the locations in the vegetative zones were separated using Turkey's Multiple Range Tests at P 0.05.

III. RESULTS

Table 1: Soil properties –Chemical and Physical properties at different locations in the study area.

SOIL PARAMETERS	LOCATIONS			
	Forest Area		Savanna Area	
CHEMICAL PROPERTIES	EFON ALAAYE	IKERE EKITI	OTUN EKITI	OMUO EKITI
pH (1:2) H_2O	5.40	6.18	5.92	6.12
Organic Carbon (%)	0.99	2.07	0.74	1.41
Organic Matter (%)	1.71	3.57	1.36	2.43
Available P (Mg/kg)	28.75	123.90	63.25	5.60
CEC (Cmol/kg)	4.47	22.28	6.16	10.19
E.A (Cmol/kg)	2.40	0.16	0.12	0.24
Elect. Cond. (µ S)	118.50	174.50	85.00	132.10
Ca (Cmol/kg)	2.29	17.07	4.24	7.35
Mg (Cmol/kg)	0.59	1.91	0.56	0.92
Na (Cmol/kg)	0.34	0.33	0.24	0.23
K (Cmol/kg)	1.14	2.86	0.98	1.45
Nitrogen (%)	0.25	0.48	0.22	0.34
PHYSICAL PROPERTIES				
Sand (%)	81.00	80.00	87.00	88.00
Silt (%)	14.60	12.60	6.60	6.60
Clay (%)	4.40	7.40	6.40	5.40
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam

3.1 Proximate composition of V*ernonia amygdalina*

The results of the proximate composition of the leaves of *Vernonia amygdalina* across locations in the different vegetative areas are presented in table 2. The percentage of moisture content in the leaves of the plant ranged from 11.34 % in Efon-Alaaye, 9.78 % in Otun Ekiti, 9.53 % in

Omuo Ekiti and 9.38 % in Ikere Ekiti. Also, the composition of fats was found to be lowest in leaves collected from Ikere Ekiti (4.23%), followed by Efon-Alaaye (4.34%), Omuo Ekiti (4.38%), and Otun Ekiti (4.58%), respectively. However, ash content was found to be highest in the leaves collected from Omuo Ekiti (14.69%), followed by Ikere Ekiti (14.18%), Efon Alaaye (13.83%), and Otun Ekiti (12.37%). Similarly, protein, crude fiber content, and carbohydrate content were observed to have varied quantities across locations in the vegetative areas (Table 4).

Table 2: Proximate composition of Vernonia amygdalina Leaves from different Vegetative areas in Ekiti State

Area	Towns	Moisture (%)	Fat (%)	Ash (%)	Protein (%)	Crude Fiber (%)	Carbohydrate (%)
Forest	Efon	11.34±0.03^{a}	4.34±0.03^{bc}	13.83±0.02^{c}	20.39±0.01^{c}	15.48±0.07^{b}	34.62±0.10^{c}
	Ikere	9.38±0.04^{c}	4.23±0.03^{c}	14.18±0.02^{b}	22.46±0.08^{a}	14.52±0.02^{c}	35.22±0.03^{b}
Savanna	Otun	9.78±0.05^{b}	4.58±0.02^{a}	12.37±0.04^{d}	18.57±0.10^{d}	16.07±0.03^{a}	38.68±0.13^{a}
	Omuo	9.53±0.04^{c}	4.38±0.01^{b}	14.69±0.01^{a}	20.74±0.03^{b}	16.08±0.01^{a}	34.58±0.09^{c}

Values followed by the same alphabet in the same column are not significantly ($p>0.05$) different from each other using Tukey's Multiple Range Test.

3.2 Mineral Composition of *Vernonia amygdalina*

The mineral composition of the leaves of *Vernonia amygdalina* from different locations in the studied vegetative areas indicated that the mineral availability was varied from one location to another across the vegetative areas. The mineral constituents (Na, K, Mn, Mg, Fe, Ca, Zn, Cu) in the various locations of both the forest and savanna areas were significantly different as revealed in Table 3.

Table 3: Mineral Composition of Vernonia amygdalina From Different Vegetative Areas in Ekiti State

Area	Towns	Na	K	Mn	Mg	Fe	Ca	Zn	Cu
Forest	Efon	62.25 ±0.43^{b}	2350.30±6 .04^{c}	28.50 ±0.23^{c}	924.00±2 .31^{a}	27.60 ±0.15^{d}	4427.33±1 .45^{c}	9.23 ±0.01^{a}	3.85 ±0.03^{c}
	Ikere	57.00 ±0.58^{d}	2870.00±5 .77^{a}	42.50 ±0.17^{a}	755.00±2 .89^{b}	34.35 ±0.14^{b}	6085.00±2 0.21^{a}	7.28 ±0.04^{c}	4.88 ±0.01^{a}
Savanna	Otun	62.15 ±0.09^{c}	2210.00±5 .77^{d}	28.22 ±0.07^{c}	760.00±5 .77^{b}	29.25 ±0.14^{c}	4490.00±5 .77^{c}	8.67 ±0.04^{b}	4.11 ±0.05^{b}
	Omuo	67.75 ±0.49^{a}	2775.00±2 .89^{b}	38.96 ±0.20^{b}	725.00±8 .66^{c}	56.20 ±0.23^{a}	4885.00±2 .89^{b}	5.70 ±0.06^{d}	2.85 ±0.03^{d}

Values followed by the same alphabet in the same column are not significantly ($p>0.05$) different from each other using Tukey's Multiple Range Test.

IV. DISCUSSION

Recently, *Vernonia amygdalina* has been on the surface of research, and many researchers have reported the extent of their potential as a primary source for outstanding and digestible sources for proximate and mineral composition.

The nutritional properties in the leaves of the studied medicinal plant reveal its relative abundance across locations in the vegetative areas. However, its contents could vary with locations, geographical properties (which affect their growing conditions), seasons, and age of the plants, as well as the soil where they were grown [13]. Also, Brady and Well [14] reported that the dietary constituents of the leaves of the studied plants are as a result of the essential amino acids that could be accumulated as a result of the influence of locations and stages of development of the plants. However, the leaves of *Vernonia amygdalina* contain a high proportion of proteins, fats, moisture, crude fiber, carbohydrates, and ash. Protein values across locations in the vegetative zones are in agreement with reports by Yeap *et al.* [6] that

Vernonia amygdalina contains 17 to 33% protein. However, the protein values obtained across locations are significantly higher when compared to the research of Igile *et al.* [15], and this could arise due to differences in soil properties, age of the plant (leaves) and climatic factors. The appreciable proportion of crude fibers in the leaves of *Vernonia amygdalina* across locations shows that the leaves are helpful in keeping the digestive system healthy and functioning properly. However, the highest proportion of carbohydrate (Otun Ekiti; 38.68%), ash (Omuo Ekiti; 14.69%), and fat (Omuo Ekiti; 4.58%) in the leaves collected from the Derived Savannah area could also be evidenced from the influence of vegetation, locations, and soil properties (Table 2).

The mineral composition of the leaves of *Vernonia amygdalina* (Table 3) across locations in the vegetative areas revealed an appreciable proportion of Calcium (Ca), Potassium (k), Sodium (Na), Manganese (Mn), Magnesium (Mg), Iron (Fe), Copper (Cu) and Zinc (Zn). Thus, no traceable amount of lead (Pb) was observed. The appreciable proportions of minerals in the leaves of the plants collected from the rainforest areas (Ikere Ekiti and Efon-Alaaye Ekiti) could result from the higher cat-ion exchange capacity (CEC) and electron affinity (E.A) of the soils in the locations (Table 1). Also, potassium and calcium play important roles in controlling the glucose level as they help to maintain the normal glucose–tolerance in the human body [16]. Similarly, the mineral compositions across locations are in agreement with the values reported by Reedy and Bhatt [17], as he claimed that variations in mineral nutrients (of the leaves of the plant) could be as a result of different locations, soil types, age of cultivation, and climatic changes. However, the proportion of minerals found in the leaves of *Vernonia amygdalina* across locations in this study was contrary to the research of Igwilo *et al.* [18], who reported a relatively lower composition in *Vernonia amygdalina* across locations in Ogun State, Nigeria. The variations in mineral compositions could be due to differences in the age of the studied plant, location, or season of collection.Hence, the assertion of Fuglie and Sreeja [19] suggested that higher mineral and chemical properties in the succulent or younger leaves compared to the older ones could be as a result of higher metabolic activities in the succulent leaves.

The mineral elements iron, zinc, manganese, and copper are believed to possess beneficial effects in the treatment of diabetes mellitus, immune function, and cell reproductive growth, especially the sperm cell [20]. Potassium and calcium also play important roles in controlling glucose levels, which aids in the maintenance of normal glucose tolerance in the human body [21].

V. CONCLUSION

The finding provides quantitative estimation of proximate and elemental analysis of *Vernonia amygdalina*, which is medicinally and nutritionally important, particularly as it is helpful in the efficient management of various diseases' symptoms. However, various soil factors and locations in the studied vegetative areas have varying effects on the composition of the studied plant. Therefore, farmers should be aware that good site selection based on a scientific approach would help in determining the medicinal potential and nutritional values of the studied plant.

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