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Research Article

Comparison of Elemental Contents of Some Edible Plant Leaves in Hong Local Government Area of Adamawa State, Nigeria

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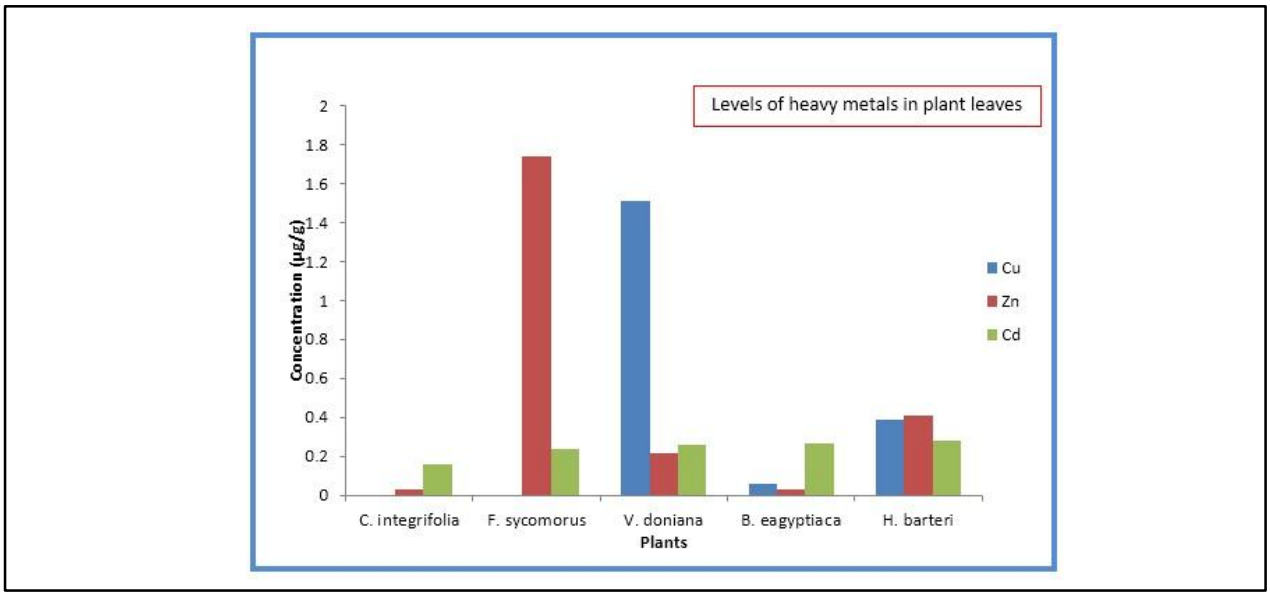
ABSTRACT

The elemental contents of *Ficus sycomorus, Celtis interifolia, Balanites eagyptiaca, Vitex doniana* and *Haemtostaphis barteri* leaves were investigated from Hong Local Government Area of Adamawa state. Atomic absorption spectrophotometer (AAS) was used to determine the elemental level in the plants. For essential elements, sodium was recorded highest in the plant investigated followed by potassium, magnesium and calcium. Zinc was observed highest in *Ficus sycomorus* followed by *Haematostaphis barteri, Vitex doniana. Balanites eagyptisca* and *Celtis integrifolia*. The concentration of copper was recorded highest in *Vitex doniana*. The levels of cadmium in the plants are in the order: *Haematostaphis bareri* > *Balanites eagyptiaca* > *Vitex doniana* > *Ficus sycomorus* > *Celtis integrifolia.* Lead was below the detectable limit of the analytical method used. The elemental compositions of the plants were within the recommended safety limit of WHO, except for cadmium which was slightly above the recommended level.

GRAPHICAL ABSTRACT



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Introduction

In Nigeria and other developing countries, as a result of food shortage and high cost of cultivated green leafy vegetables, wild and semi-wild food resources are frequently consumed as the dominant source of leafy vegetables especially in the rural communities [1]. These plant vegetables play an important role in every day cooking especially in the rural areas. In addition, the vegetables supply calories and nutrients during dry season when there is shortage of cultivated green vegetables and other food resources [2].

Plant leaves consumed as vegetables in Nigeria have been the subject of many analytical studies in the past [1-4]. Considerable information exists on the nutritional and elemental composition in plants. The content of mineral element depends to a high degree on the soil type [5]. Some of the short comings of the studies carried out are scope limitations. There is a need therefore, to carry out similar study in different locations. *Celtis integrifolia, Ficus sycomorus, Balanites eagyptiaca, Vitex doniana* and *Haematostaphis barteri* leaves are highly consumed as vegetable or salad in Hong Local Government area of Adamawa State. This has lead to our motivation in carrying out analysis on some elements (Na, K, Ca, Mg, Cu, Zn, Pb and Cd) in the plant leaves.

Experimental

Materials and methods

Study area

The study was carried out in Hong Local Government Area of Adamawa state as shown in Figure 1. It is located in the Northern guinea savannah zone on latitude $10^0 00''$ and $10^0 30''$ N and longitude $12^0 40''$ and $13^0 00''$ E. They have mean annual rainfall between 900 and 1100 m. The rainy season last for about 4–5 months. The more abundant woody plant species in this zone are: *Tamarindus indica, Taminalia, Vitex doniana, Balanites aegyptiaca, Ficus sycomorus, Ficus exasperate, Celtis integrifolia, Haematostaphis berteri, Khaya senegalensis, Afzelia Africana, Vitellaria paradoxa, Boswellia dalzielii, Ziziphus spina-christi* and among others [6]. Some of the plant leaves are eaten in the Local Government Area as vegetables or salad. The ones commonly eaten are *Celtis integrifolia, Ficus sycomorus, Balanites eagyptiaca, Vitex doniana* and *Haematostaphis barteri.*

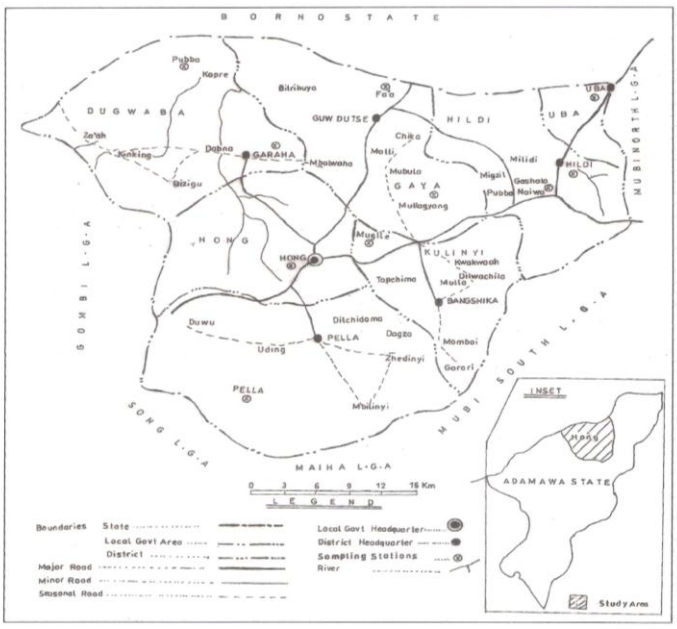

Figure 1. Map of Hong Local Government Area showing the sampling locations

Sampling and sample preparation

Sampling

Fresh tender leaves of *Celtis integrifolia*, *Ficus sycomorous*, *Balanites eagyptica*, *Haematostaphies barteri* and *Vitex doniana* were collected from 10 locations (Pella, Hong, Hildi, Uba, Gashala, Gaya, Garaha, Mugili, Fa'a and Pubba) in Hong Local Government area of Adamawa State. Each plant part was dried under shade.

Sample preparation

Each dried sample was ground to powder and sieved. Representative samples were obtained from each sample by coning and quartering techniques following the method of Crosby and Patel *et al*. [7]. This method involves making a cone shape of the sample, flatten it and divide it into four equal parts; take the opposite two quarters and discard the other two quarters. This was repeated until the sample was reduced to the size required for final analysis and stored in an air tight container.

Sample digestion

The digestion process was carried out as described by Onwuka *et al*., as follows [8]:

3.0 g of each of the powdered sample was weighed and pre-treated with 20 mL nitric acid and allowed to stay overnight. 10 mL perchloric acid was added and heated gently, then vigorously until clear solutions were obtained. The solutions were allowed to cool and then transferred to 100 mL volumetric flask and made up to mark with distilled water. The solutions were filtered and stored in plastic bottles for the analysis of Na, K, Ca, Mg, Cu, Zn, Pb and Cd using Atomic Absorption Spectrophotometer (AAS).

Statistical analysis

Analysis Of Variance (ANOVA) was used to determine the level of significance of the data obtained. Differences were considered significant if probability is less than 5% ($p \leq 0.05$) for all the data.

Results and discussion

Table 1 presents the mean distribution of essential and heavy elements in leaves of *Ficus sycomorus, Celtis integrefolia, Balanites egyptiaca, Haematostaphis barteri* and *Vitex doniana.* The values for Na were recorded highest in *Balanies egyptiaca* followed by *Ficus sycomorus* (3.90 µg/g and 3.864 µg/g respectively) which are lower than the permissible limit of WHO (400 µg/g to 500 µg/g). The amounts of K, Ca and Mg found in the leaves of plants investigated were also within the permissible limits of WHO (10 µg/g to 100 µg/g for K, 100 µg/g for Mg and 3600 µg/g for Ca). The concentrations of heavy metals observed in the samples analyzed showed highest amount of Cu in Vitex doniana (1.508 µg/g). The recommended range value for Cu by WHO is 100 µg/g to 300 µg/g. The values for Zn recorded in the entire samples were below the permissible limits of WHO (150 µg/g to 200 µg/g). Cd was detected in all the samples inestigated, having mean values of 0.238 µg/g in *Ficus sycomorus,* 0.280 µg/g in *Celtis integrefolia,* 0.280 µg/g in *Balanites egyptiaca,* 0.266 µg/g in *Haematostaphis barteri and* 0.256 µg/g in *Vitex doniana.* However, the concentrations of Cd in the samples investigated were slightly higher than the permissible level of Cd in vegetables as reported by WHO/FAO [9]. The value for Pb was below the detectable limit of the instrument used (<0.06 µg/g). Pb has low geochemical mobility and bioavailability. Its transportation above ground tissues in plants is minimal due to its retention in roots and precipitation [10]. This may be the reason Pb was not observed in the samples analyzed.

Table 1. Mean levels of elemental contents in plant leaves

Elements	*Ficicus Sycomorus*	*Celtis Integrefolia*	*Balanite Egyptiaca*	*Haematostaphis Barteri*	*Vitex Doniana*
Na	3.862	0.600	3.900	0.504	0.810
K	0.014	1.020	0.083	0.703	0.566
Ca	0.225	0.210	0.113	0.390	0.202
Mg	0.312	0.400	0.251	0.393	0.111
Cu	0.025	0.025	0.390	0.057	1.508
Zn	1.742	0.027	0.412	0.028	0.218
Pb	0.060	0.060	0.258	0.060	0.060
Cd	0.238	0.280	0.280	0.266	0.256

Comparison of total means of essential element levels in the plant leaves

Figure 2 shows the total mean concentrations of essential elements in the leaves of plants studied. The value for K was highest in *Celtis integrifolia* followed by Na, Mg and Ca. It also followed the same pattern in *Balanites eagyptiaca.* In *Ficus sycomorus,* the total composition of essential elements observed was in the order: Na>Mg>Ca>K. The amount for Na was highest in *Vitex doniana* followed by K, Ca and Mg. For *Haematostaphis barteri*, the order of element levels is: Na>Mg>Ca>K. There was no significant difference in terms of Mg and Ca in the leaves of the plants at $p \leq 0.05$. However, there was significant difference ($p \leq 0.05$) in terms of Na and K compositions. The amount of essential elements obtained in the leaves of the plants studied was lower than the amount reported in *Ficus auriculata* leaves [11].

Sodium is one of the chief extracellular ions in the body. It involves in the production of energy, transport of amino acids and glucose into the body cells and its deficiency results in hyponatremia [12]. Potassium is the principal intracellular cation. It helps to regulate osmotic pressure and pH equilibrium. The recommended daily intake is 4700 mg [13]. Its deficiency causes muscle weakness, decrease reflex responses and respiratory paralysis. Magnesium plays important role in maintaining electrical potential in nerves and membranes. It improves insulin sensitivity, protect against diabetes and its complications and also reduce blood pressure [11]. Calcium is needed for muscles development, heart and digestive system. It is also essential for the normal development and maintenance of bones [13].

Comparison of total means of heavy metal levels in the plant leaves

Figure 3 presents the total mean levels of heavy metals in plants investigated. Zn was observed highest in *Ficus sycomorus* followed by Cu in *Vitex doniana.* The concentrations of heavy metals in *Haematostaphis barteri* were in the order: Zn>Cu>Cd. For *Balanites eagyptiaca,* the value for Cd was observed highest followed by Cu and Zn. There was significant difference with regard to Zn and Cu in the samples investigated at $p \leq 0.05$. In plants, Cu plays an important role as constituent of superoxide dissimulate, which is the main component of the electron transport of photosystem.

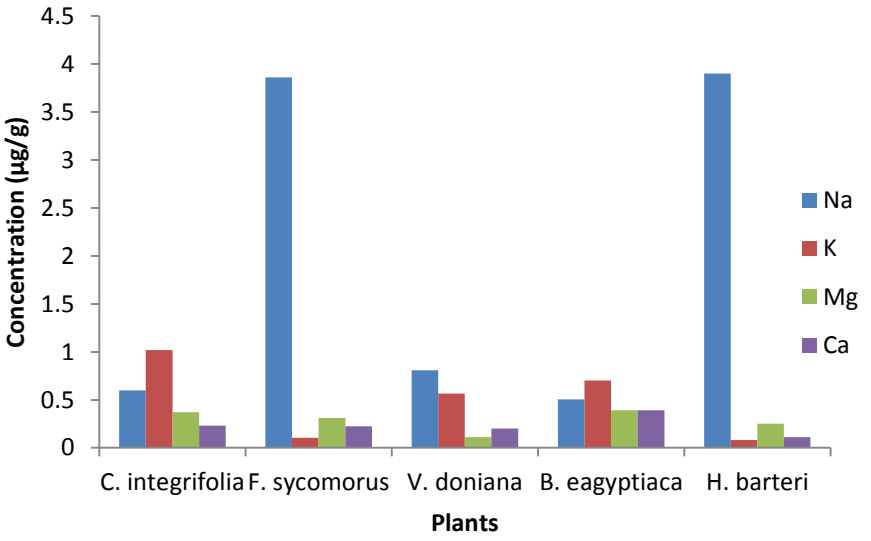

Figure 2. Bar chart of total means of essential element levels in plant leaves

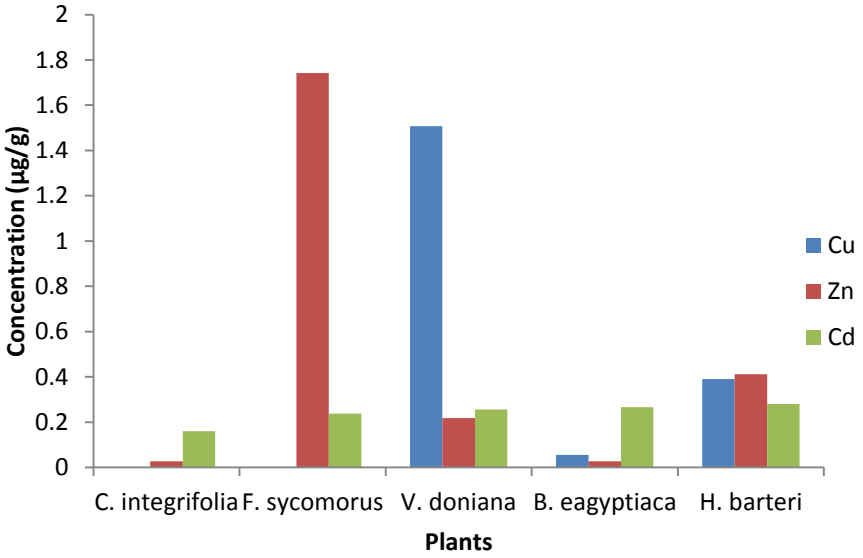

Figure 3. Bar chart of total mean levels of heavy metals in plant leaves

It is also essential for the formation hemoglobin of the red blood cells. It is required by trace quantity by humans [11].

Zn is a constituent of carbonic anhydrase localized in the cytoplasm and chloroplast used in photosynthesis [14]. It is essential constituents of enzymes that involve in carbohydrate and protein metabolism and nucleic acid synthesis. Its deficiency results in impaired growth and development, skin lesion and loss of appetite [13].

Pb was below the detectable limit of analytical method used. Pb is not readily translocated from root to shoot of plants [15]. It is toxic metal and non-essential element for human body as it causes a rise in blood pressure, kidney damage and miscarriage [11].

Conclusions

The elemental contents in the leaves of five edible plant leaves were compared. The results for essential elements showed no significant difference in terms of Mg and Ca contents at $p \leq 0.05$ among the plants, but there was significant difference in K and Na

compositions. For heavy metals, *Ficus sycomorus Vitex doniana and Haematostaphis barteri* showed considerable amount of Cu and Zn. There is no significant difference ($p \leq 0.05$) in Cd composition among the plant leaves studied. The essential elements found in these plants are required by humans for maintenance of good health.

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