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Mineral Composition of *Moringa oleifera* Leaves, Pods and Seeds from Two Regions in Abuja, Nigeria

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ABSTRACT

The mineral composition of the lamina, petiole, seed pod, seed shell, seed kernel powder and seed kernel oil of *Moringa oleifera* L. from two regions, Sheda and Kuje, Abuja, Nigeria were investigated. The results indicated that Ca, Mg, Fe and Cu in *M. oleifera* leaves, pods and seeds from Sheda were relatively higher than that from Kuje. Relatively high contents of Ca and Fe were found in the lamina and seed shell of the plant respectively from both regions. The Mg content (0.185 mg mL^{-1}) in the seed kernel oil of moringa from Sheda was significantly lower ($P \leq 0.05$) than that in the other parts of leaf and seed. The Fe content in the seed shell from Sheda was 0.2436 mg g^{-1} more than those from Kuje. Toxic element such as Pb was absent in the leaves, pods and seeds of moringa from both locations. This study confirmed that there are variations in macro and trace minerals in moringa leaves, pods and seeds from different locations. This finding might be a reference point in the selection and formulation of plant-based mineral supplement in animal and human nutrition.

Key Words: Abuja; Minerals; *Moringa oleifera*; Leaf; Pod; Seed

INTRODUCTION

In many developing countries, the supply of minerals is inadequate to meet the mineral requirements of farm animals and rapidly growing population. Minerals cannot be synthesized by animals and must be provided from plants or mineral-rich water (Mosha *et al*., 1995). Living organisms use minerals for osmotic adjustment, activate enzymes, hormones and other organic molecules that enhance the growth, function and maintenance of life processes (Aslam *et al*., 2005). Minerals are essential in animal feed and human nutrient. Human bodies daily need more than 100 mg of major minerals and less than 100 mg of minor minerals (Rajangam *et al.*, 2001). Mineral composition of a plant plays significant role its nutritional, medicinal and therapeutic values (Rajurkar & Damame, 1998; Choudhary & Rehman, 2002; Al-Kharusi *et al*., 2009). It was reported that mineral content in the leaves and seeds of moringa varied in Pakistan with location (Aslam *et al*., 2005).

Nigeria is rich in nutritionally and medicinally important flora and there are series of plants for bioprospecting. *Moringa oleifera* L. is commonly called ben oil tree and locally known as *Zogeli* among the Hausa speaking people of Nigeria. It is grown and widely cultivated in the northern part of Nigeria and many countries in tropical Africa. *M. oleifera* can be grown in a variety of soil conditions preferring well-drained sandy or loamy soil that is slightly alkaline (Abdul, 2007). Almost every part of *M. oleifera* can be used for food and as forage for livestock (Ram, 1994). The leaves can be eaten fresh cooked or stored as dried powder for several months the pods, when young can be cooked; eaten like beans (National Research Council, 2006). Its oil and micronutrients have been reported to contain antitumour, antiepileptic, antidiuretic, anti-inflammatory and venomous bite characters (Hsu, 2006).

The minerals contents in *M. oleifera* and their bio-availability have been a subject of tremendous studies. There are however limited reports on the influence of variation in geographical locations or agro-ecology of *M. oleifera* on the mineral composition in various organs of the plant in Nigeria. Confirmation of minerals content of plant materials across varied agro-ecologies is necessary in the selection and formulation of plant-based mineral supplement in animal and human nutrition. This has prompted the study of mineral composition of more and more edible and medicinal plants, which could be used as a viable source of minerals. The objective of this study was to investigate and compare the mineral components of the lamina, petiole, pod, seed shell, seed kernel powder and the seed kernel oil of *M. oleifera* in two regions in Sheda and Kuje, Abuja, Nigeria.

MATERIALS AND METHODS

Collection of leaf and seed samples: Two samples of each of the leaves, pods and seeds were assayed from each region and analysed individually in triplicate. Samples of leaves and fruits were collected from a year old *M. oleifera* plants

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located in Sheda Science and Technology Complex (SHESTCO) Botanical and Medicinal gardens near Kwali, Abuja (8°21'N; 6°25'E) and from Audu Ogbe's Farms, Kuje Abuja (9°21' N; 7°18' E), Nigeria. The regions are within the southern guinea savanna agro-ecological zone of the tropics.

Analysis of soil samples: Soil samples were taken within 0-15 cm depth from each of the two sites. Each of the composite soil samples was air-dried and sieved through a 2 mm-mesh sieve before the physical and chemical analysis. Particle size analysis was done by hydrometer method (Gee & Or, 2002). Soil pH determination was at ratio of 1:1 in distilled water. The pH determination in 1 N KCl was also carried out by pH meter. Exchangeable cation (i.e., Ca, Mg, K & Na) were extracted in 1N CH_3COONH_4 at pH 7 (McLean, 1982).

Preparation of samples: The sample materials collected were dried on the laboratory benches for 2-3 weeks to constant weight. The dried plant parts were separately ground to fine powder using a Warring 240 v 4 L blender, Thomas scientific, Swedesborn, U.K. Twenty gram each of the seed kernel powders were Soxhlet extracted with n-Hexane at 50-60°C for 24 h. The resulting solution was concentrated in rotary vacuum evaporator (RE 300B, Bar loworld Scientific Ltd., OSA, U.K) to yield an oily golden yellowish mass.

Reagents and apparatus: All the reagents and chemicals used were of analytical grade obtained from BDH and Sigma-Aldrich. The standards used were prepared in the laboratory, Chemistry Advanced Laboratory, SHESTCO, Sheda, Abuja. Distilled water and acid washed glassware were used throughout the analysis.

Wet digestion method: 2 g of each of the samples was weighed into separate beakers and treated with 20 mL of concentrated HNO_3 heated to reflux on an electric hot plate at 70-90°C until digestion is complete. Side by side, 20 mL of HNO_3 was also added to empty beakers, which served as blank. The content of the beaker is allowed to cool, filtered through Whatman No 42 filter paper into volumetric flasks and made up to volume of 100 mL with distilled water. The flasks were then covered.

Determination of minerals: Working standard solutions of Ca, Mg, Fe, Cu, Pb and Zn were prepared from stock standard solution (1000 mg L^{-1}) and absorbance were obtained for various working standard for each elements in the samples using atomic absorption spectrometer (AAS) 969 UNICAM (Sahito *et al*., 2002). The absorbance was plotted against concentration and the linear calibration curves formed revealed the real concentration of each sample. A blank reading was also taken and necessary correction was made during the calculation of concentration of various elements.

Data collected were subjected to Analysis of Variance (ANOVA) and differences among the mineral components of the plant parts were determined with Duncan Multiple Range Test (DMRT), using SAS 9.0 Statistical Package. *P* values$\leq$0.05 were considered statistically significant. Comparison of minerals content in leaf and seeds of *M. oleifera* from Kuje and Sheda, Abuja were pictorially shown with bar charts by employing Microsoft Office Excel computer software, 2007.

RESULTS AND DISCUSSION

The soils on which the plants were grown were fertile sandy loam. The pH of the soil from both sites, where moringa was planted was slightly acidic (Table I). This was in line with the findings of Anjugu (2004) on the soil survey of Abuja. The organic matter content was very high as they were up to 2.75% Kuje and 2.74% in Sheda. The total N content was very high, but the available K was very low. The soil was loose with clay content less than 6%, but Kuje soil had slightly less clayey content (0.30%) than that of Sheda. The exchangeable cations were very high, particularly Mg. All the nutrient elements except that of available K could be considered adequate for maximum growth of most tropical crops (Adeoye & Agboola, 2005).

The highest Ca content (3.463 mg g^{-1}) was observed in the lamina of *M. oleifera* from Kuje (Table II). This was significantly higher ($P \leq 0.05$) than other leaf and seed parts. There was no significant difference ($P \geq 0.05$) in the Ca content of seed shell and seed pod. Seed kernel oil had the least Ca content (0.109 mg mL^{-1}). There was no significant difference ($P \geq 0.05$) between the Mg content in the leaf lamina and the seed powder. The least quantity of Mg was found in seed kernel oil (0.0530 mg mL^{-1}). The leaf lamina had the highest Cu content (0.0400 mg g^{-1}), but not significantly difference ($P \geq 0.05$) from the content in the seed shell and the seed kernel oil. Seed kernel powder had the least Cu content (0.0150 mg g^{-1}). Prasad (1998) and Onianwa *et al*. (2001) reported a similar trend of low Cu content in Nigerian plant dietary intakes.

The quantity of Ca in the lamina and petiole of moringa obtained from Sheda was significantly higher ($P \leq 0.05$) than those in the pod and seed shell (Table III). The least Ca content was observed in seed kernel oil (0.5046 mg mL^{-1}) and was significantly lower than ($P \leq 0.05$) than in seed powder. The Mg content in seed kernel oil (0.185 mg mL^{-1}) was significantly lower ($P \leq 0.05$) than the content in other parts of leaf and seed. The highest quantity of Fe was observed in the seed shell and this was significantly higher ($P \leq 0.05$) than the contents in the other parts of seed and leaf. The highest content of Cu (0.1311 mg mL^{-1}) was observed in the seed kernel oil and the least content was in the seed powder. Anwar and Bhanger (2003) similarly reported a relatively low level of Cu in moringa leaves and pods in different regions in Pakistan. Only a minute quantity of Zn was found in the leaf stalk and seed powder.

Ca and Mg were relatively higher in *M. oleifera* leaves and seeds from Sheda. Iron was completely absent in the seed kernel oil from the two locations (Tables II & III). Zn was completely absent in the seeds and leaves from Kuje,

Table I: Physical and Chemical and properties of the top soil of the experimental sites

Soil characteristics	Kuje	Sheda
	Physical Characteristics (%)	
Sand	79.8	79.2
Silt	15.1	15.4
Clay	5.1	5.4
Textural class	sandy loam	sandy loam
	Chemical characteristics	
pH (H_2O)	6.49	6.53
pH (KCl)	5.85	5.98
Total N (%)	0.73	0.63
Available P (ppm)	6.77	6.99
	Exchangeable bases (meq/100 g/soil)	
Ca	1.99	1.96
Mg	7.67	7.71
K	0.47	0.44
Na	0.13	0.10
Al	0.03	0.02
Organic carbon (%)	2.75	2.74
CEC	4.19	4.20
Acidity	0.04	0.05
Mn (mg L^{-1})	6.39	6.41
Fe (mg L^{-1})	20.12	21.14
Cu (mg L^{-1})	1.56	1.63
Zn (mg L^{-1})	3.40	3.47

Table II: Mineral composition of leaves and seeds of *M. oleifera* from Kuje, Abuja, Nigeria

Plant part	Ca	Mg	Fe	Cu	Zn	Pb
Lamina	3.4630a**	0.7250ab	0.0410c	0.0440a	-	-
Petiole	2.8010b	0.6930bc	0.0470c	0.0270b	-	-
Pod	1.9140c	0.6640c	0.0140d	0.250b	-	-
Seed shell	2.0130c	0.5990d	0.2040a	0.0390a	-	-
Seed kernel powder	1.0290d	0.7550a	0.0750b	0.0150c	-	-
Seed kernel oil*	0.1090e	0.0530e	-	0.0450a	-	-

*****mg mL^{-1} for seed kernel oil; **Means with the same letter are not significantly different at ($P > 0.05$) by DMRT

Table III: Mineral composition of leaves and seeds *M. oleifera* from Sheda, Abuja, Nigeria

Plant part	Ca	Mg	Fe	Cu	Zn	Pb
Lamina	3.8270a**	0.8056a	0.0788ab	0.0436b	-	-
Petiole	3.7340a	0.8304a	0.1440ab	0.0350b	0.0180	-
Pod	2.3772b	0.8342a	0.0440b	0.0356b	-	-
Seed shell	2.6356b	0.7844a	0.4476b	0.0138b	-	-
Seed kernel powder	1.4162c	0.8384a	0.1185b	0.0342b	0.0096	-
Seed kernel oil	0.5046d	0.1850b	-	0.1311a		-

*****mg mL^{-1} for seed kernel oil; **Means with the same letter are not significantly different at ($P > 0.05$) by DMRT

but traces were observed in the petiole (0.018 mg g^{-1}) and seed kernel powder (0.0096 mg g^{-1}) of moringa from Sheda. Though the highest quantity of Cu was found in seed kernel oil, the oil had the least Mg and Ca content. Highest quantity of Ca was observed in the lamina from both locations in Abuja. This indicated that for a good source of Ca and Mg to farm animals or humans, lamina of Moringa could be a preferable to other parts. Generally, moringa plant from Sheda is richer in minerals than those from Kuje, Abuja. Toxic elements such as Pb was absent in the leaves

Fig. 1: Comparative Ca and Mg contents in leaf and seeds of *M. oleifera* from Kuje and Sheda, Abuja

Note: La=lamina, Pe=Petiole, SS=Seed shell, Po=PodSKP+Seed Kernel Powder; Bar Charts for each mineral followed by thesame letter are not significantly different by DMRT at $P \leq 0.005$

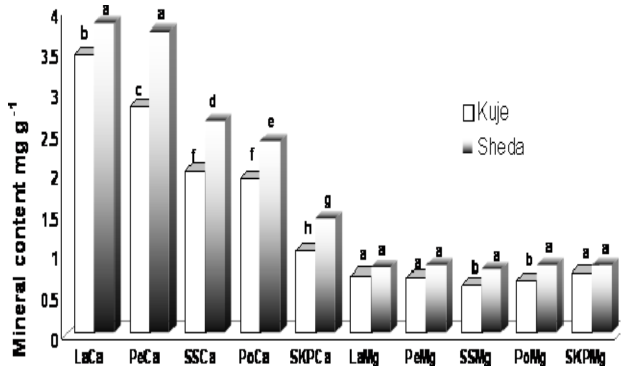
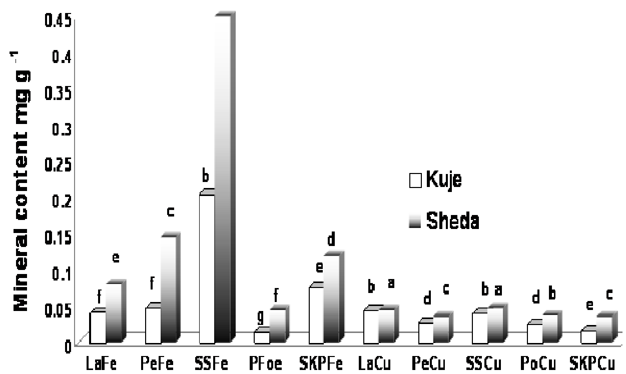


Fig. 2: Comparative Fe and Cu contents in the leaves and seeds of *M. oleifer*a from Kuje and Sheda, Abuja

La=lamina, Po=Pod, SS=Seed shell, SKP=Seed Kernel Powder, Fe=Iron, Cu=Copper; Bar Charts for each mineral followed by the same letter are not significantly different by DMRT at P



and seeds of Moringa from both locations. This observation further indicated the suitability of Moringa for consumption by humans and animals.

Minerals content in the seed kernel oil was relatively lower than from other plant parts except Cu (Tables II & III). Ca, Mg and Cu were present in the seed kernel oil ofmoringa from the two locations, while Fe, Zn and Pb were absent. Ca content of the seed kernel oil in the plant from Sheda was 0.3956 mg mL^{-1} higher than the Kuje samples. Mg and Cu contents in the seed kernel oil from Sheda were also 0.053 mg mL^{-1} and 0.045 mg mL^{-1} higher than those from Kuje, respectively. Anwar and Bhanger (2003) reported low macro elements in the seed oil of moringa in Pakistan.

This study showed that mineral content varies with location in the leaves, pods and seeds of *M. oleifera* (Fig. 1 & 2). The Ca content in the lamina and petiole of moringa from Sheda were significantly higher ($P \leq 0.05$) than others, while the significantly least Ca content was from the moringa seed kernel from Kuje (Fig. 1). Aslam *et al.* (2005) similarly reported that Ca content in the leaf of moringa is higher than those in their pods. Rajurkar and Damame (1998) studied the mineral content of medicinal plants with atomic absorption. Out of the 14 elements estimated in different plants, K and Ca were found to be present in higher level. Ca helps in transporting of long chain fatty acid, which helps in preventing of heart diseases and high blood pressure. The Mg content in the seed shell and seed part in moringa from Sheda were significantly lower ($P \leq 0.05$) than others. Fe content in the seed shell of moringa from Sheda was significantly higher ($P \leq 0.05$) than other parts. This was closely followed by the content in the seed shell from Kuje (Fig. 2). This indicated that the seed husks or un-shelled moringa seeds could be a potential source of Fe supplement for humans and livestock.

The highest copper content was from the lamina of moringa from Sheda and this was not significantly different ($P \geq 0.05$) from that obtained in the seed shell (Fig. 2). Mosha *et al*. (1995) observed a similar report from the analysis of some Tanzanian vegetables and also Kuti and Kuti (1999) have the same report on tree spinach, *Cnidoscolu*s species. Differences in mineral composition of a plant could be as a result of variation in edaphic factors and agro climatic conditions. Reedy and Bhatt (2001) confirmed a variation in the minerals content of green leafy vegetable cultivated on soil fortified with different chemical fertilizer.

In conclusion, some organs of moringa are good source of important minerals and this plant plants might be explored as a viable supplement and ready source of dietary minerals in animal and human food. There was a significant variation in macro and micro elements in moringa leaves, pods and seeds from different regions in Abuja, Nigeria. This might be attributed to the variable uptake of minerals by the plant materials by the plant materials and variable agro-ecologies of the different regions. It was specifically indicated in the present analysis that lamina of moringa is very rich in Ca and Mg, while the seed shell is richer in Fe. Other nutritional contents in various organs of moringa and the possible roles of edaphic factors on the mineral contents of the plant deserve further investigation.

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