Study of Trace element levels in Sudanese Moringa Olivera Leaves Using XRF Technique

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Abstract:

Moringa Olivera is one of the most important plants in earth in fields of nutrition and medicines, and has economic value. The main objectives of this study were to measure trace elements concentrations and calculate co-factor of some elements K, Ca, Fe, Cu and Zn. Five samples were taken from soil and leaves of Moringa Olivera from Alsamrab area, analyzed by X- ray florescence (XRF) to measure concentrations of trace elements, which are K, Ca, Mn, Fe, Cu, Zn, Pb, Br, Rb, Y, Zr and Nb which has concentrations of (6786 ± 1650, 26920 ± 1209, 1051.2 ± 902.57, 41800 ± 3994.997, 13.04 ± 1.890, 65.68 ± 11.932, 22.48 ± 5.266, 6.2 ± 1.235, 48.14 ± 7.87, 18.66 ± 1.088, 307.8 ± 55.91 and 19.54 ± 3.95 ppm), respectively. Comparison between Sudanese Moringa Olivera and African studies (Nigeria, Burkina Faso and Ghana) concentrate in Ca, K, Cu, Zn and Fe elements. Nigerian Moringa (303, 1.65, N.F., 3.33 and 13.85 ppm), respectively. Burkina Faso Moringa (2098, 1922, N.F., 5.4 and 28.3 ppm), respectively. Ghanaian Moringa (26.4, 21.7, 7.1, 13.7 and 175 ppm). The results showed significantly cofactor of K and Ca (5.6% and 2.9%). Moringa has a competitive characteristic with other Sudanese food (Mango, Baobab and Pumpkin).

Keyword: Moringa, trace element, XRF

الملخص: تعتبر المورينغا أوليفيرا هي واحدة من أهم النباتات في الأرض في مجالات التغذية والأدوية وذات قيمة اقتصادية. تمثلت الأهداف الرئيسية لهذه الدراسة في قياس تركيزات بعض العناصر الكيميائية وحساب المشترك عامل من بعض العناصر مثل البوتاسيوم، الكالسيوم، الحديد، النحاس والزنك. أخذت خمس عينات من التربة وأوراق المورينغا أوليفيرا من منطقة السامراب وتم تحليلها بواسطة مطياف لمؤشر تحليل المعادن لقياس تركيزات العناصر الكيميائية، والتي هي البوتاسيوم، الكالسيوم، المنغنيز، الحديد، النحاس، الزنك، الرصاص، برازيلي، الروبيديوم، Y، عنصر الزركون وملحوظة التي لديها تركيزات (٦٧٨٦ ± ١٦٥٠، ٢٦٩٢٠ ± ١٢٠٩، ١٠٥١,٢ ± ٩٠٢,٥٧، ٤١٨٠٠ ± ٣٩٩٤,٩٩٧، ١٣,٠٤ ± ١,٨٩٠، ٦٥,٦٨ ± ١١,٩٣٢، ٢٢,٤٨ ± ٥,٢٦٦، ٦,٢ ± ١,٢٣٥، ٤٨,١٤ ± ٧,٨٧، ١٨,٦٦ ± ١,٠٨٨، ٣٠٧,٨ ± ٥٥,٩١ و١٩,٥٤ ± ٣,٩٥ جزء في المليون)، على التوالي. مقارنة بين المورينغا أوليفيرا السودانية والدراسات الأفريقية (نيجيريا وبوركينا فاسو وغانا) نجد ان تركيز عناصر الكالسيوم والبوتاسيوم والنحاس والزنك والحديد في المورينغا أوليفيرا النيجيرية (٣٠٣، ١,٦٥، لا يوجد، ٣,٣٣ و١٣,٨٥ جزء من المليون)، على التوالي. المورينغا أوليفيرا بوركينا فاسو (٢٠٩٨، ١٩٢٢، لا يوجد، ٥,٤ و٢٨,٣ جزء في المليون)، على التوالي. المورينغا أوليفيرا الغانية (٢٦,٤، ٢١,٧، ٧,١، ١٣,٧ و١٧٥ جزء في المليون). أظهرت النتائج العامل المساعد بكثير من البوتاسيوم والكالسيوم (٥,٦٪ و٢,٩٪). المورينغا كانت فيه خصلة تنافسية مع الطعام السودانيين (مانجو، باوباب والقرع).

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Introduction:

A trace elements is an element whose concentration less than 1000 ppm (0.1%) in a sample of rock, soil, or any natural product. Trace elements include trace metals, heavy metals, micronutrients[1]. The main sources of trace elements are soil parent materials (rocks), fertilizers, biosolids, irrigation water, coal combustion residues, auto emissions and metal smelting industries[2]. Even though some trace elements originate from rocks and some are essential for plant growth and development, when present in soils at elevated levels those same elements become toxic. Trace elements that have been taken up by plants, especially those grown on contaminated soil could move up the food chain, some accumulating in the fatty tissue of animals and/or humans. Some trace elements of potential concern as soil contaminant are Arsenic (As), Boron (B), Cadmium (Cd), Chromium (Cr), Copper (Cu), Fluorine (F), Lead (Pb), Manganese (Mn), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Selenium (Se) and zinc (Z)[3]. Trace elements could be (Essential, Probably essential and non-essential elements). Essential trace elements include iron, zinc, copper, cobalt, chromium, fluorine, iodine, manganese, molybdenum and selenium. Probably essential such that nickel, tin, vanadium, silicon, boron. Non-essential trace elements, which include aluminum, arsenic, barium, bismuth, bromine, cadmium, gold, lead, lithium, mercury, rubidium, silver, strontium, titanium and zirconium is all found in plant[4]. A valid concept of the nature of soil must avoid the common error that soil is a simply a mixture of unconsolidated material, resulting from the weathering processes of underlying rocks. Soil is a natural body, having both mineral and organic components in addition to physical, chemical and biological properties[5]. Soil properties, therefore, cannot be a simple reflection of the combined properties of all soil components. Knowledge of the association of trace elements with particular soil phases and their affinity to each soil constituent is the key to a better understanding of the principles governing their behavior in soils. The "normal concentrations" of trace elements in soils are of great interest as background values needed for any assessment of the degree of soil contamination[6]. According to the Soil Science Society of America (SSSA), soil is a living system that represents a finite resource vital to life on earth. It forms the thin skin of unconsolidated mineral and organic matter on the earth's surface[7]. It develops slowly from various parent materials and is modified by time, climate, macro- and microorganisms, vegetation and topography. Soils are complex mixtures of minerals, organic compounds and living organisms that interact continuously in response to natural and imposed biological, chemical and physical force[8,9]. Soil is the main source of trace elements for plants both as micronutrients and as pollutants. It is also a direct source of these elements to humans due to soil ingestion affected by dust inhalation and absorption through skin[10].

The soil-plant transfer of trace elements is a part of chemical element cycling in nature. It is a very complex process governed by several factors, both natural and affected by humans[11,12]. Thus, the prediction of trace element uptake by plants from a given growth medium should be based on several biotic and abiotic parameters that control their behavior in soil[13,14]. Trace element concentrations in plants reflect, in most cases, their abundance in growth media (soil, nutrient solution, water) and in ambient air. Plants exhibit a variable, and sometimes specific, ability to absorb trace elements from soil. Plants absorb trace elements by roots from soil (or other growth media) and by above ground parts from aerial deposition[15,16].

Materials and Methods:

A farm of Morienga Olivera in AL-Samrab area was chosen to take samples of soil and leaves. Five samples taken from each hector on May 2014 at morning. For Leaves, it was collected from each hector. The soil samples were first ground to powder from by using mechanical grinder. Then they were pressed into a pellet form using a pressing machine. The latter consists of die system, comprising base cylinder, and plunger, two pellets of steel and extraction ring. The base was placed on the bench top, the cylinder is assembled onto the base and one of steel pellets was placed into the bore of the cylinder with polished face up. The sample is poured into the bore of the cylinder and side of cylinder is tapped, so that the powder is homogeneously distributed across the face of the polished steel pellet, the second steel pellet is then inserted with polished face down. A pressure of about 15 tons is usually applied to make a good pellet. EDXRF spectrometer was used to quantify the elemental compositions in samples. Each spectrum was collected for a lifetime of 500s, EDXRF spectrometer with Cd109 radioactive source as a source of excitation. The characteristic X-ray emitted from the sample were detected using Si (Li) detector with Full Width at Half Maximum intensity (FWHM) equal 170 eV at 5.96 KeV. The software AXIL was designed for full treatment dealing with spectra were recorded (Fig.1)

Figure 1. EDXRF spectrometer with Cd109 radioactive source as a source of excitation

The results:

In order to evaluate the quality of the analytical result obtained the IAEA standard reference material (IAEA-SOIL-7) was analyzed. The results of quantitative and qualitative analysis of the sample were shown in Figure 2, Fig.3 and Fig. 4. the relative error as a measure for accuracy are given in table 2.1.

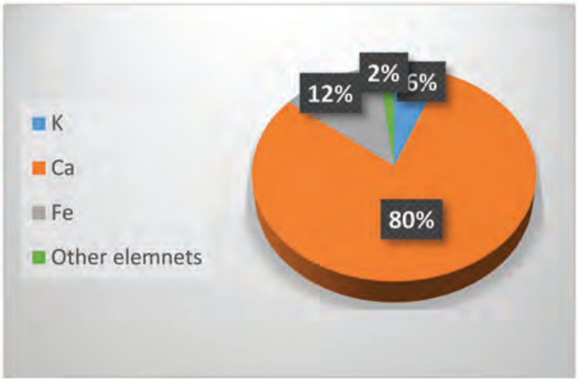

Figure 2. Most common elements in Sudanese Moringa Olivera

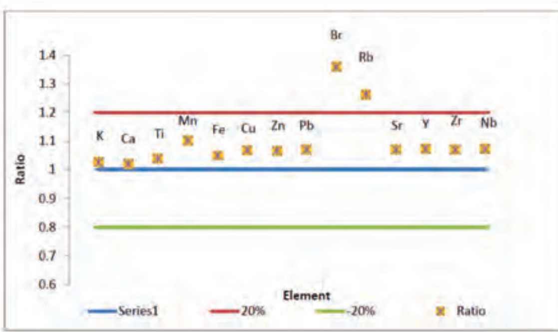

Figure 3. The concertation of different elements measured in Sudanese Morngia Oliveria

Table 1. The results of Moringa concentration in Soil (ppm) (IAEA-SOIL-7):

No.	Element	Concentration (ppm) (Mean ± Standard Deviation)
1	K	7097.5 ± 1727.2
2	Ca	26920 ± 1209.1
5	Fe	41800 ± 3994.9
6	Cu	13.04 ± 1.9
7	Zn	65.68 ±11.9

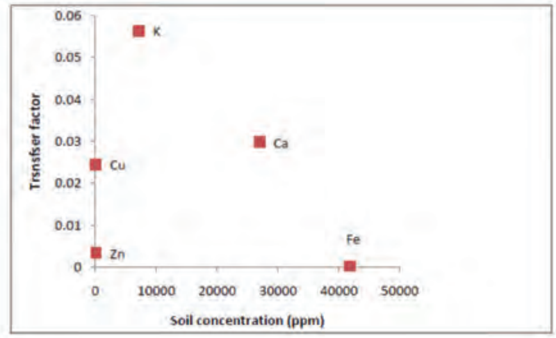

Figure 4. The Transfer Cofactor of Sudanese Moringa Olivera

Table 2. Showed results of trace elements concentration (ppm) in Moringa leaves and the cofactor:

Element	Leave	Soil Concentration (ppm)	Transfer Cofactor
K	400	7097.5 ± 1727.2	0.056358
Ca	801	26920 ± 1209.1	0.029755
Fe	10.7	41800 ± 3994.9	0.000256
Cu	0.318	13.04 ± 1.9	0.024387
Zn	0.223	65.68 ±11.9	0.003395

Table 3. The results the concentration in ppm of Ca, K, Cu, Zn and Fe Sudanese Moringa with another study from Nigeria, Burkina Faso and India:

Element	Sudanese Moringa	Nigeria Moringa	Burkina Faso Moringa	Indian Moringa
K	801	303.00 ± 16.00	2098	26.4
Ca	686	1.65 ± 0.49	1922	21.7
Fe	0.318	N.F.	N.F.	7.1
Cu	0.223	3.33	5.4	13.7
Zn	10.7	13.85 ±12.41	28.3	175

Table 4. The results trace elements concentrations of Moringa and Sudanese food:

Element	Sudanese Moringa	Mango	Baobab	Pumpkin
K	801	0.3	250	14.25
Ca	686	207	2500	315
Fe	0.318	N.F.	N.F.	N.F.
Cu	0.223	0.07	1.37	3.9
Zn	10.7	0.55	1.5	3.2

Table 5. The daily need of the human body from the trace elements in ppm (Ca, K, Cu, Zn and Fe)

Element	Sudanese Moringa	Daily Intake	Morigna Leaves
K	801	1000	801
Ca	686	3500	686
Fe	0.318	2	0.318
Cu	0.223	15	0.223
Zn	10.7	15	10.7

Discussion:

In this study, high concentrations of K, Ca, Fe, Ti, Cu, Zn, Pb, Br, Rb, Y, Nb, Mn, Zr and Sr were found. In leaves, samples observed (Zn, Fe, Ca, K and Cu) elements which transfered from soil. After calculate the cofactor of each element observed that the highest one is K (9%) then for Ca, Fe, Cu and Zn are (2%), (0.02%), (2%) and (0.3%) respectively. In 2013, Enugu State University of Science and Technology, Enugu State, Nigeria has made study on Moringa and Ficus capensis to detrmine vitamins and minerals incluing trace elements, which detected in this thesis. They found that Moringa leaves has Ca, Zn, Fe and K of (303.00±16.00, 3.33, 13.85±12.41 and1.65±0.49 ppm) respectively. In Ficus capensis also for same elements are Ca, Zn, Fe and K are (383.16±1.50, 53.33±43.33, 26.14±2.05 and 2.39±0.06 ppm) repectively(13) .Sudanese Moringa leaves has higher concentrations of Ca (801 ppm) and K (400 ppm), while in Nigerian Moringa higher in Zn (3.33 ppm) and Fe (13.85±12.41 ppm). In Ficus capensis noticed that higher in Zn (53.33±43.33 ppm) and Fe (26.14±2.05 ppm). In 2011, at Burkina Faso a study was carried on Moringa leaves to determine trace elements(14) .Study showed that concentrations of Ca, K, Fe, Zn are (2098, 1922, 28.3 and 5.4 ppm) respectively. According to Sudanese Moringa leaves Ca (801 ppm), K (400 ppm), Fe(10.7 ppm) and Zn(0.223 ppm) are less than Burkina Faso Moringa which has higer concentrations of Ca(2098 ppm), K(1922 ppm), Fe(28.3 ppm) and Zn(5.4 ppm). Department of Nutrition and Food Sciences, University of Ghana has been studied on Indian samples of Moringa leaves to detect trace elements, study observed that Ca, K, Cu, Zn, Fe has concentrations of (26.4, 21.7, 7.1, 13.7 and 175 ppm) respectively(15). In this thesis Ca and K is higher than Indian. Indian Moringa has higher concentration of Cu, Fe and Zn than Sudanese type. On other hand, Moringa could compete other types of food; particularly Sudanese food. Along with Sudanese study on common Sudanese food (Mango, Baobab and Pumkin) which carried on 2011 at Food research Centre in Shabbat, observed that very high concentrations of Ca and Fe with food detected, also for K but Baobab has higher amounts of it. For Zn Pumkin is the highest and Mango is least. Moringa has higher amounts of Ca and K beside other (Ti, Mn, Fe, Cu, Zn, Pb, Br, Rb, Sr, Y, Zr and Nb) which indicate that our soil is very rich with trace elements when compare these results with Nigerian study. Transfer cofactor show excellent results in K, Ca, Zn and Cu, so Moringa leaves is very rich in these elements, which can be major source for nutritional value.

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