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Mineral Composition of *Moringa oleifera* Leaves and Pods from Different Regions of Punjab, Pakistan

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Abstract: This study presents the mineral composition of leaves and pods of *Moringa oleifera* from different agro climatic regions of Punjab. Samples of leaves and pods were wet digested and analyzed for various minerals by using Atomic Absorption Spectrophotometer (AAS) and flame photometer. The contents K, Ca, Mg, Na in the leaves and pods of *Moringa oleifera* was found to be 19732-24397, 1839-2097; 18950-26349, 1292-1837; 98.2-109, 93.9-103.9 and 1635-2721, 1032-2105 mg kg^{-1} respectively. The concentration of Fe, Cu, Mn and Zn was found to be 205-573, 155.2-435.9; 7.3-11.2, 20.9-32.1; 76.9-112.8, 40.2-72 and 20.9-34.1, 15.3-29 mg kg^{-1} respectively. The level of P in the samples of leaves and pods was 1180-1450 and 1860-2125 mg kg^{-1} respectively. The contents of different minerals in the leaves and pods of *M. oleifera* were significantly varied from region to region. The results of present analysis revealed that pods and leaves of *M. oleifera* indigenous to different agro-climatic regions of Punjab contained a considerably high amount of Ca, Mg, K, Mn, P, Zn, Na, Cu and Fe and might be used as a viable supplement of dietary minerals.

Key words: *Moringa oleifera*, agro-climatic regions, AAS, mineral composition, leaves and pods

INTRODUCTION

Minerals are essential to life as living organisms use minerals to activate enzymes, hormones and other organic molecules that participate in the growth, function and maintenance of life processes. Minerals cannot be synthesized and must be provided from plants, vegetables or mineral rich water[1]. Minerals are the catalysts, which create a healthy environment in which the body is using vitamins, proteins, carbohydrates and fats that. This is why a complete spectrum of minerals is necessary for exemplary health[2].Minerals are essential part of plants and animals, performing different functions and are used in the synthesis of chlorophyll, protein, and phosphates, component of DNA and RNA and energy carrying coenzyme such as ATP[3].

Mineral composition of plants plays a vital role in the medicinal values of plants and their therapeutic effects on health and diseases are well attributed[4]. With the increased awareness of the crucial role of phytochemicals in human health, there is a revival of interest in the use of plants as a source for conventional and complementary therapies[5]. A number of nutritionally important minerals and their bioavailability in plants has been a subject of numerous studies[6]. This has prompted the need to study the mineral composition of more and more edible and medicinal plants which could be used as a viable source of minerals.

Pakistan is rich in medicinally important flora and there are series of plants for bioprospecting. Although, a wealth of information is available in the literature about their therapeutic uses. However, a few of them have been studied for their mineral composition and trace elemental analysis.

The titled tree, *M. oleifera* belongs to the family *Moringaceae*. It is grown and widely cultivated in Punjab plains, Sindh, Baluchistan, and NWFP In Pakistan *M. oleifera* is locally known as Sohanjna. It represents a traditionally important food commodity as the leaves; flowers, fruits and seeds of this tree are locally used as vegetables[7]. Indonesians eat both leaves and seedpods of this tree as vegetables, which are reported to taste like asparagus[8].

M. oleifera has also many medicinal and therapeutic properties, which include the treatment of ascites, rheumatism and venomous bites, and use as cardiac and circulatory stimulants. Several parts of *M. oleifera* have also been reported to show antitumor, antinuclear, inflammatory, antipyretic effects[9]. A significant work on the nutritional attributes of *M. oleifera*

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has been carried out, as reported in the literature. However, little bit is known about the mineral profile of leaves and pods of *M. oleifera* indigenous to Punjab, Pakistan. The primary objective of the present research was to investigate and study the mineral composition of leaves and pods of *M. oleifera* from different agro climatic regions of Punjab, Pakistan.

MATERIALS AND METHODS

Plant Samples: The samples of leaves and pods of *M. oleifera* were collected from mature *M. oleifera* plants around the villages from Bahawalnager, Sadiqabad and Chenabnager, Punjab, Pakistan. Two sample of each of the leaves and pods were assayed from each region and analyzed individually in triplicate. Samples of pods and leaves were further authenticated by Professor M. Ashraf, Department of Botany, University of Agriculture, Faisalabad, Pakistan

Reagents and apparatus: Authentic standards of Na, K, Ca, Mg, Fe, Zn, P, Cu and Mn were of Fluka. All the reagents and chemicals used were of analytical grade and obtained from E. Merck. Acid washed glassware and deionized water was used throughout the analysis.

Preparation of samples: Leaves and pods of *M. oleifera* were washed with deionized water and dried in an electric oven (~120°C) to constant weight. The dried plant material was then ground to fine powder.

Wet digestion method: 0.5 g of each of the material (leaves and pods) was weighed into duplicate, separate beakers and treated with 5 mL of conc. HNO_3; side by side 5 mL of nitric acid was also added to empty beakers which served as blank[10]. The flasks were covered with the watch glasses and heated to reflux on an electric hot plate at 80-100°C. After heating for one hour, the contents of flasks were treated with additional 5 mL of nitric acid, following by 2 mL of 30% hydrogen peroxide, and heating at gentle, reflux was continued for another hour. The watch glasses were removed from top of the flasks, and heating was continued until the volume of contents was reduced to semi dried. Again added 5 mL of 2 N HNO_3, heated for 2 min and the contents of the flasks were cooled, diluted appropriately with 2 N HNQ and filtered through Whatman No 42 filter paper into volumetric flasks and made up to volume of 25 mL with deionized water.

Determination of minerals: Working standard solutions of Calcium (Ca), Copper (Cu), Iron (Fe), Manganese (Mn), Magnesium (Mg), Potassium (K), Sodium (Na), Phosphorous (P) and Zinc (Zn) were prepared from stock standard solution (1000 ppm), in 2 N nitric acid and absorbance were noted for standard solution of each element and samples using Atomic Absorption Spectrophotometer (AAS) Perkin Elmer, Model A Analyst 300. The calibration curves obtained for concentration vs. absorbance data were statistically analyzed using fitting of straight line by least square method. A blank reading was also taken and necessary corrections were made during the calculation of concentration of various elements.

RESULTS AND DISCUSSION

The results of the present analysis show that the concentration of Na and K in the samples of *M. oleifera* leaves from Bahawalnagar and Sadiqabad was found to be 2721, 2591 and 20982 and 19732 mg kg^{-1}, respectively. Whereas, the Na and K content in the samples of leaves native to Chenabnagar was found to be 1635 and 24397 mg kg^{-1} respectively (Table 1). The samples of leaves of *M. oleifera* from Bahawalnagar and Chenabnagar were generally higher in their Na and K contents, respectively, as compared with those of other regions. The samples of pods of *M. oleifera* from Bahawalnagar were found to be rich in Na and K contents i.e., 2105 and 20972 mg kg^{-1}, whereas, lowest amount of Na and K was present in the samples of pods from Chenabnagar i.e. 1032 and 18369 mg kg^{-1} (Table 2). The leaves and pods of *M. oleifera* were quite comparable in the contents of Ca but varied in the contents of Na. The variation of Na and K in the samples of leaves and pods from different regions might be attributed to the variation in the agro climatic regions. Mosha *et al.*[11] studied the mineral contents in amaranth, peanut, pumpkin and sweet potato leaves. The contents of K and Na were ranged between 145.97 to 780.19 mg per 100 g of fresh vegetable, 11.5-21.31 mg per 100 g of fresh vegetable respectively. Sodium is an important mineral from medicinal point of view. Potassium is important for reducing blood pressure and also increasing blood circulation, as well as preventive aid on general heart health[12].

The amount of Ca in the sample of *M. oleifera* leaves from Bahawalnagar, Sadiqabad and Chenabnagar was found to be 22931, 18950 and 26349 mg kg^{-1} respectively (Table 1). Ca contents of the leaves native to Chenabnagar was generally higher as compared to those of other regions. Whereas, the samples of *M. oleifera* leaves from Sadiqabad were found to be lower in their Ca contents. pods of *M. oleifera* from Bahawalnagar, Sadiqabad and Chenabnagar contained Ca contents 1563, 1292 and 1837 mg kg^{-1} respectively (Table 2). Highest

Table 1: Mineral Composition of *Moringa oleifera* leaves from different regions of Punjab, Pakistan

Samples	K (mg kg^{-1})	Na (mg kg^{-1})	Ca (mg kg^{-1})	Mg (mg kg^{-1})	Fe (mg kg^{-1})	P (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mgkg^{-1})
BL	20982±7.98	2721±4.98	22931±8.89	100±0.82	205±1.52	1237±4.10	9.5±0.08	76.9±0.82	25.9±0.05
SL	19732±6.83	2591±4.12	18950±6.52	98.2±0.91	397±2.93	1450±4.61	11.2±0.05	112.8±1.06	20.9±0.06
CL	24397±8.52	1635±3.45	26349±9.52	109±1.20	573±5.64	1180±2.65	7.3±0.04	97.7±2.38	34.1±0.85

Values are mean ± SD of two samples of *M. oleifera* leaves from each region analyzed individually in triplicate.
BL Leaves of *M. oleifera* from Bahawalnager
SL Leaves of *M. oleifera* from Sadiqabad
CL Leaves of *M. oleifera* from Chenabnager

Table 2: Mineral Composition of *Moringa oleifera* pods from different regions of Punjab, Pakistan

Samples	K (mg kg^{-1})	Na (mg kg^{-1})	Ca (mg kg^{-1})	Mg (mg kg^{-1})	Fe (mg kg^{-1})	P (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
BP	20972±7.93	2105±5.21	1563±1.27	96.0±1.40	155.2±1.58	1943±6.82	26.7±0.54	40.2±0.76	21.4±0.49
SP	19735±8.65	1990±3.67	1292±1.07	93.9±1.25	280.7±2.57	2125±7.10	32.1±0.68	72.0±0.98	15.3±0.32
CP	18369±5.32	1032±4.11	1837±6.24	103.9±1.87	435.9±2.54	1860±6.89	20.9±0.09	61.0±0.68	29.0±0.74

Values are mean ± SD of two samples of *M. oleifera* pods from each region analyzed individually in triplicate.
BP Pods of *M. oleifera* from Bahawalnager
SP Pods of *M. oleifera* from Sadiqabad.
CP Pods of *M. oleifera* from Chenabnager

level of Ca was observed in the sample of pods of *M. oleifera* from Chenabnagar, whereas, least amount of Ca was found in the sample of pods from Sadiqabad. The amount of Ca in leaves of *M.oleifera* was high as compared to pods. Rajurkar and Damame[13] studied the mineral content of medicinal plants used in the treatment of diseases resulting from urinary tract disorders by non-destructive neutron activation analysis with atomic absorption. In total, 14 elements were estimated in different plants, among these K, Ca and Cl were found to be present at higher level. Ca helps in transporting of long chain fatty acid which helps in preventing of heart diseases, high blood pressure and other cardiovascular diseases.

The level of Mg in the samples of leaves of *M. oleifera* indigenous to Bahawalnagar, Sadiqabad and Chenabnagar were found to be 100, 98.2 and 109 mg kg^{-1} respectively (Table 1). Highest level of Mg was noted in the sample of leaves from Chenabnagar and lowest amount of Mg was observed in the sample from Sadiqabad. Sample of pods from Bahawalnagar, Sadiqabad and Chenabnagar were found to contain Mg 96, 93.9 and 103.9 mg kg^{-1} respectively (Table 2). pods samples native to Chenabnagar were higher in Mg content, while, samples from Sadiqabad were found to be quite low in Mg content. The level of magnesium in the leaves and pods of *M. oleifera* were comparable. Magnesium works with calcium to help transmitting nerve impulse in the brain. It also has calming effect and works on the nervous system of the people with depression.

The amount of Fe in the samples of leaves of *M. oleifera* native to Bahawalnagar, Sadiqabad and Chenabnagar were found to be 205, 397 and 573 mg kg^{-1} respectively (Table 1). Leaves of *M. oleifera* from Chenabnagar were found to be rich in iron content, while, low amount of Fe was present in the samples of leaves of *M. oleifera* from Bahawalnagar. Fe content in the samples of pods was found to be less than samples of leaves. Pods of *M. oleifera* from Bahawalnagar, Sadiqabad and Chenabnagar were found to contain iron 155.2, 280.7 and 435.9 mg kg^{-1} respectively (Table 2). Samples of pods native to Chenabnagar were higher in their Fe content as compared to other regions. Kuti and Kuti[14] determined the proximate composition and mineral content of raw and cooked leaves of two edible spinach species. The edible spinach leaves were found to be rich in iron contents. Adewusi *et al.*[15] estimated the mineral content in processed Cassava products. Mg, Fe, Ca and Zn were present in considerable amounts.

Phosphorous concentration in the samples of leaves of *M. oleifera* from Bahawalnagar, Sadiqabad and Chenabnagar was 1237, 1450 and 1180 mg kg^{-1} respectively (Table 1). Leaves of *M. oleifera* from Sadiqabad were found to be higher in P contents, whereas, samples of leaves from Chenabnagar contained less amount of P. Pods of *M. oleifera* were found to be rich in P. The content of P in the samples of pods was significantly higher than those of leaves (Table 2). Sample of pods from Bahawalnagar, Sadiqabad and Chenabnagar contained 1943, 2125 and 1860 mg kg^{-1} of P respectively. The samples of pods from Sadiqabad and Chenabnagar were found to contain highest and lowest amount of P respectively. Pods of *M. oleifera* were found to be rich in P. Freiberger *et al.*[16] studied the nutrient contents of edible leaves of seven wild plants from Niger. All the seven plants contained significantly high amount of selenium and phosphorous.

The level of copper in the samples of leaves was quite low as compared to other minerals. The contents of Cu

from Bahawalnagar, Sadiqabad and Chenabnagar was found to be 9.5, 11.2 and 7.3 mg kg^{-1} respectively (Table 1). The samples of leaves of *M. oleifera* from Sadiqabad were higher, whereas, those from Chenabnagar were generally lower. Samples of pods from Bahawalnagar, Sadiqabad and Chenabnagar contained 26.7, 32.1 and 20.9 mg kg^{-1} of Cu respectively (Table 2). The concentration of Cu was higher in the samples of pods from Sadiqabad. While, lowest amount of Cu was observed in the samples of pods of *M. oleifera* from Chenabnagar. Reedy and Bhatt[17] studied the contents of selected minerals in spinach. Contents of Cu, Zn, and K were significantly high in spinach.

A significantly high amount of manganese was also estimated in the leaves and pods of *M. oleifera*. The contents of manganese in the leaves of *M. oleifera* from Bahawalnagar, Sadiqabad and Chenabnagar was found to be 76.9, 112.8 and 97.7 mg kg^{-1} respectively (Table 1). Highest amount of Mn was found in the samples of leaves from Sadiqabad, while, lowest amount of Mn was found in the samples of leaves from Bahawalnagar. Samples of pods from Bahawalnagar, Sadiqabad and Chenabnagar contained 40.2, 72.0 and 61.0 mg kg^{-1} of Mn respectively (Table 2). Amount of Mn in the sample of pods from Sadiqabad was high, while, amount of Mn in the sample of pods from Bahawalnagar was low. The content of Mn in the samples of leaves was quite high as compared with these of pods. Cabrera *et al.*[18] described a precise and rapid method for direct determination of Mn in wine and grape samples by electrothermal atomization atomic absorption spectrometry. Mn was tested in grapes of 12 different varieties and the concentration. ranged from 0.139-1.490 μg g^{-1}.

The contents of Zn in the samples of *M. oleifera* leaves from Bahawalnagar, Sadiqabad and Chenabnagar were 25.9, 20.9 and 34.1 mg kg^{-1} respectively (Table 1). Sample of leaves from Chenabnagar were found to be higher in the contents of Zn, while, the samples of leaves from Sadiqabad contained less amount of Zn. Sample of pods of *M. oleifera* from Bahawalnagar, Sadiqabad and Chenabnagar were found to contain 21.4, 15.3, 29.0 mg kg^{-1} of Zn respectively (Table 2). The content of Zn in the samples of pods from Chenabnagar was high as compared with those of other regions. Barminas *et al.*[19] studied the mineral composition of non-conventional leafy vegetables. Zn content was highest in *M. oleifera, Adansonia digitata and Cassia tora* leaves.

The results of the present analysis demonstrated a significant variation in the mineral content of leaves and pods of *Moringa oleifera* native to different locations of Punjab. This variation in the contents of various minerals within the pods, leaves and within the regions might be attributed to the variable uptake of minerals by the plant material and variable agro climatic conditions of the subject regions. The results of present analysis revealed that leaves and pods of *M. oleifera* are a good source of important minerals and these plant organs might be explored as a viable supplement and ready source of dietary minerals in human food.

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