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Jaya Gupta
 Department of Chemistry, Agra
 College, Agra, India

Amit Gupta
 Department of Chemistry, Agra
 College, Agra, India

A.K. Gupta
 Department of Chemistry, Agra
 College, Agra, India

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Determination of trace metals in the stem bark of *Moringa oleifera* Lam.

Jaya Gupta, Amit Gupta, A.K. Gupta

Abstract

The stem bark of *Moringa oleifera* were digested with HNO₃ and HClO₄ (4:1) and the contents of trace elements such as As, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Ni, Mn, Pb, and Zn were determined by atomic absorption spectroscopy. The presence of beneficial element i.e., Fe, Zn, K, Mg, Mn, Ca, Co, Ni are within limit. The concentration of heavy trace elements Cr, Cd and Pb are within limit, but the concentration of Cu and As are high.

Keywords: *Moringa oleifera*, atomic absorption spectroscopy, essential trace elements, heavy metals.

1. Introduction

Moringa oleifera belongs to family Moringaceae. It is also commonly known as sahnjana, sainjna in Hindi, sajina in Bengali, ben oil tree, miracle tree and mothers best friend, 'Drumstick' and horse radish tree in English. It is medium sized tree about 10-12m height. It is considered to be rich in proteins, vitamins, minerals, folic acid and β-carotene. Every plant part such as leaves, roots, fruits, flowers, bark is used as food having high nutritional value. *Moringa oleifera* is used as a drug in the treatment of asthma^[1] and possess the antidiabetic^[2], antianaphylactic^[3], antimicrobial^[4], antioxidant^[5] anti-bacterial, antibiotic, anti-inflammatory, antithyroid antiulcer, antispasmodic, cholesterol-lowering, anti-HSV, antifungal, diuretic, antihypertensive, hepatoprotective, antitumor^[6] activity. In past few years research of trace element distribution in medicinal plants^[7-9] becomes important. Trace elements are the essential for human health and they prevent several diseases, but when these elements are in high concentration they are dangerous. The atomic absorption spectroscopy is an important method for detection of trace elements^[10-11].

2. Materials and Methods

Stem bark of *Moringa oleifera* are picked from Agra and Aligarh. For fifteen days, the samples were air dried under shade. Then powdered with the help of warming blender, 2.5gm ground dried plant leaves were placed in a 250 ml conical flask, 2.5 ml concentrated HNO₃ was added slowly with constant shaking. The mixture was heated on a hot plate until the production of brown fumes ceases. The content of beaker was cooled and 10 ml of 70% HClO₄ was added. It was heated again very gently until the solution turns colorless and allowed to evaporate to a small volume. Now cooled and added double distilled water and was filtered into a 100 ml flask using Whatman filter paper and volume was diluted with double distilled water. The total concentrations of As, Ca, Co, Cr, Cu, Cd, Fe, Mg Ni, Mn, K, Pb, Zn etc. were analyzed by atomic absorption spectroscopy (Model: Perkin Elmer A Analyst 100).

3. Results and Discussion

The concentration of calcium in the stem bark sample of Agra is 2295.582 ppm and 2487.224 ppm in the sample of Aligarh. Calcium is essential for all organisms. Calcium is required for strong bones and teeth^[12]. Calcium is important for the normal contraction of heart muscles. Calcium is required for coagulation of blood. Excess of calcium concentration in blood may lead to calcification of several internal organs. Deficiency of calcium ion in blood lead to a disease called 'tetany', osteoporosis, rickets etc. The concentration of calcium is within limit. In the sample of Agra concentration of iron is 204.862 ppm and 180.769 ppm in the sample of Aligarh. For Fe in medicinal plants limits have not yet been established by WHO in 2005. The dietary limit of iron in the food is 10-60 mg per day^[13]. For the formation of hemoglobin iron

Correspondence:
Jaya Gupta
 Department of Chemistry, Agra
 College, Agra, India

is necessary. Iron is required in the process of cellular respiration in the human body. Deficiency of iron causes anemia, depression, poor resistance to infection, weakness etc.

Table 1: Essential Trace Elements

Element		Ca	Co	Fe	K	Mg	Mn	Ni	Zn
<i>Moringa oleifera</i> (Stem Bark) of Agra	Mean	2295.582 ppm	0.156 ppm	204.862 ppm	1963.421 ppm	95.737ppm	74.835 ppm	1.392 ppm	9.973 ppm
Element		Ca	Co	Fe	K	Mg	Mn	Ni	Zn
<i>Moringa oleifera</i> (Stem Bark) of Aligarh	Mean	2487.224 ppm	0.182 ppm	180.769 ppm	1753.532 ppm	89.443ppm	76.323 ppm	1.212 ppm	8.241 ppm

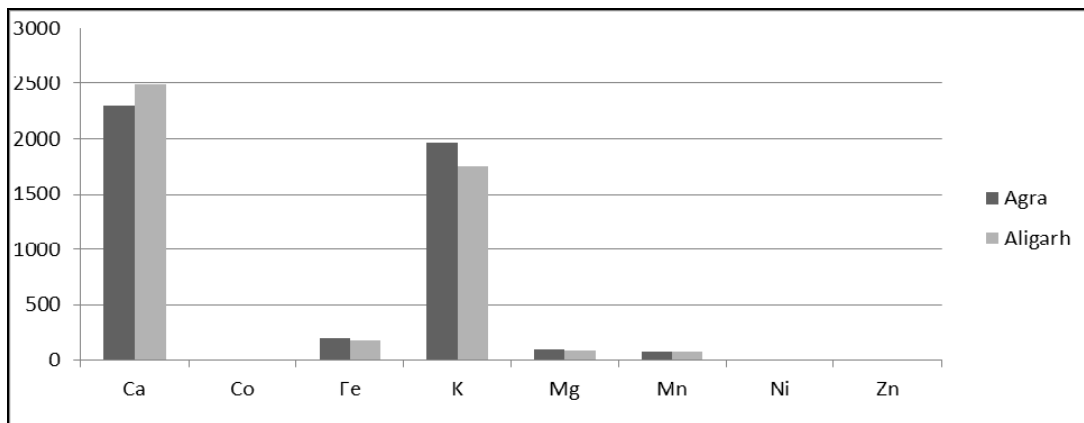


Fig 1.1: Comparative study of essential trace elements in Agra and Aligarh

Table 2: Harmful Heavy Metals

Element		As	Cr	Cd	Cu	Pb
<i>Moringa oleifera</i> (Stem Bark) of Agra	Mean	2.354 ppm	0.193 ppm	0.485 ppm	8.793 ppm	0.295 ppm
Element		As	Cr	Cd	Cu	Pb
<i>Moringa oleifera</i> (Stem Bark) of Aligarh	Mean	3.182 ppm	0.131 ppm	0.548 ppm	9.228 ppm	0.311 ppm

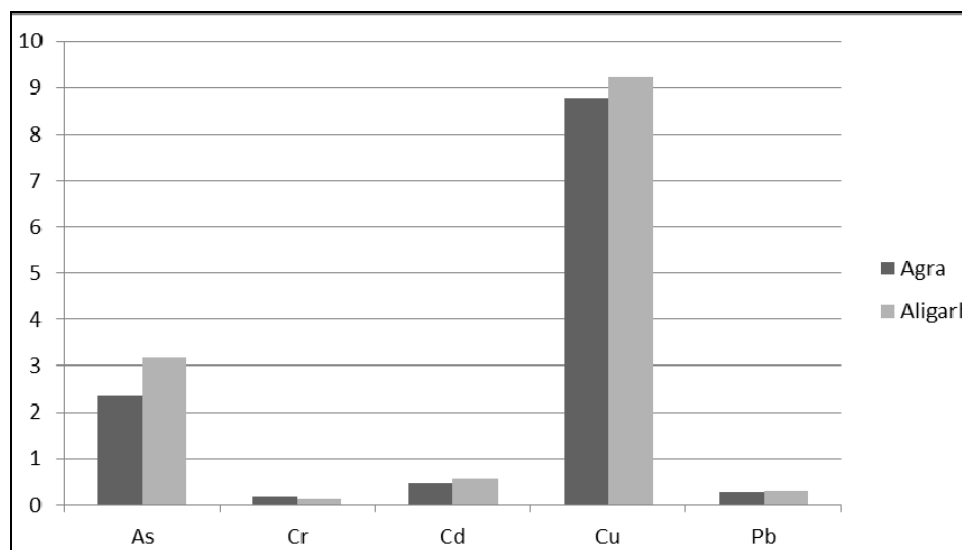


Fig 2.2: Comparative study of harmful heavy metals in Agra and Aligarh

The concentration of K in stem bark of *Moringa oleifera* is 1963.421 ppm in the sample of Agra and 1753.532 ppm in the sample of Aligarh. It regulates acid-base balance in the cell. Potassium reduces blood pressure [14]. It is essential in protein bio-synthesis by ribosomes. It is found in blood plasma cells, muscles and nerves.

The concentration of cobalt in the sample of Agra is 0.156

ppm and in the sample of Aligarh is 0.182 ppm. Cobalt is a constituent of Vitamin-B₁₂ which is most vital for the formation of normal blood cells and plays an important role in the synthesis of hemoglobin, DNA and several other enzymes. In medicinal plants, there is no established criterion for cobalt.

The concentration of magnesium in the sample of Agra is 95.737 ppm and in the sample of Aligarh is 89.443 ppm.

Magnesium works with calcium to help transmitting nerve impulses in the brain. Mg is required in the plasma and extracellular fluid, where in helping in maintaining osmotic equilibrium. Magnesium has a calming effect and works on the nervous system of those peoples, suffering from depression. In blood its quantity is 2-4 mg/100 ml.

The concentration of manganese in the sample of Agra is 74.835 ppm and that of Aligarh is 76.323 ppm. Manganese activate many metalloenzymes like arginase, carboxylase, pyruvate. It works as co-factor in respiratory enzymes. Mn provides resistance to disease. Excess of manganese causes adverse effects on the lungs and brain. Its deficiency results in several skeletal and reproductive abnormalities. The estimated dietary intake of Mn in adults is 11 mg/day. WHO (2005) established no limit for Mn. Thus, manganese is within limits.

The concentration of Ni in the stem bark sample of Agra is 1.392 ppm and 1.212 ppm in the sample of Aligarh. Nickel is required for production of insulin in the body. Deficiency of nickel causes liver disorder [15]. No limit yet been given by WHO in 2005 for Ni in medicinal plants. Thus concentration nickel in *Moringa oleifera* is within limits.

The concentration of zinc in the sample of *Moringa oleifera* is 9.973 ppm in the sample of Agra and 8.241 ppm in the sample of Aligarh. Zinc is found in more than 200 proteins and enzymes. Forebrain development, DNA synthesis, steroidogenesis bone formation, wound healing zinc is required. High concentration of zinc is neurotoxin. Normal daily intake of Zn is 12-15 mg per day. The permissible limit set by FAO/WHO (1984) in edible plants was the 27.4 ppm. Thus concentration of zinc is within limits.

The concentration of arsenic in bark, root sample of Agra is 2.354 ppm and 3.182 ppm in the sample of Aligarh. Arsenic is an element essential to life. In medicinal plants concentration of arsenic recommended is less than 1.0 ppm. So, it is more than permissible limit in stem bark of *Moringa oleifera*. Excess of arsenic causes metabolic disorder, dermatitis, lung cancer, cardiovascular and neurological effects and may cause death through enzyme inhibition.

The concentration of copper is 8.793 ppm in stem bark samples of Agra and 9.228 ppm in sample of Aligarh. Excess of copper causes dermatitis, metallic taste in the mouth, hair and skin discoloration etc. Copper play role in some neurological conditions like Alzheimer's disease, Wilson's disease, Prion disease. Traces of copper are required for normal synthesis of haemoglobin. Normal daily intake of copper is 2-5 mg per day. In edible plants permissible limit set by FAO/WHO in 1984 was 3.00 ppm. Thus, in *Moringa oleifera* copper is more than permissible limit. Sample of Aligarh contains more copper in comparison to sample of Agra.

The concentration of cadmium in the stem bark of Agra is 0.485ppm and 0.548 ppm in the sample of Aligarh. Cadmium is very hazardous to human. It is non-essential trace element. As cadmium accumulates in the environment throughout the food chain, it poses a serious threat to human beings. Cadmium causes high blood pressure, damages kidneys and liver. Excess if cadmium causes a disease known as Itai-Itai. The permissible limit set by WHO is 0.2 to 0.81 ppm. Thus concentration of cadmium in *Moringa oleifera* is within limits. Concentration of Cr in the sample of Agra is 0.193 ppm and 0.131 ppm in the leaf sample of Aligarh. Deficiency of chromium causes diabetes, growth failure, hyperglycemia, neuropathy, and atherosclerosis. Trivalent chromium is necessary for the normal metabolism of cholesterol, fat and glucose. Hexavalent chromium is a mucous membrane and skin irritant. Chromium is one of the known environmental

toxic pollutants in the world. Excess of chromium causes respiratory trouble, liver and kidney damage, skin rashes etc. No limit yet been established by WHO (2005) for Cr. In medicinal plants, Canada set 2 ppm permissible limit in the raw medicinal plant material. Thus, concentration of Cr is within limits.

The concentration of lead in stem bark sample of Agra is 0.295 ppm and 0.311 ppm in a sample of Aligarh. Lead is non-essential element and has no beneficial effects in humans. Exposure of lead produces harmful effects. Lead can cause abnormal brain, chronic nephritis of the kidneys, anemia, oxidative stress etc. The permissible limit set by WHO is 0.1 to 10 ppm. Thus, concentration of lead in both the sample of *Moringa oleifera* is within limit.

Thus, on the basis of above results, it is found that *Moringa oleifera* contain useful trace elements Ca, Fe, Zn, Mg, K, Mn, Co, Ni are within limits. Harmful heavy metals Cr Cd, Pb are also within limit but concentration of Cu and As are high. Essential elements interact with some organic compounds such as flavonoids, influencing their biological activity so they must be removed if they are in excess.

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