

MANAGING TRACE ELEMENT'S DEFICIENCY VIA MEDICINAL PLANTS- A REVIEW

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ABSTRACT

Essential trace elements or micro-nutrients are necessary for maintaining the life processes in plants and animals including humans. An element is defined essential when it is required to support adequate growth, reproduction and health when all other nutrients are optimal. The required amounts of trace elements are much lower than the required amounts of macronutrients. For most of the essential trace element low uptake/intake causes deficiency and high uptake/intake causes toxicity. Currently Fe, Cu, Zn, Se, Cr, Co, I, Mn and Mo are classified as important trace elements for livestock. In the body, minerals have four main functions: (i) structural, (ii) physiological, (iii) catalytic and (iv) hormonal or regulatory. Many of the trace elements are especially involved in the latter two tasks. The Ingested nutrients should be available for digestion, absorption, transport, utilization and elimination. Micronutrient deficiencies can be managed with dietary intake. Medicinal plants contain essential and trace elements which are very important for the human body. Various elements of Biological importance for human metabolism were found to be present in varying concentrations in most of the medicinal plants. This article uses the references of articles which helps us to supplement Fe, Cu, Zn, Se, Cr, Co, I, Mn and Mo with help of plant sources.

KEYWORDS: Trace elements, Ayurveda, Fe, Cu, Zn, Se, Cr, Co, I, Mn and Mo.

INTRODUCTION

Plant materials are widely used by many countries as home remedies and nutritional supplements. Medicinal plants contain essential and trace elements, which can be available to the human body from any kind of consumption of herbs. The plant availability of trace elements in the soil, or the capability of the soil to deliver essential trace elements to agricultural crops is essential for our ability to produce high quality agricultural products. This is

especially true for production systems where the farmers are mainly depending on the delivery capacity of trace elements of their own soil and of local production of organic fertilizers like farm manure.¹ One-third of the world's population suffers from micronutrient deficiencies primarily due to inadequate dietary intake (Fielder and Macdonald, 2009)². Nearly four decades ago, many attempts have been made, particularly in the field of medical science,

to establish relationships between the concentration of elements and specific biological dysfunctions or disease^{3,4}. These studies have successfully been established the impact of the concentration of the elements on the human health. Every element has some specific importance in the life system, though it may be present in the human organism in very minute quantities. Their increase or deficiency is responsible for upsetting the equilibrium and normal functioning of the human system. There are many medicinal plants in Ayurveda which

has trace elements which could be used as supplements for trace elements for better management of health and to correct the mal absorption.

APPROACH

Utilization of medicinal plants in this regard can be done as follows:

1. Resource plants with trace elements
2. Plants which correct metabolism so that trace elements are absorbed to a normal extent and the deficiency is cleared.
3. Cultivation of plants with trace elements as manure.

Table no 1: List of scientifically proven medicinal plants with trace elements.

Sl no	Medicinal plant	Botanical Name	Trace elements Supplement
1	Amalaki	<i>Phyllanthus emblica</i> Linn	Iron (Fe)
2	Ardraka	<i>Zingiber officinale</i> Roscoe	Iron (Fe)
3	Kumari	<i>Aloe vera</i> tourn. Ex Linn	Copper (Cu)
4	Shigru	<i>Moringa oleifera</i> Linn	Zinc (Zn)
5	Godhuma	<i>Triticum sativum</i> Lam),	Selenium (Se)
6	Lashuna	<i>Allium sativum</i> Linn	Selenium (Se)
7	Nuts : <ul style="list-style-type: none"> • Akshota • Vatada • Mukulaka • Kshudra beeja • Brazil nuts 	Walnut – <i>Juglans regia</i> Linn Badam- <i>Prunus amygdalus</i> Batsch Pista – <i>Pistacia vera</i> Linn Deshee badam/ Jangali badam - <i>Terminalia catappa</i> Linn <i>Bertholletia excelsa</i>	Selenium (Se)
8	Methika	<i>Trigonella foenum-graecum</i> Linn	Chromium (Cr+3)
9	Ajaji	<i>Nigella Sativa</i> Linn	Cobalt (Co)
10	Narikela	<i>Cocos nucifera</i> Linn	Iodine (I)
11	Kushmanda beeja	<i>Benincasa cerifera</i> Savi	Magnanese (Mn)
12	Masoor	<i>Lens culinaris</i> Medic	Molybdenum (Mo)

Iron (Fe):

Iron is important for the formation of haemoglobin and also plays an important role in oxygen and electron transfer in human body. The need to screen medicinal plants used in

traditional medicine for their elemental composition is highly desirable¹.

Medicinal plants:

-Amalaki (*Phyllanthus emblica* Linn)

It is also a rich source of Ascorbic acid (AA), a known iron bioavailability

enhancer. This study showed that *amla* juice enhances iron dialysability threefold over the control in the cell-free digestion model. In addition, the presence of *amla* juice increased iron uptake in Caco-2 and HepG2 cell lines by 17.18 and 18.71 times respectively, which was more than that in the control. In the presence of *amla* juice, iron dialysability and uptake were also better than those seen in the positive control, i.e. AA + FeSO₄ mixture. AA at an equivalent molar ratio as that found in *amla* juice increased iron dialysability only by 1.45 in cell-free models and 13.01 and 12.48 times respectively, in Caco-2 and HepG2 models⁵.

-Ardraka (*Zingiber officinale* Roscoe)

The results of clinical study of Zinger supplementary therapy for Iron absorption in Iron deficiency anaemia showed Percentage rise in Haematological and iron related parameters indicated that the ginger and iron supplementation was found to be effective in correcting anaemia and iron deficiency. This study concluded that ginger assist in iron absorption and to be beneficial as a supplement in therapy of anaemia⁶. This study also quoted that ginger as an antioxidant agent which helps to reduce oxidative stress caused by allopathic iron supplements.

Copper (Cu):

Copper (Cu) is an essential redox-active transition element that play vital role in various metabolic processes. Being toxic, its quantity in plants should be very low. It is essential to the human body since it forms a component in many enzyme systems, such as cytochrome oxidase, lysyl oxidase and an iron-oxidizing enzyme in blood. The observation of anaemia in copper deficiency

is probably related to its role in facilitating iron absorption and in the incorporation of iron in haemoglobin¹.

Medicinal plant:

-Kumari (*Aloe vera* tourn. Ex Linn)

Aloevera extract was orally administrated in a dose of 300 mg/kg body weight daily for 21 successive days before irradiation (5 Gy as an acute dose) and 7 days post exposure. Aloe vera administration led to a significant elevation in Cu and Zn levels of liver tissue as well as Fe and Cu levels of intestine tissue, while it decreased blood Cu concentration compared with control. Aloe vera extract administration pre- and post-g-irradiation resulted in noticeable improvement in the studied antioxidant status of liver tissue; restored the control levels of Fe and Cu levels in liver and intestine as well as intestinal Zn⁷.

Zinc (Zn):

Zinc is essential to all organisms and has an important role in metabolism, growth, development and general wellbeing. It is an essential co-factor for a large number of enzymes in the body. Zinc deficiency leads to coronary heart diseases and various metabolic disorders¹.

Medicinal plant:

-Shigru (*Moringa oleifera* Linn)

Moringa oleifera leaves contain fiber, fat, proteins and minerals like Ca, Mg, P, K, Zn, Cu, Fe, and S. The presence of minerals and vitamins help in boosting the immune system and cure a myriad of diseases⁸

Selenium (Se):

It is a major structural component of many enzymes such as glutathione peroxidase, thioredoxin reductase and deiodinases.

These enzymes play important roles in antioxidation, reproduction, muscles function and tumors prevention. It is important that the recommended daily intake of selenium be covered by its intake to ensure proper operation of the functions which it occurs¹.

Medicinal plants:

-Godhuma (*Triticum sativum* Lam), Lashuna (*Allium sativum* Linn),

-Nuts: Akshota (Walnut – *Juglans regia* Linn), Vatada (Badam- *Prunus amygdalus* Batsch), Mukulaka (Pista – *Pistacia vera* Linn), Kshudra beeja (Deshee badam/ Jangali badam – *Terminalia catappa* Linn), Brazil nuts- (*Bertholletia excelsa*)

It is established that by increasing the selenium content of soil the selenium content of wheat can be considerably increased, which as being the most important cereals, can considerably contribute to the satisfaction of the human selenium requirements⁹.

In another study Wheat, garlic, and cod fish were intrinsically labeled with Se-77 or Se-82 stable isotopes. Labelled meals were fed in random order to 14 adults, with a minimum washout period of six weeks between each test meal. Apparent absorption was measured as luminal loss using a fecal monitoring technique over an 8-day period. Plasma appearance of the isotope was measured at 7, 24, and 48 hours post-ingestion. Selenium absorption (+/- SD) was significantly higher ($p < 0.001$) from wheat (81.0 +/- 3.0%) and garlic (78.4 +/- 13.7%) than from fish (56.1 +/- 4.3%). Lowest plasma concentration was observed after the fish meal at all three time points, with a peak at 24 hours, whereas wheat produced the

highest plasma concentration at all three time points and peaked at 7 hours. Selenium absorption from wheat and garlic was higher than from fish, and inter-individual variation was low. Form of selenium and food constituents appear to be key determinants of post-absorptive metabolism¹⁰.

-Nuts: Akshota (Walnut – *Juglans regia* Linn), Vatada (Badam- *Prunus amygdalus* Batsch), Mukulaka (Pista – *Pistacia vera* Linn), Kshudra beeja (Deshee badam/ Jangali badam – *Terminalia catappa* Linn), Brazil nuts- (*Bertholletia excelsa*)

Some bioactive constituents of nuts, such as tocopherols, phytosterols, folic acid, **selenium**, and magnesium, are purported to have antioxidant, anti-inflammatory or anti carcinogenetic properties¹¹.

-*Terminalia catappa* Linn: Its micronutrients (Iron, zinc, copper, iodine, chromium, selenium, manganese, molybdenum, and nickel) helps to regulate human body functions¹².

Brazil nuts (*Bertholletia excelsa*, Family Lecythidaceae)

Selenium concentration in Brazil nut varies between 8 and 83 $\mu\text{g/g}$ and is among the highest found within foods consumed by humans are the richest known food source of selenium, with mean concentrations reported in the literature between 8 and 83 $\mu\text{g Se/g}$. Concentrations in unshelled nuts are reported to be greater than in shelled nuts. Animal studies suggest that the bioavailability of selenium in Brazil nuts is equal to that in sodium selenite for the restoration of both tissue selenium and selenoprotein activity and that these nuts may be successful in tumour prevention randomized controlled clinical study

conducted in New Zealanders to see the response of both blood selenium concentration and activity of the selenoprotein GPx to Brazil nut supplementation revealed that consumption of 2 Brazil nuts daily is as effective in raising plasma selenium concentration and GPx activities as is the consumption of a 100g selenium selenomethionine supplement during a period of 12 wk. The study also recommended the public to include as few as 1 Brazil nut/d in the diet would avoid the need for fortification of foods or for expensive supplements to improve the selenium status of New Zealanders¹³.

Chromium (Cr+3):

Researchers have proven that Chromium has an improving effect on insulin binding and increases the number of insulin receptors on the cell surface and sensitivity of pancreatic β -cells together with an overall increase of insulin-sensitivity¹⁴. It is also proven to act as a co-factor for insulin and therefore, Cr activity in the organism is parallel to insulin functions¹⁵. Cr deficiency leads to impaired glucose tolerance and increased insulin release subsequently leading to hyperinsulinemia¹⁶.

Medicinal plant:

-Methika (*Trigonella foenum-graecum* Linn)

Researches proves that fenugreek seeds are beneficial in the treatment of diabetes¹⁷. An another study proves that plant tolerance to toxic metals improves if soils are ameliorated with farm yard manure¹⁸. One of the preliminary study is the proof for concept of accumulation of Cr from soil into fenugreek seeds and leaves grown in soil

applied with Potassium dichromate. The study gives a probability that the medicinal efficacy of Fenugreek in the case of diabetes could enhance, if it uptakes chromium from the soil^{18,19}.

Cobalt (Co):

Deficiency of cobalt leads to fatigue, digestive disorders, and neuromuscular problems. As cobalt's deficiency also leads to decreased availability of B12 vitamin, there is an increase of many symptoms and problems related to B12 deficiency, particularly pernicious anaemia, and nerve damage^{20,21}.

Medicinal plant:

-Ajaji (*Nigella sativa* Linn)

Cobalt ion is considered a beneficial element for higher plants due to its direct role in their metabolism. *Nigella sativa* plants were subjected to different levels of Co^{2+} i.e , 0, 25, 50 and 75mg/L. The quality and quantity of *Nigella sativa* essential oil were proportional to Co^{2+} levels. These results showed that Co^{2+} should be considered in the chemical characterization of the oil produced from essential oil-bearing plants when treating by Co^{2+} ²¹.

Iodine (I):

Iodine is a key component of thyroid hormones. A lack of iodine can lead to different physical and mental pathologies. Goitre is considered endemic when $\geq 10\%$ of the population suffers from that pathology, usually due to a low content of iodine in soil and plants and also due to lack of diversified food items²².

Medicinal plant:

-Narikela (*Cocos nucifera* Linn)

Coconut oil contains iodine combined with other nutrients to boost thyroid activity²².

Coconut water contains a variety of nutrients including vitamins, minerals, antioxidants, amino acids, enzymes, growth factors, and other phyto-nutrients. Coconuts grown near the sea, the roots have access to a continual supply of mineral rich salt water. These minerals are absorbed by the roots and find their way into the fruit of the coconut. For this reason, coconut water is a good source of the major minerals like magnesium, calcium, and potassium. It is particularly rich in potassium, an essential nutrient; one 8-ounce cup of coconut water has more potassium than a banana. It also contains a variety of trace elements such as zinc, selenium, **iodine**, sulphur, manganese, boron, molybdenum, and others. All derived from volcanic soils and seawater from which the coconut palms are grown. All of these minerals are in the form of electrolytes so they are easily absorbable by the human body. Many of the health benefits attributed to coconut water can be traced to its mineral content²³.

A study by name Chemical composition and properties of coconut water which reported to have a variety of nutrients including vitamins, minerals (like Magnesium, Calcium And Potassium), antioxidants, amino acids, enzymes, growth factors, trace elements (Zinc, Selenium, **Iodine**, Sulphur, Manganese, Boron, Molybdenum)²⁴.

Manganese (Mn) :

Deficiency can cause serious health threats including bone loss, muscle and joint pain, and changes in mood¹.

Medicinal plant:

-Kushmanda beej (*Benincasa cerifera* Savi)
It is reported that the pumpkin seeds are richly endowed in macro elements

(magnesium, phosphorus and calcium) and moderate amounts of micro elements (calcium, **manganese**, copper and zinc) and thus the seed could be used as a valuable food supplement²⁵.

Molybdenum (Mo):

Molybdenum deficiency is very rare. Molybdenum deficiency leads to poorly functioning sulfite oxidase and are prone to toxic reactions to sulphites in foods. It also been reported as a consequence of Non-molybdenum supplemented TPN [Total parenteral nutrition] for long period of time results in high blood levels of Sulfite and urate, in much the same way as molybdenum co factor deficiency. Symptoms are tachycardia, tachypnea, head ache. Vomiting and coma²⁶.

Medicinal plant:

-Masoor (*Lens culinaris* Medic)

Lentil is an important dietary source of protein, fibre, minerals, vitamins, and antioxidant compounds and is also an excellent source of macronutrients (P, K, Ca, Mg, and Na), micronutrients (Fe, Zn, Cu, and Mn), and trace elements (Al, Cr, Ni, Pb, Co, Se, **Mo**)²⁷.

DISCUSSION

The pharmacological properties have been attributed to active chemical contents. Though trace elements have been reported to play an important role in the formation of these active chemical constituents, a direct correlation between elemental composition of the medicinal plants and their remedial properties has not yet been established^{12, 13}. There are many source plants for trace elements like Amalaki and Ardraka which helps directly in iron supplement and helps in availability of iron. Where in Kumari

helps in absorption of copper and Iron at the level of liver and intestines so that it helps in improving antioxidant status of Liver, Iron and Copper absorption at the level of Intestines and reduces copper concentration in blood. Site of absorption is also a matter of concern for replacement of depleted micro nutrients. Shigru, Narikela, Masoora are the plant sources which helps in improving health status by supplementing the trace elements which helps to boost the immunity. Trace elements like selenium, chromium and cobalt can be used as manure for cultivating the medicinal plants so that the plants absorb and supplement them to humans, in order to get added benefits from consuming. When large quantities of selenium is needed to improve its status in the body, Nuts like Brazil nuts, *Terminalia Catappa* can be consumed as nuts are richest source of Selenium.

Medicinal plants like Aloe vera is proven to improve the metabolism and helps in increasing the bioavailability of nutrients in human being by slowing down the absorption so that the vitamins last longer in the plasma with aloe vera. *A. vera* is a very promising future nutritional herbal bioenhancer²⁷.

Rasayana drugs like Amalaki acts at the level of Rasa, under the influence of Agni (digestive fire), it directly enriches the nutritional value of the adhya dhatu i.e Rasa dhatu. This in turn vitalises the succeeding dhatus and leads to well-formed dhatus (tissues) in the body and there imparts strength and health. Rasayana drugs acting at the level of Agni, improves the digestion and metabolism so that the bio availability

of trace elements would be made to the body in the quantity sufficient.

Ginger helps in improving metabolism so that the absorption and delivery of components to the functional site(s) is enhanced.

Medicinal plants have divergent properties. In ayurveda there are many references which helps to understand properties of drugs like Ardraka and Amalaka which are said to have pandugna karma^{28,29,30}. In vruکشayurveda there is a chapter by name “ Poshana Vidhi” which focuses on providing nutrition to the plants by increasing the fertility of the soil³¹.

CONCLUSION

The Micronutrients in the diet is important for optimal growth and development. Adequate vitamins and minerals in diet is needed for good health. Micronutrient deficiencies mainly result from low concentrations in the daily diet as well as poor bio availability of dietary constituents. Elemental profile of medicinal plants helps in developing a stronger basis for appreciating the curative effects of the plant. Nutrition education/communication should encourage increased consumption of plant sources of vitamins and minerals among human population. Even the intake of these plants sources can be increased by means of food fortification with their extracts which can supplement the trace elements to the body to curb nutrient deficiencies.

Medicinal plants like Shrigu(*Moringa oleifera*), Kumari (*Aloe vera*) help stimulate the metabolism so that the gastro intestinal absorption of nutrients can be achieved to the optimal level.

The concentrations of minerals in most plant sources are not sufficient to meet daily dietary requirements when these foods are consumed in typical amounts. Hence there has been an interest in increasing the mineral concentrations of various seed crops. Although food supplements were traditionally used to treat mineral deficiencies, agricultural strategies for increasing micronutrient density in foods are now being assessed as sustainable and long-term solutions.

Enrichment of food crops with mineral nutrients is currently a high-priority research area. Producing micronutrient-enriched cultivars (bio-fortification) either agronomically or genetically, and improving the bioavailability of these minerals are considered a promising and cost effective method to manage micronutrient deficiencies. There are many medicinal plants which serve as the safe and better source of essential trace elements and their efficacy should be explored with science based researchers.

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