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Original Research Paper

Variation of the Heavy Metal Content in Parts of *Artocarpus lakoocha (Roxb.)* Using ICP-AES Technique

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ABSTRACT

Herbal medicines are analysed for heavy metals. They are found to have higher concentration of one or more elements. Therefore, the need for limit tests of heavy metals arises for herbal medicines. There is also a need for heavy metal analysis to be an integral part of the standardization of herbal medicines. *Artocarpus lakoocha* (Roxb.) is a perennial tree found in west coast from Kokan southwards to Kerala and in Tamil Nadu. It has many pharmacological activities such as antiviral, anticancer and anti HIV. Six common heavy metals Fe, Cr, Zn, Cu, Ni, and Pb were analysed by Atomic Emission Spectroscopy, which uses the technique of Inductively Coupled Plasma. ICP-AES is one of the analytical techniques used to determine the concentration of certain metallic ions in solution by measuring the intensity of emission of light at a particular wavelength when a solution of the substance being examined is introduced into a flame.

INTRODUCTION

Metals have a great significance to humans as a few elements like zinc, copper and iron form important components of cell and co-factors in several metalloenzymes. It is, however, alarming that increased concentration of these metals can affect mineral and enzyme status of human beings. The metals irreversibly bind to active sites of enzymes, thereby destroying normal metabolism producing high-level toxicity (Rai & Pal 2002).

Heavy metals are a matter of concern in the herbal drugs, especially as certain plants have the tendency of storing heavy metals from the soil, polluted water and atmosphere (Newall et al. 1996, Baker 1994, Ghosh & Guhasarkar 2001). During their evaluation, plants did not develop uptake mechanisms that differentiate between essential and non-essential metals. Due to lack of selectivity, the presence or concentration of a metal in the tissue of a plant does not tell us anything about plant's requirement for the metal. In this respect, the accumulation of metals is related to the plant's age. This is one of reasons for the observed variability of metal concentrations in plants.

In the past few years there has been resurgence in the usage of herbal medicine among the traditional as well as the modern consumers of herbal products. As a result, the demand for high standard, reliable and contaminant free herbal medicine is increasing by the regulatory agencies, consumer groups and manufacturing units. There are number of reports indicating that plants may be able to acclimatize to presence of pollution and contamination (Borovik 1990, Passaw 1978, Ross 1994). However, the complete mechanism of metal tolerance for any plant has yet to be described. There is also limited information available on the limits of metal tolerance and the actual metal concentration (Arnon & Sdtout 1939).

Thus, metal tolerance may be the result of genetically inherited physiological mechanism. The

ability of a plant to respond phenotypically to a stress may, therefore, be an important mechanism in the survival of a plant (Baker et al. 1994, Peterson 1978, Schmid 1992).

Artocarpus lakoocha (Roxb.) belongs to the family Moraceae. It is a valuable tropical tree species native to India and used for fruit, furniture, timber and feed. The lakoocha fruits are generally eaten fresh. Each fruit contains 20-30 seeds that are fleshy with thin seed coat. The edible fruit pulp is believed to act as a tonic for liver (Srivastava et al. 1986). Raw fruits and male flower spike are acidic and astringent. *A. lakoocha* is a perennial tree found on west coast from Kokan southwards to Kerala and in Tamil Nadu. It has many pharmacological activities such as antiviral, anticancer and anti-HIV. Six common heavy metals were analysed by Atomic Emission Spectroscopy, which uses the technique of inductively coupled plasma. ICP-AES is one of the analytical techniques of trace elements (Alloway 1990).

MATERIALS AND METHODS

Leaves and bark of *A. lakoocha* were collected, powdered and analysed separately by using ICP-AES technique. The tree powder was analysed for six heavy metals, i.e., Cu, Cr, Pb, Fe, Zn and Ni.

ICP is based on principle of atomic emission spectroscopy. ICP-AES is one of the most advanced techniques for the trace elements analysis as well as major and minor constituents of aqueous and non-aqueous solutions as it has a wide linear dynamic range unlike atomic absorption spectroscopy.

RESULTS AND DISCUSSION

The normal range of concentrations of the six heavy metals namely in normal plants are presented in Table 1 (Borovik 1990, Passaw 1978, Ross 1994, Alloway 1990). The results of the heavy metal analysis are presented in Table 2. The concentration of nickel was minimum 2.18 ppm in leaves and 1.95 ppm in bark. The concentration of iron was 581.69 ppm in leaves and 84.31 ppm in bark. The concentration of copper was 10.57 ppm in leaves and 21.09 ppm in bark. The concentration of zinc was 22.38 ppm and less than 1 ppm in bark. Pb concentration was above the normal range. It was 30.21 ppm in leaves and 57.27 ppm in bark. The concentration of chromium was 5.68 ppm in leaves and 7.65 ppm in bark.

Amongst the six metals analysed from leaves and bark of *A. lakoocha*, concentration of Fe was maximum and concentration of Ni was least in different parts of the tree. There was variation in the total metal concentration between leaves and bark of the tree. Fe showed significant variation in the analysed metals. The results, however, require further investigation, especially to correlate with the environmental levels of the heavy metals. As investigated in the present study, *A. lakoocha* does not provide ample evidence to indicate pollution related accumulation of heavy metals. From the study, it showed that *A. lakoocha* do accumulate some heavy metals at levels more than the normal range reported in other plants. This is specifically true with Fe in leaves, Cu in bark and Pb in both. However, this seems to be a normal trend with most of the herbal medicines (Passaw 1978). The major scientific and medical interest in iron is because it is an essential metal, but toxicological considerations are important in terms of accidental acute exposures and chronic iron overload, due to idiopathic haemochromatosis or as a consequence of excess dietary iron or frequent blood transfusions. As iron was found to be in excess in leaves, it might impair the function of organs, especially liver, pancreas, heart, joints and pituitary gland, whereas iron deficiency may lead to anaemia, fissures at the corner of the mouth and koilonychias. Deficiency of lead shows signs of anorexia, convulsions,

Table 1: Typical concentration of six metals in plants.

Metal	Normal range in plant material (ppm)	Concentration in contaminated plants (ppm)
Copper	4-15	20-100
Zinc	3-100	100-400
Lead	0.1-10	30-300
Nickel	0.02-5	10-100
Iron	50-300	300-400
Chromium	1-10	20-400

Table 2: Metal concentration (ppm) in *Artocarpus lakoocha* (Roxb.).

Metal	Bark	Leaves
Copper	21.09	10.57
Zinc	N.D.	22.38
Lead	57.27	30.21
Nickel	1.95	2.18
Iron	84.31	581.69
Chromium	7.65	5.68

coma and death due to generalized cerebral oedema and renal failure, whereas lead in excess amount can cause abdominal pain, headache, irritability, joint pain, fatigue and anaemia.

Excess of chromium leads to occupational renal failure, dermatitis and pulmonary cancer, whereas its deficiency leads to impaired glucose tolerance and confusion. Nickel administrated parenterally in animals is rapidly distributed to the kidney, pituitary, lungs, skin, adrenals, ovaries and testes. The intracellular distribution and binding of nickel is not well understood. It has been known that occupational exposure to nickel predisposes humans to lung and nasal cancer whereas deficiency of nickel alters glucose metabolism and decreases tolerance to glucose. The concentration of zinc and copper in *A. lakoocha* is within the concentration limit present in plants contaminated with these metals. Since, the levels of these heavy metals vary with the different parts of the plant, it may be suggested that these higher levels could be related to normal physiology of the plant.

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