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RESEARCH ARTICLE

Toxicity of heavy metals in Totapuri mango in Chittoor district of Andhra Pradesh

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SUMMARY: The present study is an attempt to assess the extent of toxic metals, including Cd, Cu, Pb, Ni, Zn and As in Totapuri mango variety collected from richly growing orchards of Chittoor district of Andhra Pradesh. Metals are essential for maintaining human health throughout life and food production and its safety is an important aspect of the measure of the any nation's growing economy and it is a popular trend to find out the trace elements and metal contents. In the present investigation, heavy metals *viz.,* Cd, Cu, Pb, Ni, Zn and As were estimated by Atomic absorption spectroscopy, which indicated that the highest concentrations were observed with a elevated concentrations of Cd, As and Pb metals ranging from 0.222±0.54 to 0.416±0.32, 0.444±0.65 to 0.722±0.36, and 0.04±0.23 to 0.48±0.12, respectively and the remaining metals were present within the limits of the FAO/WHO guidelines. The impact of trace metals in higher concentrations on human health and its implications were discussed.

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Key Words :
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Mango (*Mangifera indica* L.) is considered as one of the most popular fruits among millions of people grown throughout the tropics and subtropics worldwide. India is the world's largest producers and it is an emerging tropical export crop produced in about 90 countries in the world. Andhra Pradesh ranks first in production and Chittoor district ranks second and much economy to the fruit industries. Contamination of food and food products are the major public concern world wide and during the last decade, the increasing demand of food safety has stimulated research regarding the risk associated with consumption of food stuffs contaminated by pesticides, heavy metals and toxins (D'Mello, 2003). The implication associated with heavy metal contamination is of great concern, particularly fruits and their products which affect the annual income of the mango farmers and exporting industries. Moreover, these metals can pose a significant health risk to humans, particularly in elevated concentrations above the very low body requirements (Gupta and Gupta, 1998). Fruits are an integral part of human diet as they supply vitamins and minerals, the important constituents essential for human health (Mumzuroglu *et al.,* 2003) and the mangoes are most important source of vitamin A and C besides remarkable medicinal properties. The assessments of these nutrients in various raw foods depend on source, body burden and locality (Tahvonen and Kumpulainen, 1995; Cabrera *et al.,* 1995). Safe limits of toxic elements are applied in most instances because of first, possible toxicity of the element and second, the feasibility of the limit in relation to good manufacturing practice. An element is essential when it is consistently determined to be present in all healthy living tissues and its deficiency symptoms are noted, depletion or removal.

Agricultural activities have been identified as contributors to increasing toxic metal contamination through the application of various types of pesticides and fertilizers. The information on the intake of toxic heavy metals through the food chain is important in assessing risk to human health. Heavy metals enter the human body through inhalation and ingestion, with ingestion being the main route (Tripathi *et al*., 1997). Of the essential metals, iron, copper and zinc are well known for their biochemical role in the human body. Iron is an essential metal biological system *i.e.* haemoglobin of the blood, which is the most important iron complex consisting of the globulin protein with four haeme units attached to it. Likewise, copper is required as cofactor in different oxidative and reductive enzymes (Nair *et al.,* 1997). Zinc another essential element is approximately 100 times as abundant as copper in the human body and it has the ability to occupy low symmetry sites in enzymes (Szymczak *et al.,* 1993; Olivares and Uauy, 1996; Ikeda and Murakami, 1995). Nickel and chromium plays its role as coenzymes in different enzymes. Apart from these advantages, the increased or decreased concentration of these metal containing fruits consumption is associated with different disorders like increased blood level and hypertension due to decreased concentration of Ni, kidney and lung diseases due to copper, iron deficiency causing anemia and few cancers are associated due to the accumulation of heavy metals like arsenic (Ismail *et al.,* 2011). In the view of above deliberations and considering the facts, the present study was undertaken to assess the significant concentrations of the heavy metals *viz.,* cadmium, copper, lead, nickel, zinc and arsenic in major growing orchards of Totapuri mango pulps in Chittoor district of Andhra Pradesh.

EXPERIMENTAL METHODOLOGY

Survey and collection of mango samples :

A roving survey was conducted in five regions of mango orchards which has the best climatic conditions for the cultivation of mangoes especially Totapuri variety *viz.,* Chittoor–S_1, Puttur –S_2, Bangarupalem–S_3, Damalacheruvu–S_4 and Tirupati–S_5 , respectively in Chittoor district of Andhra Pradesh and the samples of Totapuri pulp were randomly collected in selected orchards where the losses were higher due to heavy metal contamination by discussion and meetings with local farmers.

Heavy metals and sample preparation :

The heavy metals *viz.,* Cadmium (Cd), Copper (Cu), Lead (Pb), Nickel (Ni), Zink (Zn), and Arsenic (As) were chosen to screen in the mango pulp samples collected from five different regions. All the chemicals and reagents used in this study were analytical grade purchased from Merck and Sigma, USA. The fruits were surface washed following with three changes of distilled water and air dried. The fruits were cut, to 20 ml of mango pulp sample, 10 ml of HCl was added and the contents were mixed thoroughly and increased the pulp volume to 100 ml with double distilled water. The contents were centrifuged and filtered to remove the solid particles as per procedure described by McHard *et al.* (1976) and Meranger (1970). Standard replications were maintained for all the samples.

Estimation of heavy metals :

Standard solutions of heavy metals (2-8 ppm) were prepared using Cadmium chloride ($CdCl_2$), Copper sulphate ($CuSO_4$), Lead chloride ($PbCl_2$), Nickel chloride ($NiCl_2$), Zinc chloride ($ZnCl_2$), Sodium arsenate (Na_2As) and the working standards were prepared just before commencing the experiment. The concentrations of heavy metals in the pulp solution were estimated using Atomic absorption spectrophotometer (Model No: AA-6800; Shimadzu, Japan, and slit width 0.7 nm) and the estimations were carried out using the hallow cathode lamp depending upon the element to be tested.

EXPERIMENTAL FINDINGS AND DISCUSSION

In the present study, the presence of heavy metals were recorded in the Totapuri variety of mango collected from majorly growing regions in Chittoor district of Andhra Pradesh. The concentration of heavy metals *viz.,* Cu, Ni and Zn were below the toxicity range but the metals As, Cd and Pb were found to be above the normal elevations. The results obtained are depicted in Table 1and Fig. 1-5. Macro and trace elements

Table 1 : Concentrations of heavy metals in Totapuri mango pulp samples at different areas of Chittoor district Andhra Pradesh

Sr. No	Metal	Concentrations of heavy metals in µg/kg				
		S_{-1}	S_{-2}	S_{-3}	S_{-4}	S_{-5}
1.	Cd	0.388±0.38	0.222±0.54	0.416±0.32	0.361±0.21	0.341±0.14
2.	Cu	0.142±0.47	0.285±0.85	0.714±0.1.2	2.142±0.78	0.198±0.24
3.	Pb	0.04±0.23	0.2±0.1	0.36±0.15	0.48±0.12	0.41±1.32
4.	Ni	0.388±0.87	0.111±0.13	0.166±0.63	0.277±0.32	0.181±0.37
5.	Zn	0.307±1.2	0.6±0.13	0.938±0.21	0.953±1.78	0.562±0.34
6.	As	0.444±0.65	0.722±0.36	0.3694±0.23	0.611±0.21	0.581±0.45

Note: S_{-1}: Chittoor area samples; S_{-2}: Puttoor area samples; S_{-3}: Bangarupalem area samples; S_{-4}: Damalcheruvu area samples; S_{-5}: Tirupati area samples

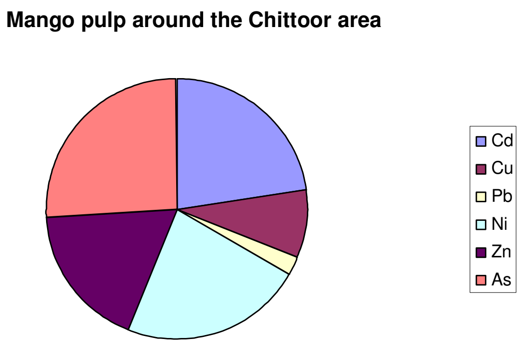

Fig. 1: Toxic levels of Totapuri mango pulp around Chittor area

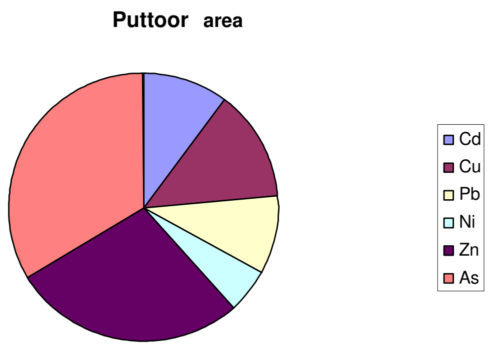

Fig. 2: Toxic levels of Totapuri mango pulp around Puttur area

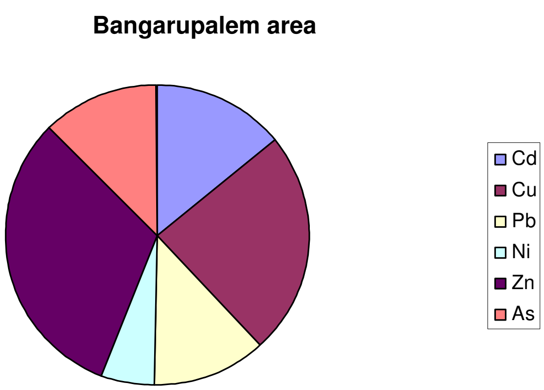

Fig. 3 : Toxic levels of Totapuri mango pulp around Bangarupalem area

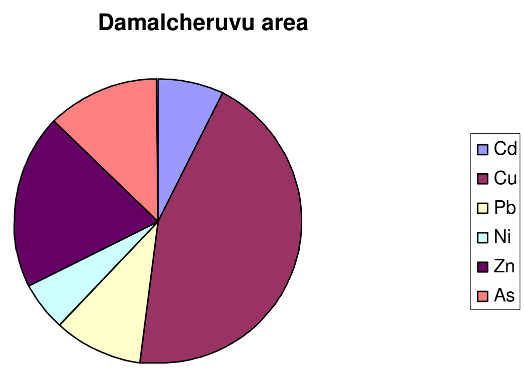

Fig. 4 : Toxic levels of Totapuri mango pulp around Damalcheruvu area

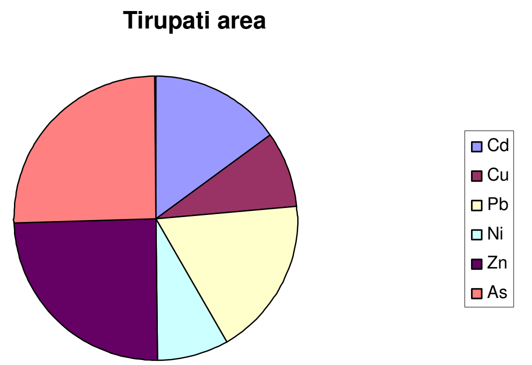

Fig. 5 : Toxic levels of Totapuri mango pulp around Tirupati area

play a significant role for maintaining health in humans. However, non-essential trace elements like Pb, Cd. Cr and Ni which are non-biodegradable thus, persist everywhere in the environment and have the ability to deposit in various body organs which pose a great threat to the human health (Singh *et al*., 2004; Chen *et al.*, 2005). The dietary limit in food and food stuff for cadmium is 0.1 μgg^{-1} and higher concentration of cadmium exerts deterimental effects on human health and causes severe diseases such as tubular growth, kidney damage, cancer, diarrhoea and incurable vomiting. A substantial quantity of ripe mangoes are converted into pulp for use in jams, jellies, nectars, squashes, juices, paper/chips, mango toffees, ice creams, milk shake, fruit cocktail and in topping products (Hussain *et al*., 2003). Therefore, most of the fruit processing industry in India preserve mango pulp for the manufacture of mango products all around the year.

In the present study, the presence of Pb above the normal levels (0.48±0.12 μgg^{-1}) is a increasing concern as the lead if exceeding the maximum permissible limits (0.20.1 μgg^{-1}) in human, affect nervous system, bones, liver, pancreas, teeth and gum and causes blood related disorders. Agricultural soils irrigated with waste water get severely contaminated with heavy metals and the crops grown on such soils can accumulate a significant amount of heavy metals in different tissues (Khairiah *et al*., 2009; Muchuweti *et al*., 2006). Heavy metals are of great significance in echo-chemistry and exo-toxicology because of their toxicity and tendency to accumulate in human organs (Viqar and Ahmad, 1992) and consumption of toxic heavy metals in unsafe concentrations through vegetables may lead to accumulation of the metals in different organs like liver and kidney (Sharma *et al.,* 2009) leading to cardio-vascular, nervous system, kidney and bone disorders (Jarup, 2003). A number of evidences were reported on heavy metal concentrations in both vegetables and fruits (Husain *et al.,* 1995). Lead metal showed the high concentrations in only samples from Bangarupalem (0.36±0.15 $\mu g g^{-1}$), Damalcheruvu (0.48±0.12 $\mu g g^{-1}$), and Tirupati area (0.41±1.32 $\mu g g^{-1}$). But in the case of arsenic, the tested samples show highest concentrations when compared with FAI/WHO guidelines with a range of 0.3694 ± 0.23 to 0.722 ± 0.36 and observed highest concentrations in the Puttur area samples (0.722±0.36 $\mu g g^{-1}$). The concentration of arsenic exceeding the maximum permissible limits (0.03 $\mu g g^{-1}$) in foodstuff cause short term (nausea, diarrhoea, weakness, loss of appetite, cough and headache) and long term (cardio-vascular diseases, diabetes and vascular diseases) chronic diseases. The estimated concentrations of heavy metals present in the samples were compared with the permissible limit recommended by FAO/WHO (2009).

Jassir *et al.*(2005) reported elevated levels of heavy metals in vegetables from markets at Riyadh city in Saudi Arabia due to atmospheric deposition. Elevated levels of heavy metals in vegetables sold in the market of Varanasi, India were observed by Sharma *et al.* (2008 a,b). Kumar *et al.* (2009) reported that heavy metal contents of vegetables around Jaipur city, India were well above WHO critical toxic levels. In conclusion, the data presented in this study evidence that most of the Totapuri fruits contained essential trace metals within the safe limits of FAO/WHO guidelines, with the exception of heavy metals *viz.,* As, Cd and Pb which were accumulated in excessive concentrations.

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