

# Spectrometric Determination of Heavy Metals Present in Mango Fruit of Nepali Origin

*Naresh Pant<sup>1</sup>, Anup Subedee<sup>1</sup>, Ram Bahadur Gharti<sup>2</sup>, Santu Shrestha<sup>1\*</sup>*

<sup>1</sup>Amrit Campus, TU, Lainchour, Kathmandu, Nepal

<sup>2</sup>Department of Mines and Geology, Kathmandu, Nepal

\*Email: santu\_shrestha@hotmail.com

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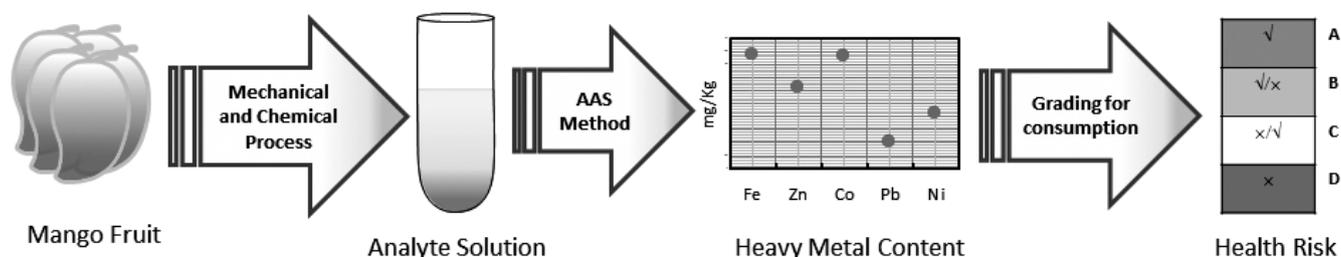
## Highlights

- Fifteen fully ripe mango samples were sampled from local market of Kathmandu.
- Extracted pulp of mango was taken and oven dried at 150 °C for 24 hours.
- The digest samples were analyzed for heavy metals (Fe, Zn, Co, Pb and Ni) using the AAS.
- The concentration of the Lead (Pb) was found below the detection limit of the instrument used.

## Abstract

Quantitative determination of heavy metals; Fe, Zn, Co, Pb and Ni in Mango fruit of Nepali origin, locally sourced was carried out. Fifteen Mango samples were collected by random sampling method, converted into analyte sample by standard method and analyzed by using Atomic absorption spectrometric method. The amount of heavy metals Fe, Zn, Co and Ni present in sample was,  $0.570 \pm 0.48$ ,  $0.510 \pm 0.031$ ,  $0.431 \pm 0.021$ ,  $0.106 \pm 0.003$  mg/kg respectively. The results indicated the concentration of Zn & Co were higher (WHO 0.320 & 0.05), and the concentration of Nickel (Ni) was below the maximum permissible limit issued by WHO. The concentration of the Lead (Pb) was found below the detection limit of the instrument used.

## Graphical Abstract



**Key words:** AAS method, Concentration, Heavy Metals, Mango.

\*Corresponding author

## INTRODUCTION

Quality of food has been a main concern globally regarding the effect associated with the intake of food stuffs contaminated by heavy metals. Food is the major source of toxic elements in trace amount by human being. Fruits are especially used in raw form as staple part of food (Farid and Enani, 2010). Regular consumption of fruit is essential in providing nutrients to the human body. Fruits are good sources of dietary fiber, minerals and phytochemicals. Phytochemicals function as antioxidants, phytoestrogens, and anti-inflammatory agents (Slavin and Lloyd, 2012). Different types of antioxidant components such as vitamin E, carotenoids, phenolic compounds, ascorbic acid, phytosterols are found in different fruits and vegetables (Ravimannan and Nisansala, 2017). Fruits and vegetables intake lowers tendency of cardiovascular disease and obesity. Mango pulp are good source of antioxidants (Rocha et al., 2007). Mango (*Mangifera indica*) kernel has been reported for phytochemicals and antioxidant activity (Arogba et al., 2012). Fruits like Mango may contain heavy metals as they receive minerals from soil and water. Some heavy metals are essential but some are toxic above certain limit (Doherty et al., 2014). Many literatures have been reported about the determination of heavy metals in fruit samples. Tegegne et al., 2015, had determined heavy metals (Zn, Fe, Cu, Mn, Co, Ni, Cr, Pd and Cd) in selected edible fruits namely avocado, mango, papaya, pineapple, orange and banana purchased from local markets of Ethiopia. The concentrations of zinc(Zn), copper(Cu), iron(Fe), chromium(Cr), manganese(Mn), cobalt(Co) and nickel(Ni) in apple, orange and mango fruit juice from local market of Saudi Arabia has been measured (Farid and Enani, 2010). The contents of lead (Pb), copper (Cu), Iron (Fe), and manganese (Mn) in Mango fruit of Nigeria has been measured by using AAS and found within the permissible level given by WHO (Chata et al., 2018). The concentration of Ni, Cd, Cr, Mn and Pb in all samples plum, orange, mango and strawberry has been measured (Anastácio et al., 2018). Similarly, Dehelean and Magdas in 2013 measured the heavy Metal Content of Some common Commercially available Fruit Juices (apple, peach, apricot, orange, kiwi, pear, pineapple, and multi fruit) on Romanian market.

National and international regulations on food safety have set the optimum levels of heavy metals in food. Some of heavy metals have been identified to effect in greater extent to the nutritive values of agricultural products. So the assurance of food quality regarding heavy metal concentration is important for good health. Determination of such heavy metals is common practice all over the world regarding the fruit/food safety concern.

Mango is native to south Asia, which is one of the most widely cultivated fruit in the tropics. It is the national fruit of both Pakistan and India (GIMA, 2013) with India having the highest production in the world (Ahmed et al, 2014). The fruit is rich in antioxidants and reduces the risk of cardiac disease, effective in anti cancer and anti viral activities (Daud *et al.*, 2010). Composition of mango fruits differ chemically regarding different cultivars, and area of production. Storage techniques using coatings and packaging materials extend the storage life with appreciable retention of physical, chemical and sensory parameters (Hulme, 1971; Abbasi *et al.*, 2011). In Nepal, it is reported that about 56% of the total summer fruit area is occupied by mango whereas it covers 42% of total summer fruit production. Eastern and central region of Nepal are highest production area. Sarlahi, Siraha, Saptari, Rautahat and Jhapa are major mango production districts of Nepal (Pandey *et al.*, 2017). There is no sufficient studies found on the heavy metal concentrations in the fruits in Nepal, though regular monitoring and assessment of concentration of heavy metals in the vegetables and fruits has been reported in the developed and some developing countries. The heavy metal intake by people through the fruits and vegetables is of major concern as it has direct impact on the health. The determination of concentration of heavy metals in the mango would help to know the health impact of consuming this fruit. So, this study is focused to investigate the concentrations of heavy metals in Mango of Nepali origin.

## Materials and Methods

### Sample collection and pulp extraction

Fifteen fully ripe mango samples were sampled from local market of Kathmandu by random sampling method, washed with double distilled water and dried. The pulp of mango was separated from kernel and skin by stainless steel knife and stored in refrigerator below 4°C.

### Sample digestion

Extracted pulp of mango was dried in oven at 150 °C for 24 hours until it became brittle and crisp. Then this solid mass was grounded by using mortar and pestle, which was washed with acid. Exact 3.0 g of each of the grounded powder sample was heated in silica crucible in muffle furnace at 450 °C for 4hrs. Heated samples were taken out, cooled and treated with 2.5 mL

of concentrated  $\text{HNO}_3$  and covered with watch glass, which was further heated at a temperature of  $90^\circ\text{C}$  for 1hr and allowed cooling. Then 5mL of 9.25 HCl was added to dissolve the sample and digested using hot plate. Further the digest was cooled, to which 20 mL of double distilled water added and filtered using Whatman No. 41 filter paper. The filtrate obtained was diluted up to 50mL by adding double distilled water. All the samples were prepared three times to minimize the chances of error.

### Determination of heavy metals

The digest samples were analyzed for heavy metals (Fe, Zn, Co, Pb and Ni) using the AAS (SHIMAZDU- 7000, Japan). The calibration of the instrument (AAS) was done with calibration blank and three series of calibrating standard solution. For each of five heavy metals - Iron (Fe), Zinc (Zn), Cobalt (Co), Lead (Pb) and Nickel (Ni), four standard solutions of various concentrations (0.5ppm, 1ppm, 2ppm and 5ppm) were prepared. The absorbance of all standard solutions of various concentrations (0.5ppm, 1ppm, 2ppm and 5ppm) for all the five metals (Fe, Zn, Co, Pb and Ni) were measured and a calibration curve was prepared as shown in Figure 1, then the absorbance of the sample solutions were measured to determine the concentration of different metals (Fe, Zn, Co, Pb and Ni).

### Data analysis

Heavy metal concentrations in the mango fruit were analyzed in triplicate and compared with maximum permissible limit of WHO for each metal. The mean value and standard deviations of concentrations of metal were determined.

## Results and Discussion

The mean concentration of the metals (Fe, Zn, Co, Pb and Ni) in mango fruit collected from local market of Kathmandu is presented in Table 1. The results of triplicate data are expressed as mean  $\pm$  standard deviation (SD).

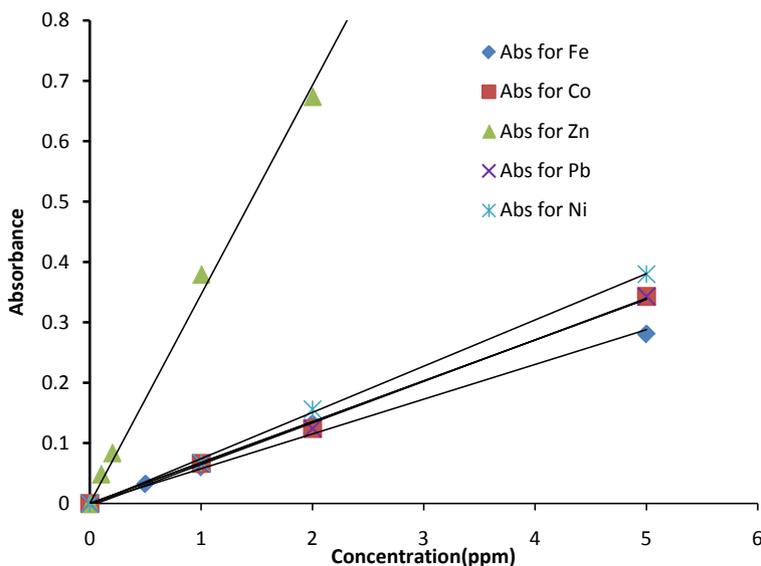


Fig 1: calibration curve for heavy metals (Fe, Co, Zn, Pb and Ni) to be measured.

### Iron

Iron is one of the important component of the human blood. The deficiency of iron in the blood can lead to the serious health problems including anemia. Results showed that the concentration of iron in the mango fruit is  $0.570 \pm 0.48$  mg/kg, which is within the maximum permissible limit of WHO (0.80) mg/kg.

### Zinc

Zinc is an essential element of the body and component of many coenzymes, essential for synthesis of protein, DNA, RNA and insulin. The results show that the concentration of zinc in the mango fruit is  $0.510 \pm 0.031$  mg/kg which is higher than the maximum permissible limit of WHO (0.30) mg/kg.

## Cobalt

Cobalt is the integral part of vitamin B-12. Cobalt is also involved in the production of red blood cells, antibacterial and antiviral compounds. But excessive intake of the cobalt may cause the high production of red blood cells. The concentration of the cobalt found in the mango fruit is  $0.431 \pm 0.021$  mg/kg which is higher than the maximum permissible limit of WHO.

## Lead

Lead may enter the body through air, water and food. Lead cannot be removed from fruit and vegetable by washing with water. The concentration of lead in the mango fruit was below the detectable level of the instrument which shows that either lead is absent in the sample or present in trace amount.

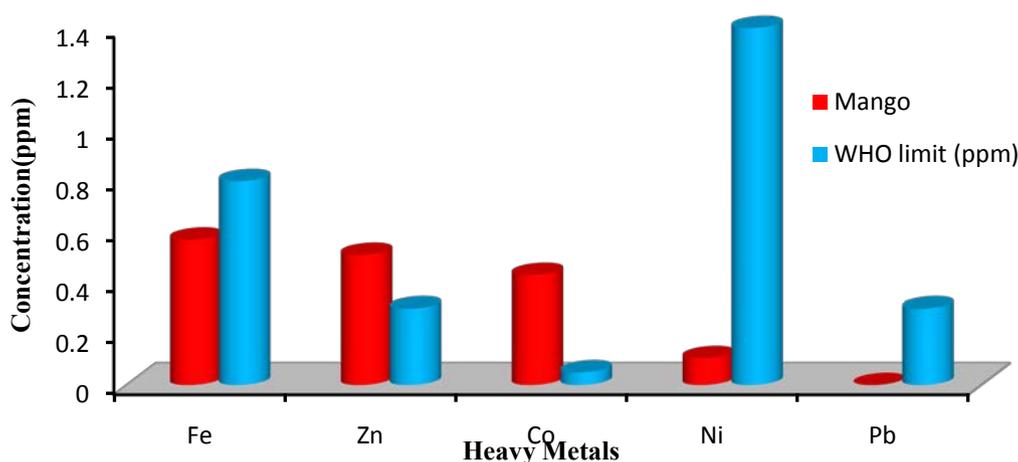
## Nickel

Nickel is required in small amount for the body and plays important role in the production of insulin. Its deficiency causes disorder in the functioning of the liver. The concentration of nickel found in the sample is  $0.106 \pm 0.003$  mg/kg which is below the maximum permissible limit of WHO.

Among the metals analyzed the concentrations of zinc and cobalt were found higher than the maximum permissible limit of WHO whereas the concentration of iron, lead and nickel were within the acceptable limit. The higher concentration of the metals may be due to sources of production as it comes from different region of the country, contamination during transportation, exposure to environmental pollution, pollutants found in irrigation water, soil. Furthermore agronomic practices such as application of fertilizers, pesticides could be also responsible for the accumulation of these metals. The high concentration of cobalt may be due to exposure of production region to industrial wastages, dumpsites containing decomposed batteries. The data in Table 1 shows the concentration of heavy metals in mango fruit in part per million and reported as mg/kg and compared with WHO maximum permissible limit. Comparative bar diagram of Fe, Zn, Co, Pb and Ni with WHO maximum permissible limit for mango fruit is shown in Figure 2.

**Table 1** Average concentration of Heavy Metals (meanSD, n = 15, mg/kg or ppm dry weight) in mango.

| Heavy Metals | Mango Samples     | Permissible Concentration Limit by WHO (ppm) |
|--------------|-------------------|--|
| Fe           | $0.570 \pm 0.48$  | 0.80   |
| Zn           | $0.510 \pm 0.031$ | 0.320  |
| Co           | $0.431 \pm 0.021$ | 0.05   |
| Pb           | --                | 0.3  |
| Ni           | $0.106 \pm 0.003$ | 1.40   |



**Figure 2** Concentration of Fe, Zn, Co, Pb and Ni in Mango samples

## Conclusions

The concentration of heavy metals in the Mango samples were determined by using Atomic absorption spectroscopy (SHIMAZDU- 7000, Japan). The results obtained reveals that among the essential metals, concentration of each Zn and Co in the mango sample were higher but all other metals among measured lies within the maximum permissible limit of WHO. High concentration of the metals may be due to exposure to polluted environment of the region of production, contamination during transportation, the composition of the soil, irrigation water, and storage practices. In addition agronomic practices such as fertilizers, pesticides, and ripening agent used could also be reason for it. The results indicate that on consumption of mango, high amount of Zn and Co is also consumed. The study shows that further study should be carried out to identify the exact source of contamination regarding area of production, cultivars, irrigation sources and agronomic practices. If reproducible data are obtained then the matter is very serious as mango is highly consumable summer fruit all over the country. Regular monitoring of heavy metals in fruits and vegetables supplied to the market is essential to reduce the health risk of the people. Government should set up a regulatory body for continuous monitoring of heavy metals in fruit and vegetables.

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