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Assessment of Some Heavy Metals in Selected Vegetables, Fruits and their Respective Soil

Arif Ullah Shah[1], Luqman I. Alrawi[2], Fazal Wahid[1], Muhammad Rahim[3,]*, Nadir Khan[1], Shahid Nawaz[1], Rehan Ali[1], Qamar Sultana[4]
1-Department of Chemistry, Government College Peshawar, Khyber Pakhtunkhwa, Pakistan
2-Chemistry Department, College of Sciences, Kirkuk University, Kirkuk Iraq
3-School of Chemical Sciences, Universiti Sains Malaysia, 11800 Pulau Penang, Malaysia
4-National Center of Excellence in Physical Chemistry, University of Peshawar, KP, Pakistan
* Corresponding Author: kpk566@gmail.com

***Abstract*- High concentration of heavy metal content of fruits and vegetables may reduce their antioxidant properties. Therefore, the concentration of selected heavy metals such as Cr, Ni, Mn, Fe, Mg, Cu and Pb in vegetables (*Colocasia esculanta* and *Abelmoschus esculentus*) and fruits (*Psidium guajava* and *Pyrus*) was assessed using atomic absorption spectrophotometer. The highest concentrations of heavy metals in vegetables and fruits were found 0.019, 0.008, 0.072, 0.241, 1.754, 0.107 and 0.014 mg/g for Cr, Ni, Mn, Fe, Mg, Cu and Pb, respectively. Level of Cr was found higher in *Colocasia esculanta* (0.011 mg/g). The highest level of Ni was found in *Pyrus* (0.008mg/g) while lowest in the Soil of *Abelmoschus esculentus* (0.003 mg/g). The highest level of Mn was observed in Soil of *Colocasia esculanta* (0.072 mg/g) while lowest in *Abelmoschus esculentus* (0.007 mg/g). Maximum level of Mg was found in Soil of *Psidium guajava* while minimum in *Colocasia esculant. Abelmoschus esculentus* showed highest level of Cu while minimum level was found in *Colocasia esculanta*. Pb showed maximum amount in *Psidium guajava* and minimum in soil of *Abelmoschus esculentus.* The values of Cr, Ni, Mn, Fe, Mg, Cu and Pb in all samples are in the safe limit. However the study indicates that the vegetables, fruits and soil samples are contaminated by toxic heavy metals.**

***Keywords*- Heavy metals, Vegetables, *Colocasia esculanta*, *Abelmoschus esculentus*, Fruits, *Psidium guajava*, *Pyrus*, Soil**

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I. INTRODUCTION

THE term heavy metal refer to any metallic elements that has density greater than 4g/cm^3 [1]. Accumulation of heavy metals by Fruits and vegetables depend on plant species as well as temperature, moisture, organic matter, pH, nutrient availability and concentration of heavy metals [2]. The total concentration of heavy metals in soil and water varies from local to regional and further to continental level [3,4]. Heavy metals find their way into the environment from natural resources such as minerals and ores as well as through industrial resources [5,6].

Heavy metals rank high in leafy vegetables. It has been found that the concentrations of heavy metals in vegetables per unit dry matter generally follow the order: leaves > fresh fruits > seeds [7]. Although certain heavy metals (Cr, Mn, Ni, Cu and Fe) are essential components for various biological activities within the human body however, elevated levels of them can cause numerous health consequences. Certain metals like Pb, Cd, Hg and As are non- essential, toxic elements which are associated with many chronic diseases in human being [8].

Vegetable is a plant or part of plant used for food purpose as well as reducing many health related diseases. Eating vegetables is important pathway to absorb dietary minerals useful for health development [9]. Lady finger (*Abelmoschus esculentus*) is a flowering plant in the mallow family. The plant is cultivated in tropical, subtropical and warm temperate regions around the world. It is composed of 90% water, 2% protein, 7 % carbohydrates ,vitamin C and vitamin K, with moderate amount of thiamin and magnesium [10]. Colocasia (*Colocasia esculanta*) is a tropical plant grown primarily for its edible corms and leaves. The leaves are rich in vitamins and minerals. It is also sold as an ornamental aquatic plant [11].

Fruit is the seed-bearing structure in flowering plants formed from the ovary after flowering Fruits and vegetables are very useful for the maintenance of health [12]. Guava (*Psidium guajava*) is a common tropical fruit cultivated and enjoyed in many tropical and subtropical regions. It comes in the family of *Myrtaceae*, in the genus *Psidium* [13]. Pear (*Pyrus*) is shrub species of genus Pyrus in the family *Rosaceous*. Pears are consumed fresh, canned, as juice, and dried. The juice can also be used in jellies and jams. It has high nutritional value with reasonable amounts of vitamins A, B1, B2, B3, and C and minerals like sodium, potassium, phosphorus, calcium, magnesium, and iron [14-15]. Fruits and vegetables are a good source of vitamins, minerals [16], fibers [17], thiamin, niacin,

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riboflavin, folic acid, pantothenic acid, vitamin B_6, vitamin C [18], minerals [19], flavonoids [20] and antioxidants. Antioxidants are the chemical compounds which inhibit oxidation [21] and prevents the generation of high reactive oxygen species (HROS) [22, 23]. Whereas, heavy metals initiate the production HROS and reduce the antioxidant properties of fruits and vegetables [24]. Therefore, this study was designed to analyze Lady finger (*Abelmoschus esculentus*), Colocasia (*Colocasia esculanta*), Guava (*Psidium guajava*), Pear (*Pyrus*) cultivated and marketed and their corresponding soil samples for Cr, Ni, Mn, Fe, Mg, Cu and Pb.

II. MATERIAL AND METHODS

A. Materials and Instrument

Analytical grade chemicals with high purity of 99.9% (Merck Darmstadt, Germany) were used for analysis. Standard solutions of heavy metals were prepared by dilution of 1000 ppm certified standard solutions (Fluka Kamica Busch Switzerland) of the respective metal. The samples were analyzed for heavy metals using atomic absorption spectrophotometer (Perkin Elmer AAS-700).

B. Samples Collection and Treatment

Fruits, guava (*Psidium gujava*) and pear (*Pyrus*), vegetables, lady-finger (*Abelmoschus esculentus*) and colocasia (*colocasia esculenta*), and their respective soil samples were collected from different farmland of Peshawar zone Khyber Pakhtunkhwa, Pakistan during summer 2016.

Edible portions of vegetables and fruits were washed with tap water and then with distilled water to remove the dust particles. The samples were cut into slices using clean knife. These samples were dried in an oven at 80 ^{0}C till constant weight. The dried samples were crushed with the help of mortar and pestle and stored in clean plastic bags. The soil samples were dried in oven at 80 ^{0}C till constant weight, crushed and homogenized by passing through sieve.

C. Digestion of Fruit and Vegetable Samples

5g of dry fruit or vegetable sample were weighed out into beaker and then mixed with 10mL nitric acid, 10mL sulphuric acid and 20mL per chlorate acid respectively using dropping pipette. The mixture was then digested on hot plate oven till the transparent solution was achieved. The resulting solution was cooled and filtered with filter paper. The filtrate was diluted to 50mL with distilled water. Filtered samples were stored in plastic bottles and labeled for heavy metals analysis through atomic absorption spectrophotometer.

D. Digestion of Soil Samples

Soil samples of 5g of were added into Teflon beaker and digested with a mixture of 1mL $HClO_4$ and 10mL HF (Hydrofluoric acid). Samples were placed on a hot plate for 15 minutes. On completion of digestion, the samples were cooled and 20 mL of distilled water was added the solution was filtered. The filtrate was diluted upto 50mL, and samples were kept in plastic bottles and labeled. Then the samples were taken to the atomic absorption spectrophotometer for metal analysis.

III. RESULTS AND DISCUSSIONS

The mean concentration along with standard deviation of heavy metals in the selected vegetables and fruits and their respective soils are as shown in Table 1. All metal concentrations are reported in weight/volume basis (mg/g). Mean concentration of heavy metals in fruits and vegetables are shown in Fig. 1 and Fig. 2, respectively. Chromium concentration was observed in the range of 0.011 mg/g to 0.002 mg/g in vegetables and fruits. Highest concentration was found in *Colocasia esculanta* while lowest concentration was found in *pyrus*. Similarly in soil of respective vegetables and fruits was in the range of 0.010 mg/g to 0.019 mg/g. Highest concentration was found in soil of *Colocasia esculanta* while lowest was found in soil of *pyrus*.

Lead concentration in current study was ranged from 0.010 mg/g to 0.015 mg/g. Highest concentration was found in *Psidium Guajava* (0.014 mg/g) while lowest concentration was found in *Abelmoschus esculentus* (0.010 mg/g). Similarly in soil of corresponding vegetables and fruits lead concentration was in the range of 0.003 mg/g to 0.004 mg/g. Highest concentration was found in soil of *Colocasia esculanta* (0.004 mg/g) while lowest was found in the soil of *Abelmoschus esculentus* (0.003 mg/g).

Copper concentration in selected vegetables and fruits was observed from 0.001 mg/g to 0.010 mg/g. Highest level was found in *Abelmoschus esculentus* (0.017 mg/g) while lowest in *Colocasia esculanta* (0.001 mg/g). Similarly in soil of corresponding vegetables and fruits was in the range of 0.002 mg/g to 0.003 mg/g. Highest concentration was found in soil of *Pyrus* (0.002 mg/g) while lowest was found in soil of *Colocasia esculanta* (0.00352 mg/g).

Magnesium concentration was investigated from 0.147 mg/g to 1.405 mg/g. Highest concentrations was found in *Abelmoschus esculentus* (1.40 mg/g) while lowest was found in *Psidium guajava* (0.147 mg/g). Similarly in soil of corresponding vegetables and fruits was in the range of 0.300 mg/g to 1.754 mg/g. Highest concentration was found in soil of *Colocasia esculanta* (1.754 mg/g) while 0.300 mg/g amount was found in soil of *Pyrus.*

Iron level in tested samples was found from 0.556 mg/g to 0.111 mg/g. Maximum concentration was found in *Psidium guajava* (0.111 mg/g) while lowest in *Colocasia esculanta* (0.0556 mg/g). Similarly in soil of respective vegetables and fruits was in the range of 0.233 to 0.211 mg/g. Highest concentration was found in soil of *Colocasia esculanta* while lowest was found in soil of *Psidium guajava*. Manganese in the vegetables and fruits studied was found to be in the range of 0.007 mg/g to 0.071 mg/g. Maximum concentration was found in *Pyrus* while lowest in *Abelmoschus esculentus*. Similarly in the soil of corresponding vegetables and fruits was in the range of 0.055 to 0.072 mg/g.

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Table 1. Concentrations of heavy metals in selected vegetable, fruits and their respective soil samples

Sample I.D.	Mean Concentration (mg/g) ± Standard Deviation						
	Cr	**Pb**	**Cu**	**Mg**	**Fe**	**Mn**	**Ni**
A	0.011±0.003	0.014±0.003	0.001±0.000	0.172±0.008	0.056±0.000	0.042±0.003	0.005±0.000
A1	0.019±0.002	0.004±0.000	0.002±0.000	1.754±0.002	0.233±0.006	0.072±0.002	0.004±0.000
B	0.003±0.000	0.010±0.001	0.011±0.002	1.405±0.076	0.099±0.001	0.007±0.000	0.004±0.000
B1	0.010±0.002	0.003±0.000	0.002±0.000	0.902±0.005	0.235±0.004	0.055±0.000	0.003±0.000
C	0.003±0.000	0.014±0.001	0.006±0.001	0.147±0.012	0.111±0.009	0.052±0.001	0.007±0.001
C1	0.013±0.002	0.004±0.000	0.003±0.000	1.040±0.070	0.241±0.008	0.070±0.000	0.005±0.000
D	0.002±0.000	0.014±0.001	0.001±0.000	0.210±0.008	0.093±0.000	0.071±0.004	0.008±0.001
D1	0.012±0.002	0.003±0.000	0.004±0.000	0.300±0.006	0.241±0.002	0.069±0.001	0.005±0.000
WHO*	0.06	0.1	0.06	2	0.076	0.1	0.09

** Mean value of the WHO Standard for food and Soil, A = Colocasia esculanta, A1 = Soil of the Colocasia esculanta garden, B = Abelmoschus esculentus, B1 = Soil of the Abelmoschus esculentus garden, C = Psidium guajava, C1 = Soil of the Psidium guajava garden, D = Pyrus, D1 = Soil of the Pyrus garden*

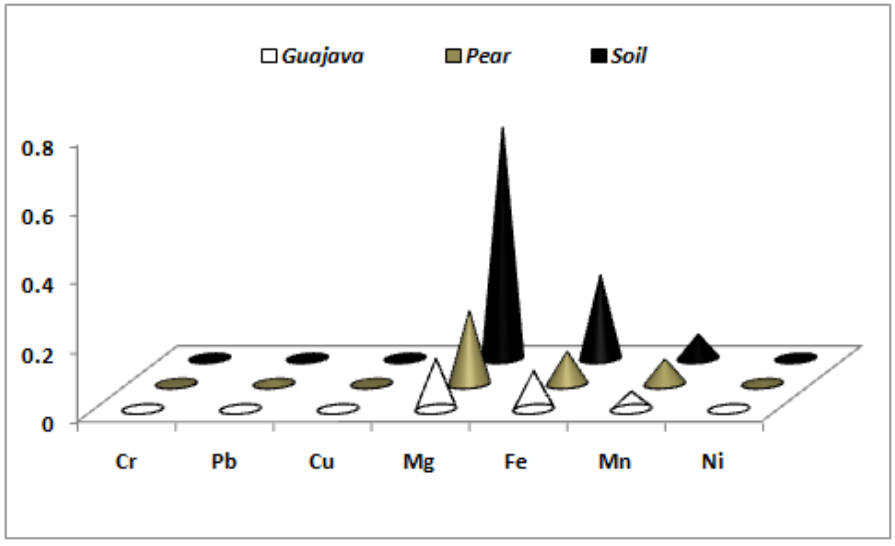

Fig. 1. Mean concentration of heavy metals in fruits samples

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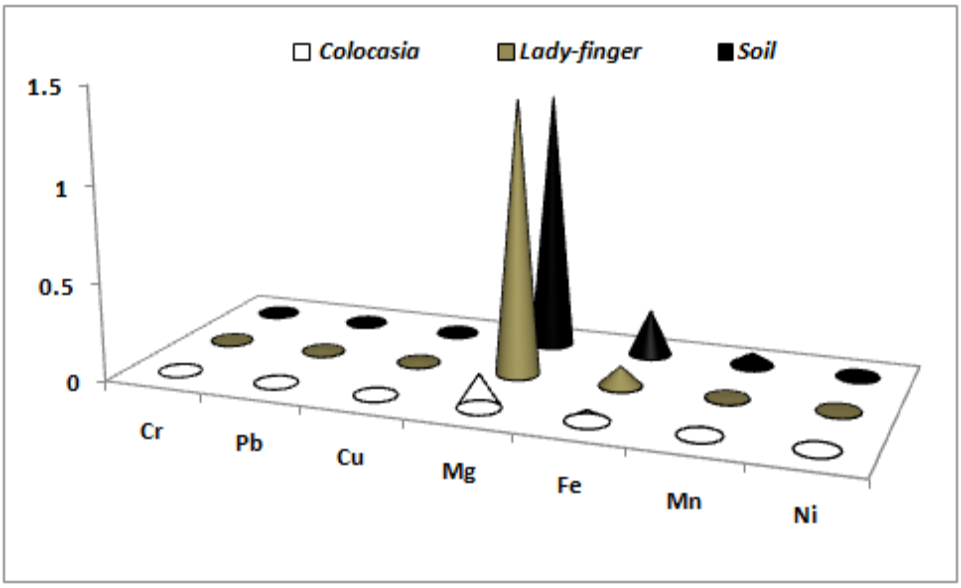

Fig. 2. Mean concentration of heavy metals in vegetable samples

Highest concentration was found in soil of *Colocasia esculanta* while lowest was found in soil of *Abelmoschus esculentus*.

Concentrations of Nickel was found in range of 0.004 mg/g to 0.008 mg/g. Highest level was present in *Pyrus* and lowest in *Abelmoschus esculentus*. Similarly in soil of corresponding vegetables and fruits was in the range of 0.003 mg/g to 0.005 mg/g. Highest concentration was found in soil of *Psidium guajava* and lowest was found in soil of *Abelmoschus esculentus*.

IV. CONCLUSIONS

The present study has generated data on heavy metals in selected vegetables, fruits which are cultivated and marketed in district Peshawar Khyber Pakhtunkhwa, Pakistan and their respective soil. The concentration trend of various heavy metals in *Colocasia esculanta* and respective soil is in the order of Mg‘> Fe > Mn > Pb > Cr > Ni > Cu and Mg‘> Fe > Mn > Cr > Pb > Ni > Cu respectively. Similarly in case of *Abelmoschus esculentus*and respective soilis the order of Mg > Fe > Cu > Pb > Mn > Ni > Cr and Mg > Fe > Mn > Cr > Ni > Pb> Cu. For *Psidium guajava* Mg‘> Fe > Mn > Pb > Ni > Cu > Cr and for its soil is Mg‘> Fe > Mn > Cr > Ni > Pb > Cu. In case of *Pyrus*, the order found is Mg > Fe > Mn > Pb > Ni > Cr > Cu and for its soil is Mg > Fe > Mn > Cr > Ni > Cu > Pb . It has been concluded that both vegetables and their soil contain more amount of Mg and Fe. Furthermore, concentration of selected heavy metal in the studied vegetables and fruits is acceptable for human consumption as their level are below as compare to the standard permissible levels. Although the obtained concentrations are lower than WHO standards, and effect of exposure to sub-limital levels of toxic metals are not known. Therefore, close monitoring of heavy metals in fruit and other food commodities remains important.

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