The Lighthouse Journal of Natural Sciences, Vol. 01, Issue 02, Winter 2022, pp. 1-9

Contamination Levels of Some Heavy Metals in Selected Vegetables Grown in Urmar Bala of District Peshawar, Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

The levels of Cr, Pb, Fe, Ni and Cd have been assessed in edible part of selected vegetables: Bottle gourd (Lagenaria siceraria), Aubergine (Solanum melongena), Lady Finger (Abelmoschus esculentus) and Regde gourd (Luffa acutangula). The range of heavy metals in samples are as: Chromium (Cr) is 0.00 mg/kg in all vegetable samples: Lead (Pb) is from 6.4 mg/kg to 1.35 mg/kg, Iron (Fe) is from 56.45 mg/kg to 31.15 mg/kg, Nickel (Ni) concentration (19.5mg/kg) found only in lady finger (Abelmoschus esculentus), Cadmium (Cd) in the range of 0.75 to 0.6mg/kg. Heavy metals concentration in selected vegetables is in the order of: Aubergine (Solanum melongena) (Pb > Fe > Cd), Bottle gourd (Lagenaria siceraria) (Fe > Cd), Lady Finger (Abelmoschus esculentus) (Fe > Ni > Pb) and Regde gourd (Luffa acutangula) (Fe > Pb). The trend revealed that concentrations of Fe were found maximum in all vegetables except Aubergine (Solanum melongena). When compared with standards, the levels of iron and nickel were found below, but lead and cadmium above their maximum permissible limits according to guidelines set by FAO/WHO.

Keywords: *Heavy metals, Vegetables, Lagenaria siceraria, Solanum melongena, Abelmoschus esculentus, Luffa acutangula, Lead (Pb), Chromium (Cr), Nickel (Ni), Iron (Fe), Cadmium (Cd), Centralized Resource laboratory (CRL).*

INTRODUCTION

Pollution may be organic or inorganic. Inorganic pollution is due to heavy metals in environment [1]. Natural as well as anthropogenic sources are responsible for these elements in aquatic system and soils [2]. Anthropogenic contributions exceed nature due to rapid urbanization and industrial development [3]. Industrial and domestic waste is main cause of heavy metals in surface as well as ground water and soils [4]. Cr, Mn, Ni,

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Manuscript Received: Oct 15, 2022
Manuscript Accepted: 27 Dec, 2022

Cu, and Fe are required for various functions however when exceeding their maximum permissible level causes negative health effects [5]. Metals are responsible for chronic toxicity in humans, based on their concentration, way of exposure and the time of exposure. It is therefore very essential to assess heavy metal contamination and develop plans for their remediation and protect human [6].

Vegetables are very important for human life and animals because they contain proteins, vitamins, iron, calcium and other nutrients [7]. They are also responsible for neutralization of acidic substances form during digestion. [8]. Vegetables are beneficial to maintain health and prevent various diseases [9]. Vegetables receive these metals through their roots from soil and irrigation water, transported to their shoots and finally accumulate in their tissues. Ingestion of heavy metals in water is influenced through deposition, level of heavy metals in soil [10]. The hypothesis about current study is that information about heavy metals analysis in soil, fruits and vegetables of study area is limited. Since its land is most fertile and agriculture is the main source of income. It is irrigated through wastewater from industries and residential area. So it can be contaminated with heavy metals. Therefore it was decided to sought out heavy metal contamination of selected vegetates mostly grown there for the benefits of general public and residence of the area.

RESEARCH METHODOLOGY

Description of study area

This present research study was conducted in summer-2019 by collecting selected vegetables from Urmar Bala of district Peshawar, Khyber Pakhtunkhwa, Pakistan. Geographical coordinates of this area are: 33°57'17.9"N and 71°40'54.8"E. It is located at a distance of 11.2 km / 7.0 mi away from Peshawar. It has very fertile land and different vegetables and fruits are grown here which are consumed locally as well as marketed.

Collection of vegetables samples

Four types of vegetables Bottle gourd (*Lagenaria siceraria*), Aubergine (*Solanum melongena)*, Lady Finger (*Abelmoschus esculentus*) and Regde gourd (*Luffa acutangula*) were collected from four different farms of study area randomly. These are common grown and consumed vegetables in Urmar Bala of district Peshawar, as well as marketed. The samples were kept in polythene bags, labeled and brought to laboratory to department of chemistry at Government College Peshawar, Khyber Pakhtunkhwa, Pakistan. Only edible part was used for analysis.

Samples preparation and treatment

Vegetable samples were cleaned from dust and other undesirable materials first with tap water and then with distilled water. By means of clean knife the vegetables were changed into pieces. These pieces were then dehydrated in the oven at 100 ^{0}C. The dried pieces were powdered through mortar and pestle. The powdered samples were kept in polyethylene bags for further study.

Acid digestion and metal determination of sample

From each vegetable sample, 1 gm was taken in beaker and treated with 3 ml of HNO_3 (Nitric acid) and 1 ml HCl (Hydrochloric acid). To get clear solution for each sample, the di-acid mixture was digested on hot plate oven. After digestion completion, the solution was cooled and then filtered through filter paper. With distilled water, solution was diluted to 50mL. Filtered samples were brought to Centralized Resource laboratory (CRL) University of Peshawar for heavy metals (Cr, Pb, Fe, Ni and Cd) determination through Atomic Absorption Spectrophotometer (Model: AAS 700, Perkin Elmer, USA) . The final concentration of metals in each sample was calculated using formula [12]:

$$\text{Concentration (mg/kg)} = \frac{\text{Concentration (mg/L)} \times V}{W}$$

where V= final volume (50mL) of solution, W= initial weight (1g) of sample used.

DISCUSSION AND ANALYSIS

Heavy metals in vegetables

Heavy metals concentrations in different vegetable species of the study area were compared with the standards set by FAO/WHO for vegetables and discussed briefly: **Chromium (Cr):** In current study, chromium was not detected in all vegetables samples of study area.

Lead (Pb): Lead values were observed from 1.35 to 6.4 mg/kg. Its maximum concentration was observed in Aburgine was (6.4mg/kg) while lowest concentration in Regde gourd (1.35mg/kg) but not detected in bottle gourd **(Figure1)** It has been seen that concentration of lead in Aubergine, Lady finger and Redge gourd was above the maximum permissible level (0.1mg/kg) given by FAO/WHO-2011. The decreasing order of lead in vegetable samples was: Aubergine > Lady Finger > Regde gourd > Bottle gourd

Iron (Fe): Iron concentrations in current study were absorbed in the range of 56.45 to 31.15 mg/kg. The highest concentrations of iron was investigated in Regde gourd (56.45 mg/kg) and lowest in lady finger (31.15 mg/kg) **(Figure 2).** Concentration of iron in all vegetables samples were well below the maximum permissible level

(425.5mg/kg) given by FAO/WHO. The decreasing order of iron in current vegetable was: Regde gourd > Bottle gourd > Aubergine > Lady Finger.

Nickel (Ni): It has been found that concentration of Nickel was 19.5 mg/kg in lady finger which is below the maximum permissible level (66.9mg/kg) while in all the remaining vegetables samples its concentration not founded **(Figure 3).**

Cadmium (Cd): Highest concentrations of cadmium was observed in Aubergine was 0.75 mg/kg and lowest concentration in Bottle gourd 0.6mg/kg respectively. It was observed that cadmium concentration in both vegetables samples exceeded the maximum permissible level (0.05mg/kg) according to FAO/WHO-2011. Similarly in Lady Finger and Regde gourd cadmium was not detected **(Figure 4).**

Studies from other countries like Brazil, Vietnam, India and Bangladesh for determination of heavy metals are summarized in **Table 3**. Comparison indicate that presences of Chromium (Cr) in our result are lower than literature values. Similarly presences of Lead (Pb) and Nickel (Ni) in our results are more than in Bangladesh [16], Brazil [13] and Vietnam [14] but lower than India [15]. Levels of Cadmium (Cd) in current study in more than those investigated in Brazil and Vietnam but lower than those in India and Vietnam for lady finger.

Table 1: Common and botanical names of vegetable samples**.**

English name	**Local name**	**Scientific name**	**Edible part**
Bottle gourd	Kadoo	*Lagenaria siceraria*	Fruit
Aubergine	Baingun	*Solanum melongena*	Fruit
Lady finger	Bhindi	*Abelmoschus esculentus*	Fruit
Regde gourd	Turai	*Luffa acutangula*	Fruit

Table No 2: Concentration of heavy matals (mg/kg) in selected vegetables of the study area.

Name of samples	Final concentration (mg/kg)				
	Cr	Pb	Fe	Ni	**Cd**
Bottle gourd					

	ND	ND	44.45	ND	0.6
Aubergine	ND	6.4	34.75	ND	0.75
Lady finger	ND	3.75	31.15	19.5	ND
Redge gourd	ND	1.35	56.45	ND	ND

ND: not detected

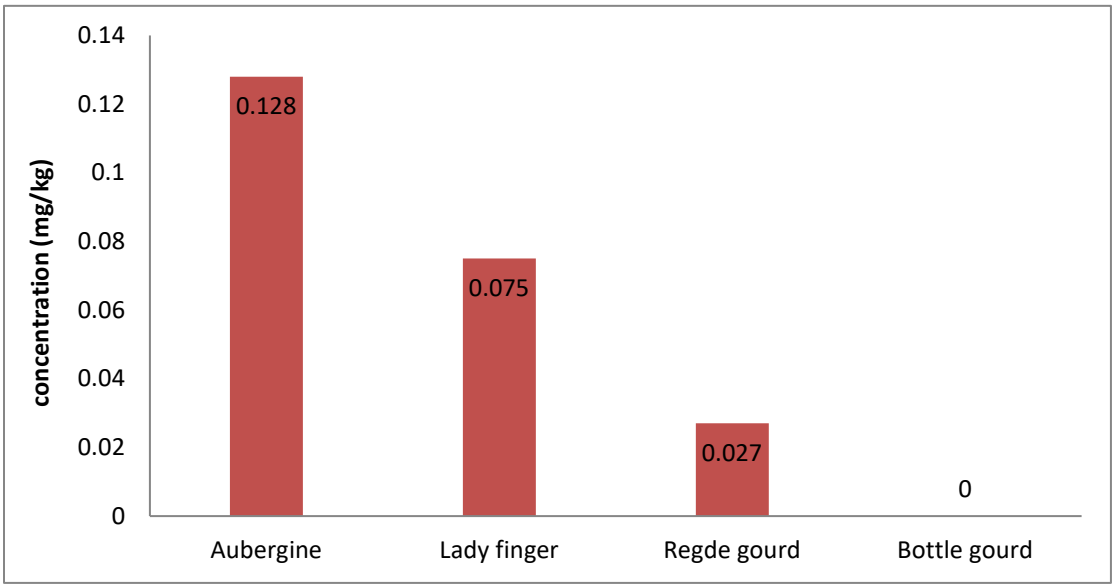

Figure 1: Concentration (mg/kg) of Lead (Pb) in selected vegetables

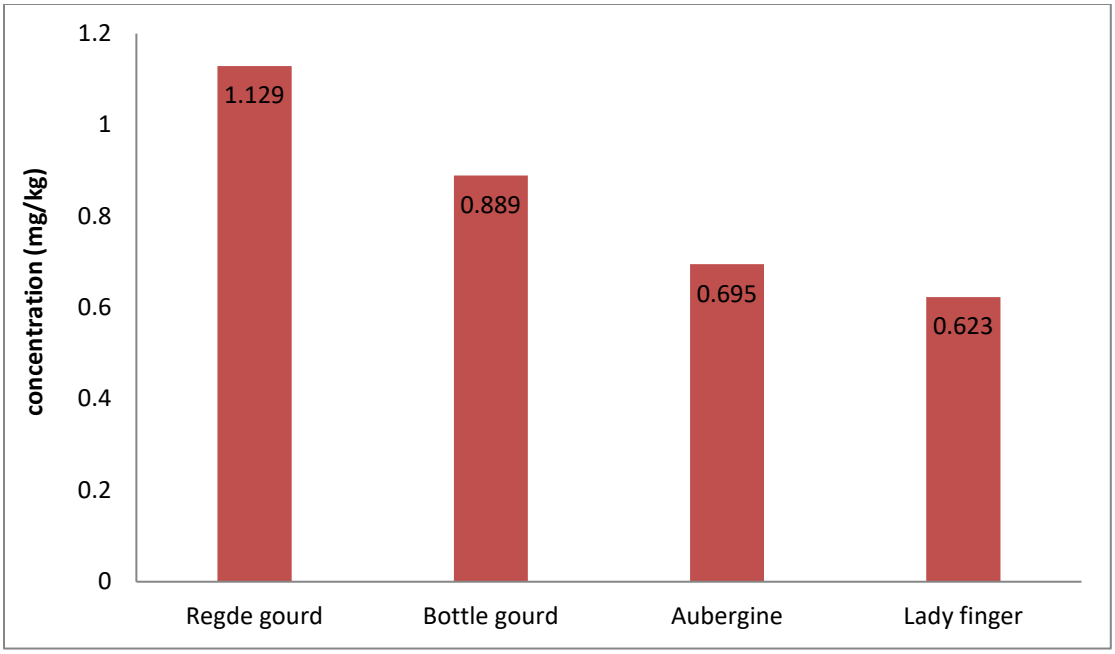

Figure 2: Concentration (mg/kg) of Iron (Fe) in selected vegetables

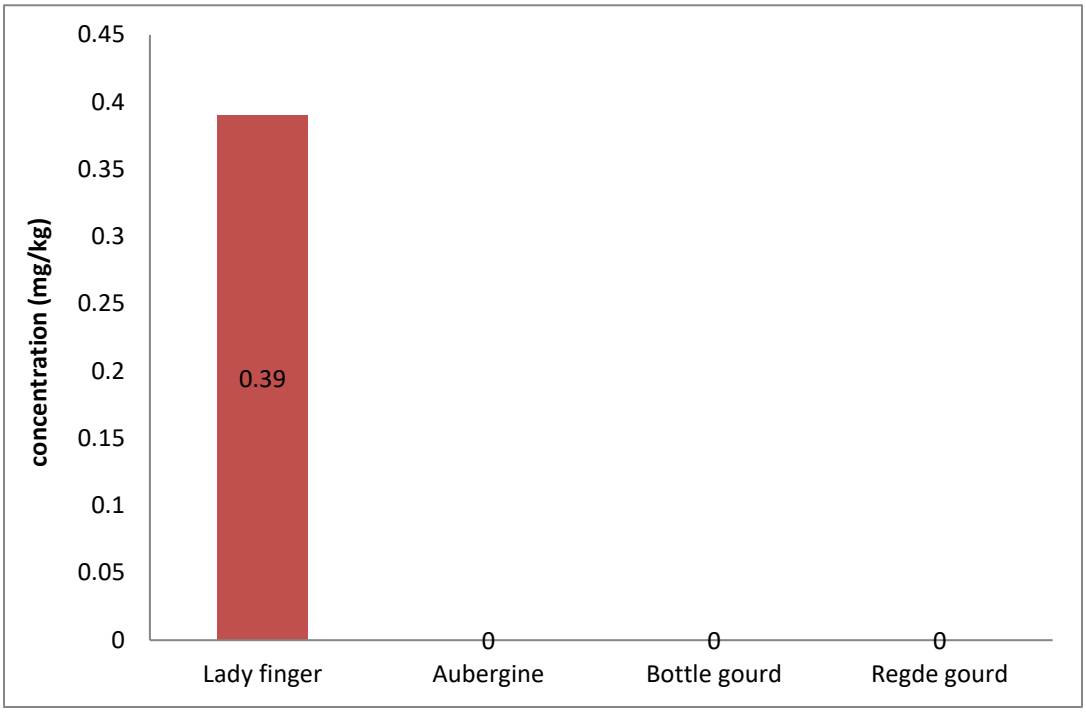

Figure 3: Concentration (mg/kg) of Nickel (Ni) in selected vegetables

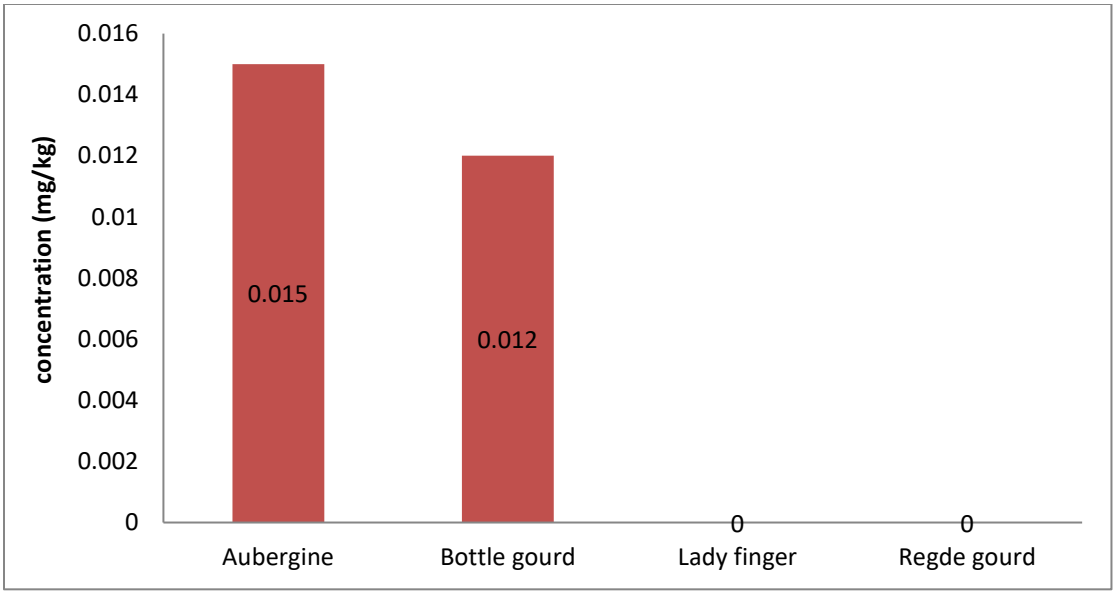

Figure 4: Concentration (mg/kg) of Cadmium (Cd) in selected vegetables

Table 3: Literature comparison of the heavy metals in selected vegetables from different countries.

Country	Vegetables	Cr	Pb	Fe	Ni	Cd	Unit	References
Brazil	Aubergine	0.16	0.44	-	0.13	0.04	(mg/kg)	[13]
	Lady finger	0.21	1.31	-	0.48	0.0		
Vietnam	Aubergine	0.11	0.70	-	-	0.09	(mg/kg)	[14]
	Lady finger	0.58	0.97	-	-	0.96		
India	Lady finger	64.62	26.43	-	58.96	15.04	(mg/kg)	[15]
Bangladesh	Bottle gourd	0.83	1.06	-	-	-	(mg/kg)	[16]

CONCLUSION AND RECOMMENDATIONS

Heavy metals accumulate in vegetables due to their presence in irrigation water and soil. Concentrations of these metals vary among the tested samples of vegetables, which show their different uptake capabilities and accumulation in their edible parts. The vegetables in present study were tested for the levels of heavy metals (Cr, Pb, Fe, Ni and Cd). Among these metals, level of iron was found more in all selected vegetable except Aubergine where lead found maximum. It has been observed that levels of Iron and Nickel in all vegetables samples were below their maximum permissible levels while Lead and cadmium exceeded their permissible limit in most vegetables samples. Therefore, it was concluded that vegetable of this area should not be consumed too much as possible. It is strongly recommended that periodic survey should be conducted on all food committees to protect the health of end user.

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