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Analysis of heavy metals (Pb and Cd) in soil, peach fruit and its accumulation in human blood

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Abstract

Heavy metals are among the most hazardous substance present in the environment. Their presence in soil results in contamination of plants and consequently the food we obtain form plants. Consumption of contaminated food (fruits and vegetables) is the major cause of toxic metals transfer into human body. Cadmium (Cd) and lead (Pb) are among the most toxic heavy metals and cause serious health problem in humans. The current study was conducted to evaluate the concentration of cadmium in soil, peach fruit and human blood. Soil was collected from peach gardens and blood samples were taken from individuals. Blood samples were taken at two stages; before and after consumption of peaches. The obtained result showed that concentration of Cd in soil exceed the World Health Organization (WHO) standard limit while Pb concentration in soil was recorded within safe limit. Concentration of Pb and Cd in peach fruit exceed the safe limit while its seed contain lower concentration of the metals. The concentration of Cd and Pb in blood sample before treatment were (1.86 ppm) and (5.95 ppm) respectively. While the concentration of Cd and Pb in blood sample after treatment was (1.88 ppm) and (6.00 ppm) respectively. After treatment of peach, increase in the concentration of Cd and Pb was found in blood sample. Further investigation is suggested to find the effect of toxic metals like Cd and Pb on human physiology and biochemistry.

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Introduction

Peach (*Prunus persica*) belongs to the family Rosaceae and mostly found in temperate and sub-tropical areas of the world. The worldwide production of peach fruit is about 18.42 million tons, (FAO, 2008, Scorza and Okie, 1990). Peach is the second most important stone fruit after apricot and cultivated on an area of 15,657 hectors. Annually about 94,490 tons production of peach occur in Pakistan. The Punjab province contributes 5,000 tons, Khyber Pakhtunkhwa 57,800 tons and Baluchistan 25,400 tons. Peaches are produced in Attock, Muree, Khushab, Peshawar, Swat, Hazara, North Waziristan, Chitral, Quetta, Pishin, Loralai, Qilla Saifullah, Qilla Abdullah, Mastung, Kalat and Northern areas of Pakistan.

Peach fruit comprise of phytochemicals (vitamins, antioxidant, and phenolic compounds), Vitamins (Vitamin A, Vitamin B1, Vitamin B2, niacin and contains ascorbic acid) and minerals (Calcium, Phosphorus, Iron, and Potassium). It also contain high level of carotenoids and phenolic compounds (Tomas-Barberan *et al*., 2001). High contents of an antioxidants in nutrition has a key role in decreasing cardiac risks (Verlangieri *et al.,* 1985; Ascherio *et al*., 1992). Peach fruit kernel is used to regulate blood circulation and beneficial use during chronic constipation (Hou and Jin, 2005).

Plants are highly exposed to cadmium toxicity when grown in contaminated soil. Cadmium due to its high mobility can easily enter the plant roots and translocate from roots into the aerial parts of a plant (Barrelo and Poschenrieder, 1992). Acidic soil increase the mobility of Cd in soil and its absorption into plant roots (Miller *et al*. 1976). Basic soil decrease translocation of Cd from soil into plants (Haghiri, 1974). Cadmium damage plants by altering the cellular stability and severely affect the metabolic pathways of cells. Cadmium can binds with the active sites of certain biochemical compounds like nucleic acid and amino acids that eventually disturb their metabolism activities. Severe effects of cadmium on plant genomes have been reported (Chaudhuri, 1994). Cadmium induce the production of reactive oxygen species (ROS) and results in oxidative stress by destroying various enzymes and other structures inside the plant cell (Shaw *et al*. 1995, Gallego *et al*. 1996, Laspina *et al*. 2005).

Cadmium enters into the human body mainly through consumption of contaminated food and tobacco smoking cadmium. It can accumulate permanently for a very long period in human body and effect almost all the systems of body particularly lungs, liver and kidneys (Nordberg *et al*. 2010). Cadmium has also been reported as potential carcinogen and cause cancer at different organs of the body (Waalkes, 2003).

Lead is a naturally occurring element and a pleiotropic toxicant with obvious effects on human health at high levels. Soils contaminated with Pb causes severe reduction in crop productivity thereby posing a serious problem for agriculture (Johnson and Eaton, 1980). Although Pb is not an important nutrient for plants, majority of lead is easily taken up by plants from the soil and accumulated in root while only a small amount was translocated upward to the shoots (Patra *et al*. 2004). Lead (Pb) is one of the universally distributed most abundant toxic elements in the soil. It applies adverse effect on growth, morphology and photosynthetic processes of plants. Lead is known to inhibit seed germination of *Spartiana alterniflora* (Morzck and Funiccllli, 1982), *Pinus helipensis* (Nakos, 1979). The effect of Pb depends on concentration, type of soil, soil properties and plant species.

Persistent accumulation of heavy metals through food stuff may lead to chronic effect in the liver and kidney of humans and causes disruption of numerous biochemical processes leading to kidney nervous, cardiovascular, and bone diseases (Jarup, 2003). The hematological effects of lead have been documented for many years and the biochemical basis for such alterations are now rationally well recognized. Lead may also induce the development of anemia but this effect only arises at high levels of exposure (Zielhuis, 1975).

Indeed, children may die from the neurological effects of lead without even developing anemia. Acute effects of lead on the central nervous system (CNS) are generally seen in children heavily exposed from pica and are clear by severe encephalopathy which can terminate in coma and death (Piomelli, 1980). Toxic heavy metals (cadmium and lead) reach human body mostly through contaminated plants food. In present research we have selected peach plant for studying concentration of Cd and Pb in their fruit.

Materials and methods

Soil samples (base of peach trees at 15-20 cm depth) were collected from peach gardens and dried in sunlight. The mature fruit and seeds were collected from the different gardens of peaches in district swat "khwaza-khela, langar" in the month of March 2015. Seeds were removed from the fruits and both the fruits and seed parts were dried in oven at 48 ^{o}C. The dried samples were grinded into powdered and stored in plastic envelopes. Blood samples were collected from three volunteers at the age of about 24 years. Blood was taken from the individuals at two stages; before eating of peaches and 4hr after eating 1 kg of peaches. Blood samples were taken from the individuals at each stage. Blood samples were dried and grinded into powdered. The blood powder samples were stored in small sized plastic bags.

Acid digestion, cadmium and lead analysis

Dried samples of blood, fruits and soil were acid digested by using the method of Allen (1974). Each powder sample were digested separately by taking (0.25 g) powdered sample in 50 mL flasks and 6.5 mL of mixed acid solution (nitric acid, sulfuric acid and perchloric acid in ratio of 5: 1: 0.5) was added and were then kept on an electric hot plats until white fumes came out from the flasks. After digestion samples were transferred into 50 mL volumetric flasks and the volume was made up to 50 mL with distilled water. The samples were filtered and the filtrates were kept in plastic bottles for further analysis of cadmium concentration. After digestion the filtered samples were analyzed for Cd and Pb contents using Atomic Absorption/Flame Spectrophotometer at Centralize Resource Laboratory of Peshawar Khyber Pakhtunkhwa, Pakistan.

Statistical analysis

In all experiments, three replicates were used for each sample. Data was analyzed for mean values and presented in graphical form.

Results

Analysis of metals concentration in soil, peach fruit, peach seeds and blood samples

Concentration of heavy metals in replicates of cadmium in soil samples was (2.43 ppm and 3.21 ppm) and lead was and (14.65 ppm and 16.94 ppm) respectively. By comparing the mean of Cd and Pb in soil sample, it was found that the concentration of Pb is greater than Cd as shown in the Fig. 1. The concentration of heavy metals (Cd and Pb) in peach fruit was presented in (Fig. 2). The Cd Concentration in peach samples was (2.23 ppm and 2.47 ppm) and Pb (6.45 ppm and 8.05 ppm).

Table 1. Comparison of Cd and Pb in soil, peach and blood samples.

Sample	Metals	R1 ppm	R2 ppm	R3 ppm	Mean ppm
Soil	cadmium	3.21	2.43	3.11	2.91
	lead	16.94	15.8	14.55	15.8
Peach	cadmium	2.47	2.35	2.23	2.35
	lead	7.47	8.05	6.45	7.32
Seed	cadmium	0.2	0.14	0.11	0.15
	lead	1.02	0.91	0.43	0.786
Blood before treatment	cadmium	1.34	2.2	2.04	1.86
	lead	6.37	5.95	5.53	5.95
Blood after treatment	cadmium	1.35	2.21	2.07	1.87
	lead	6.4	5.99	5.61	6.0

The comparative study of both metals, it was observed that lead concentration in peach fruit was much higher than the concentration of cadmium (Fig. 2). Fig. (3) shows concentration of heavy metals i.e. Cd and Pb in peach seeds sample.

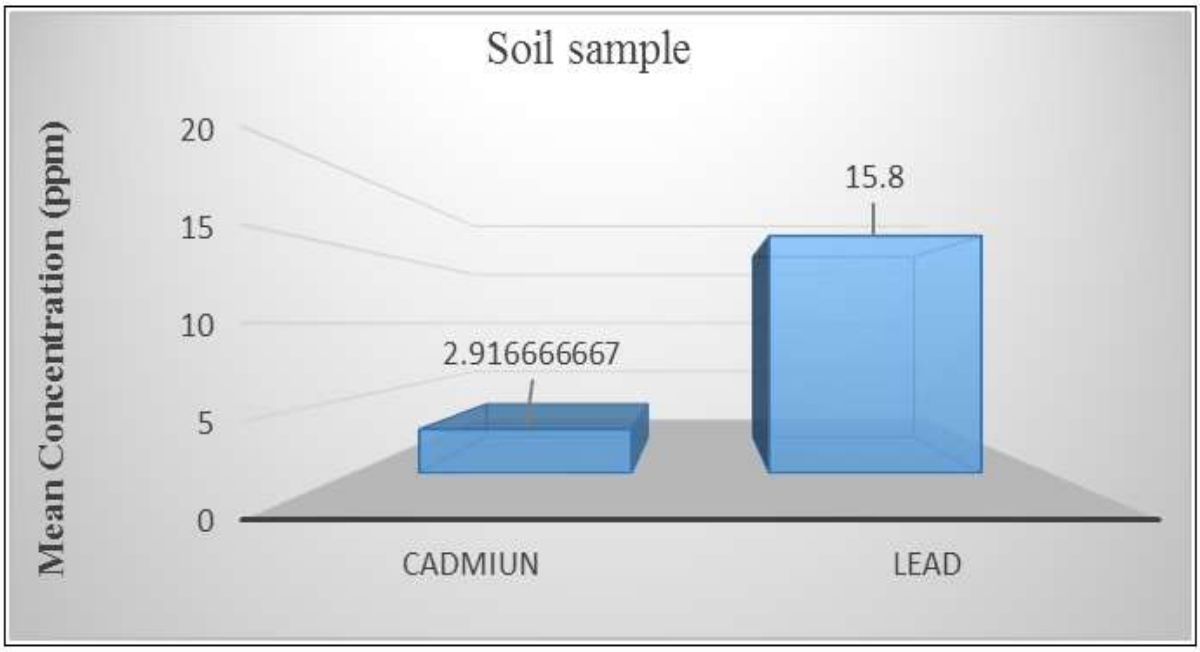

Fig. 1. Mean concentration of lead and cadmium in soil samples.

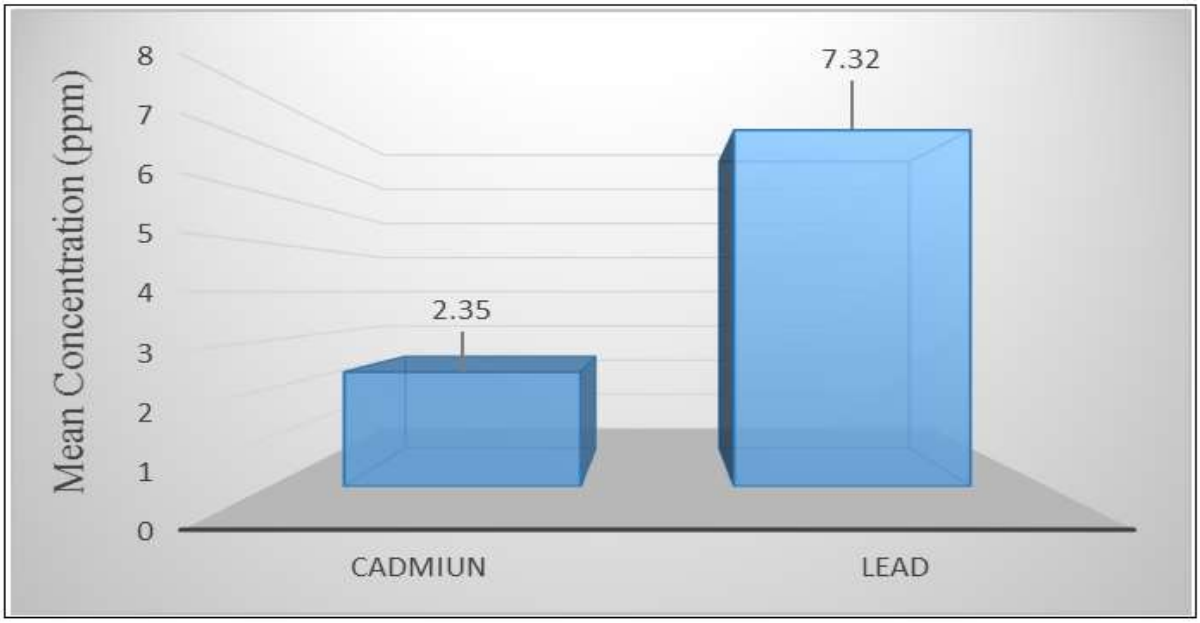

Fig. 2. Mean concentration of lead and cadmium in peach samples.

The range of Cd concentration in seeds sample was (0.11 ppm and 0.20 ppm) and Pb was (0.43 ppm and 1.02 ppm) respectively. Comparison of both the values of Cd and Pb shows that the concentration of Pb is greater than Cd as shown in Fig. 3. The Concentration of heavy metals (Cadmium and Lead) in blood sample before treatment range between (1.34 ppm and 2.2 ppm) and (5.53 ppm and 6.37 ppm) respectively (Fig. 4). After treatment, the concentrations of Cd and Pb were raised. The range of Cd after treatments was (1.35 ppm and 2.21) and Pb was (5.61 ppm and 6.4 ppm) respectively (Fig 5).

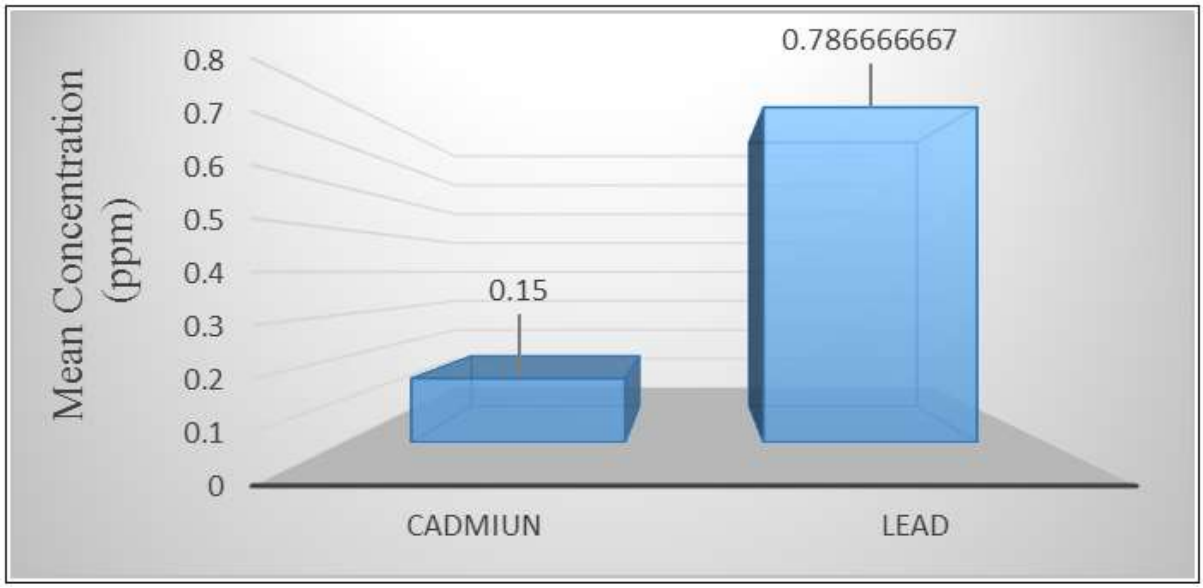

Fig. 3. Mean concentration of lead and cadmium in seed samples.

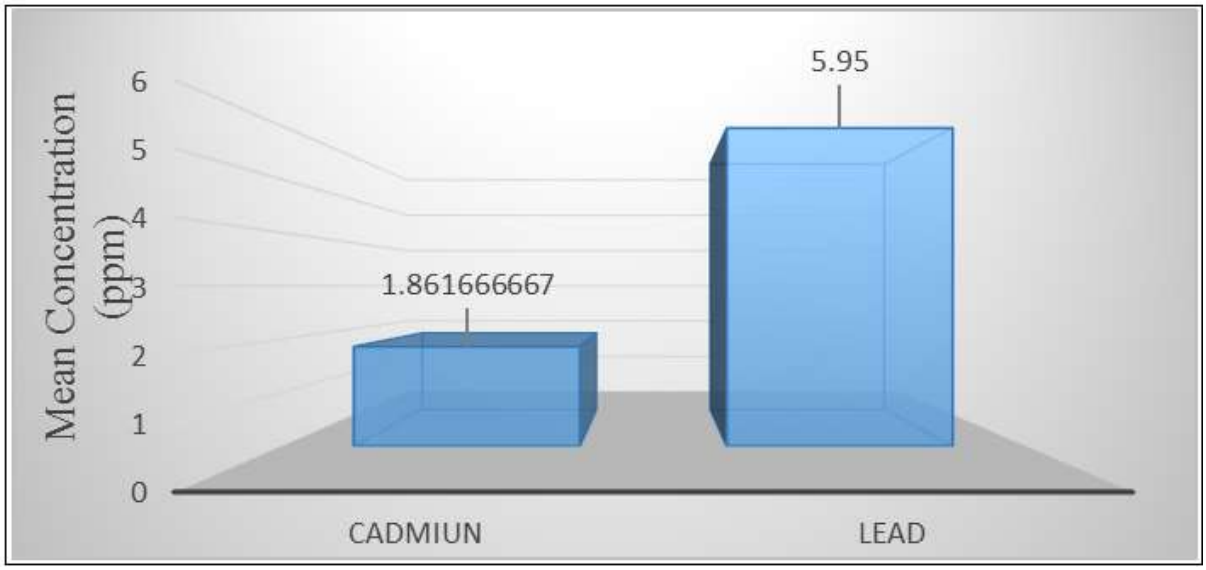

Fig. 4. Mean concentration of lead and cadmium in blood before treatment.

The comparison of both Cd and Pb shows that the concentration of Cd is lower than Pb Fig (4 and 5).

Concentration of Blood metal and Overall Comparison of Cd and Pb concentration

The Concentration of heavy metals (Cadmium and Lead) in blood sample after eating of peach were (0.015 ppm and 0.05 ppm) respectively (Fig. 6). Lead concentration in blood sample was found much higher than the concentration of cadmium (Fig. 7). The overall concentration of Cd and Pb was presented in (Table 1). In soil, high concentration of Pb was found as compared to Cd. In peach fruit and seeds sample high Pb concentration was observed as compared to Cd. High amount of Pb was found in human blood before and after treatments as compared to Cd.

Discussion

Soil act as a reservoir for a variety of substances. Some of these substances have nutritional value for plant growth and development while others are toxic in nature for plants and animals. Heavy metals are among the highly toxic substance present in soil. Cadmium (Cd) and lead (Pb) are the most hazardous heavy metals (Ahmad *et al.,* 2015).

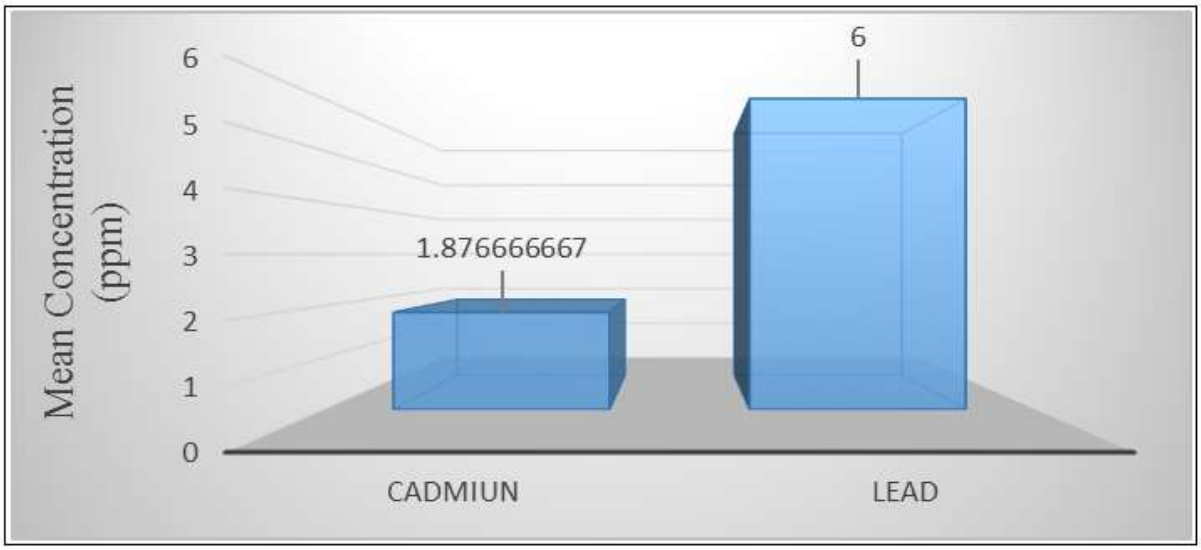

Fig. 5. Mean concentration of lead and cadmium in blood after treatment.

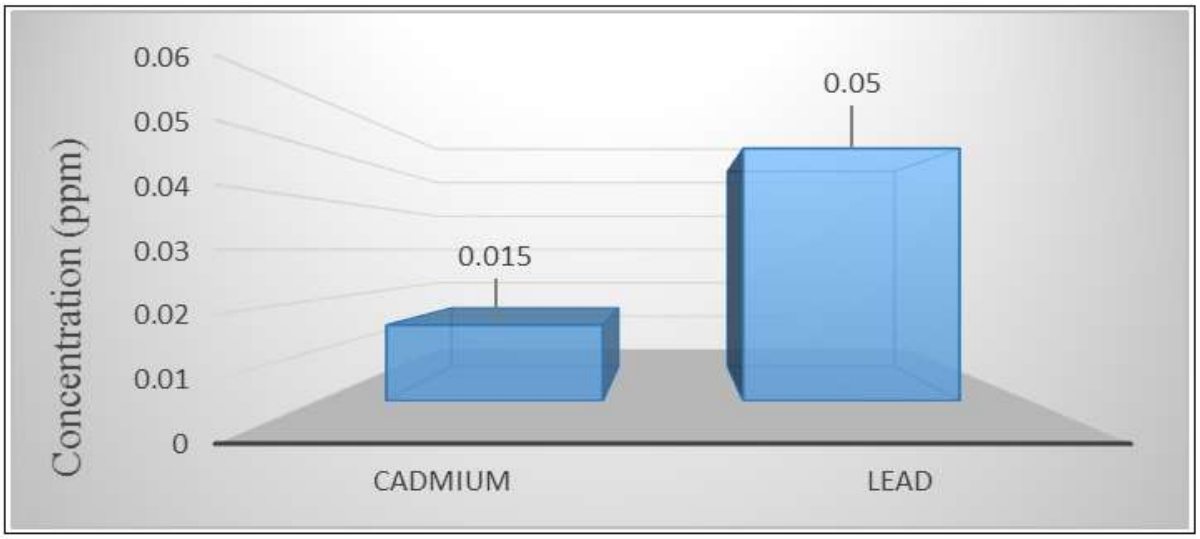

Fig. 6. Increase in blood concentration of heavy metal after single meal of contaminated peach.

Our results demonstrated high concentration of Pb in soil as compared to Cd. Presence of these metals in soil results in their absorption by plants and subsequent accumulation in their edible parts such as fruits. In present investigation we evaluated the concentration of Cd and Pb in peach fruit and it was found that concentration of Pb was much higher in the fruit samples as compared to Cd. Concentration of Cd exceed the WHO permissible limit (1 µg/g) in soil while Pb concentration in soil was within the permissible limit (50 ppm) (Temmerman *et al.,* 1984).

The assessment of metals contents in peach represents one of the factors in the evaluation of their quality taking into consideration that some plants may accumulate particular metals, especially cadmium. Heavy metal contamination of surface soils is prevalent at many industrial and mining sites throughout the world.

Lead is considered one of the most frequently encountered heavy metals of environmental concern and is the subject of much remediation research. Concentration of Cd in soil exceeds the World Health Organization (WHO) permissible limit while Pb concentration in soil was recorded within safe limit set by WHO.

It was noted that peach fruit exceed the safe limit for concentration of both the metals while seed of peach contain lower concentration of the metals. Increase in concentration of Cd and Pb in human blood was recorded after peach meal. Further investigation is suggested to find the effect of toxic metals like Cd and Pb on human physiology and biochemistry.

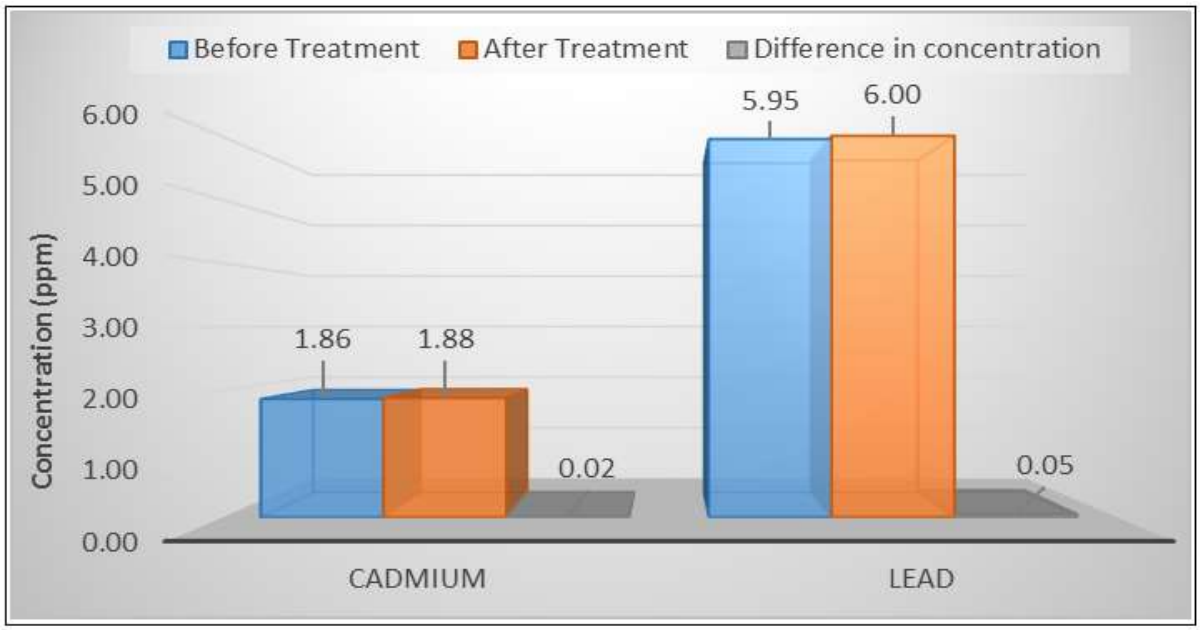

Fig. 7. Increase in Cadmium and Lead concentration in blood.

References

Ahmad A, Hadi F, Ali A, Jan AU. 2015. Enhanced phytoremediation of cadmium polluted water through two aquatic plants Veronica anagallis-aquatica and *Epilobium laxum*. Environment Science and Pollution Research. **4**, 66-73.

Allen SE. (1974). Chemical Analysis of Ecological Materials. Blackwell Scientific Publication, Oxford, London.

Anonymous. 2010. Agricultural Statistics of Pakistan. Ministry Of Food, Agriculture. Livestock (Economic Wing). Government of Pakistan.

Ascherio AE, Rimm EL, Giovannucci GA, Colditz B, Rosner WC, Willet F, Sacks, Sampers MJA. 1992. Prospective study of nutritional factors and hypertension among US men. Circulation **86,** 1475-1484.

Chaudhuri S, Messing J. (1994). Allele-specific parental imprinting of dzr1, a post-transcriptional regulator of zein accumulation. Proceedings of the National Academy of Sciences of the United States of America **91,** 4867–4871.

Chen G. 1990. Effects of heavy metals on the growth of cucumber seedlings. Chinese Bulletin of Botany **7,** 34-39.

FAO. 2008. Crop Water Information*: Maize*. Water development and management unit. FAO.

Gallego SM, Benavides MP, Tomaro ML. (1996). Effect of heavy metal ion excess on sunflower leaves: evidence for involvement of oxidative stress. Plant Science, **121**,151–159.

Haghiri F. 1974. Plant uptake of cadmium as influenced by cation exchange capacity, organic matter, zinc and soil temperature. International Journal of Environmental Quality **3**,180.

Hernberg S, 2000. Lead poisoning in a historical perspective. American Journal of Industrial Medicine **38,** 244-54.

Hernberg S. 2000. Lead Poisoning in a Historical Perspective. American Journal of Industrial Medicine **38**, 244- 254.

Jarup L. 2003. Hazards of heavy metal contamination. British Council Medical Department. **68**, 167.

Johnson MS, Eaton JW. 1980. Environmental contamination through residual trace metal dispersal from a derelict lead-zinc mine. Journal of Environmental Quality **9,** 175-179.

Kader AA. 2002. Recommendations for maintaining postharvest quality. Post, harvest Technology Research Information Center. Department of Pomology. University of California. One Shields Avenue Davis, 95616-8683.

Khan S, Khan NN. 1983. Influence of lead and cadmium on growth and nutrient concentration of tomato (*Lycopersicum esculentum*) and egg, plant (*Solanum melongena*). Plant Soil **74,** 387–394.

Laspina NV, Groppa MD, Tomaro ML, Benavides MP. 2005. Nitric oxide protects sunflower leaves against Cd-induced oxidative stress. Plant Science **169,** 323–330.

Miller JE, Hassete JJ, Koppe DE. 1975. Interaction of lead and cadmium of electron energy transfer reaction in corn mitochondria. Plant physiology **28,**166–171.

Miller JE, Hassett JJ, Koeppe DE. 1976. Uptake of cadmium by soybean as influenced by soil cation exchange capacity, pH and available phosphorus. Journal of Environmental Quality **3**, 56-64.

Morzck E, Funicclli NA. 1982. Effect of lead and on germination of *Spartina alterniflora* Losiel seeds at various salinities. Environmental and Experimental Botany **22,** 23–32.

Nakos G. 1979. Lead pollution: fate of lead in soil and its effects on *Pinus haplenis*. Plant Soil **50,**159–161.

Nordberg GF. 2010. Biomarkers of exposure, effects and susceptibility in humans and their application in studies of interactions among metals in China. Toxicology Letters **192**, 45-49.

Patra M, Bhowmik N, Bandopadhyay B, Sharma. 2004. Comparison of mercury, lead and arsenic with respect to genotoxic effects on plant systems and the development of genetic tolerance. Environmental and Experimental Botany, **52,** 199-223.

Piomelli S. 1980. The effects of low-level lead exposure on hemo metabolism. In Needleman, H. L. (Ed), Low Level Lead Exposure: The Clinical Implications of Current Research, 67-74.

Scorza R, Okie WR. 1990. Peaches (*Prunus*) in Genetic resources of temperate fruit and nut rops. Acta Horticultural, **290,** 177-231.

Sharma P, Dubey RS. 2005. Lead toxicity in plants. Plant Physiology **17,** 35–52.

Sharma RK, Agrawal M, Marshall FM. 2008). Environmental Pollution. **154**, 254-260.

Shaw BP. 1995. Effect of mercury and cadmium on the activities of antioxidative enzymes in the seeding of *Phaseolus aureus*. Biological Plant **37,** 587-596.

Sinha SK, Srinivastava HS, Mishra SN. 1988. Nitrate assimilation in intact and excised maize leaves in the presence of lead. Bulletin of Environmental Contamination and Toxicology **41**, 419–422.

Stiborova M, Pitrichova M, Brezinova A. 1987. Effect of heavy metal ions in growth and biochemical characteristic of photosynthesis of barley and maize seedlings. Biological Plant **29,** 453–467.

Stiborova M, Pitrichova M, Brezinova A. 1987. Effect of heavy metal ions in growth and biochemical characteristic of photosynthesis of barley and maize seedlings. Biological Plant **29**, 453–467.

Temmerman LO, Hoenig M, Scokart PO. 1984. Determination of "normal" levels and upper limit values of trace elements in soils. Zeitschrift für Pflanzenernährung und Bodenkunde **147,** 687–694.

Tomas-Barberan FA, Gil MI, Cremin P, Waterhouse AL, Hess-Pierce B, Kader AA. 2001. HPLC-DAD-ESIMS analysis of phenolic compounds in nectarines, peaches, and plums. Journal of Agricultural and Food Chemistry **49**, 4748–4760.

Verlangieri AJ, Kapeghian JC, El-Dean S, Bush M. 1985. Fruit and vegetable consumption and cardiovascular mortality. Medical Hypotheses **16,** 7-15.

Waalkes 2003. Effect of cadmium on DBA-(cytosine-5) methyltransferase activity and DNA methylation status during cadmium-induced cellular transformation. Experimental Cell Research **4,** 355-365.

Zielhuis RL. 1975. Dose-response relationships for inorganic lead, Biochemical and hematological responses. International Archives of Occupational and Environmental Health **35**, 1-18.