



## Heavy Metal Levels in Vegetables and Soil Cultivated with Industrial Wastewater from Different Sites of Chunian and Jamber, District, Kasur

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**Abstract:** In human diet, vegetables play important role to maintain the physiological conditions. Due to anthropogenic activities and pollution, the food items become contaminated. The present study was performed to evaluate the level of heavy metals in the vegetables irrigated with wastewater across Chunian and Jamber, district, Kasur. Level of heavy metals from the study area like Zinc, Lead and chromium in the soil, water and vegetables was compared. The four sites of each city and 10 vegetables e.g. potato, radish, carrot, fenugreek, spinach, tomato, Onion, Turnip, Cauliflower, Pangalo were selected to conduct the experiment. The vegetables were irrigated with industrial wastewater and the concentration of heavy metals was measured by the atomic absorption spectrophotometer (AAS). We concluded that the level of heavy metals was beyond the FAO limits in irrigated water due to industrial waste. In Jamber and Chunian, the level of Zn and Pb was high and beyond the FAO safe limits in the all water sample, the level of Cr was much higher only in the water sample of one site from Jamber. The concentration of zinc was higher in soil samples as compared to lead and chromium. Zn and Pb in vegetables of study area were labeled as priority pollutants but this concentration was within the safe limits set by FAO. However, constant inspection of heavy metals is recommended to avoid accumulation in the food chain and thus avoid human health risks.

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The concept “heavy metal” is a problematic term. It has never been defined by an authoritative body, but many have attempted to give a definition. The term is often used when addressing potentially toxic metals. The term was introduced by Bjerrum in 1936. Increasing the rate of heavy metals is a global issue. It affects directly and indirectly our agricultural system which causes serious health issues. Pakistan is also suffering from this problem because there is a shortage of clean water Azizullah *et al.*, (2011). Heavy metals that are also environmental pollutants if ingested through food, then it causes health problems. Heavy metals can bio-accumulate through biological chains through wastewater of industries and kitchen sewage Zhou *et al.*, (2016). Heavy metals accumulation depends on many regional factors e.g. types of industries, living style of population of area and careless disposal of wastes. Long exposure of field soil with the wastewater causes the increase of heavy metals concentration in soils and ultimately in plants Nyamangara *et al.*, (1999); Mapanda *et al.*, (2005);

Sharma *et al.*, (2007) which ultimately causes serious problems which is of serious concern. Metals have two types, essential and non-essential metals. Metalloids such as arsenic (As) are also included in heavy metals category because of their resemblances in chemical properties and environmental behavior Bati *et al.*, (2016). Toxicity produced by heavy metals is due to contamination of irrigated water, the use of high amount of fertilizers and pesticides with heavy metals, insecticides, herbicides, industrial emission, harvesting process and transportation. Soil and water contamination with heavy metals is also caused by wastewater irrigation, sludge applications, waste disposal, industrial activities and vehicular exhaust. It is observed that crops and vegetables are irrigated in the wastewater and this wastewater is taken up by the plants. Crops and vegetables that grow in that contaminated soil absorb more heavy metals than those that are grown in uncontaminated soils Sharma *et al.*, (2009). Trace elements can occur as residues in vegetables and edible products through their presence

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in the environment as results of human activities such as industry, farming and car exhaust Hu et al., (2017). It is also polluted during their process, storage and marketing. Those crops and vegetables that are irrigated in that wastewater have high level of heavy metals and when ingested by any consumer it causes problems. If we want to evaluate the health risks, it is essential to identify the quantity and probability of a source to lead risk agents into the environment, estimation the amount of risk agents that come into contact with the human-environment limitations and calculate the health significance of the revelation Ma et al., (2006). According to the National Research Council (NRC), 1983, this procedure involves four steps, identification of risks, exposure evaluation, dose or response estimation, and risk classification. Use of industrial effluents and sewage waste on agricultural and field land has become a common practice in the world. The toxic metals can be transferred into plant

tissues from the polluted soil. These metals have destructive effects on the plants and may cause health problems to man and animals when ingested. The intention of the experiment conducted was to explore the trace element (heavy metal) concentrations in different soil, water and vegetable samples of Jamber and Chunian, District Kasur.

## MATERIALS AND METHODS

**Description of study area:** The study was conducted in Jamber and Chunian tehsils of district Kasur. Jamber is a small town near Phoolnagar and it is the part of Pattoki Tehsil in Punjab, Pakistan. Jamber is located at 30°56'56"N 73°44'36"E and 66 kilometers away from Lahore. Chunian is located at 30°58'0"N 73°58'60"E and at an elevation of 177 meters and lies about 70 km south of Lahore. Figure 1 represents coordinates of sampling sites.

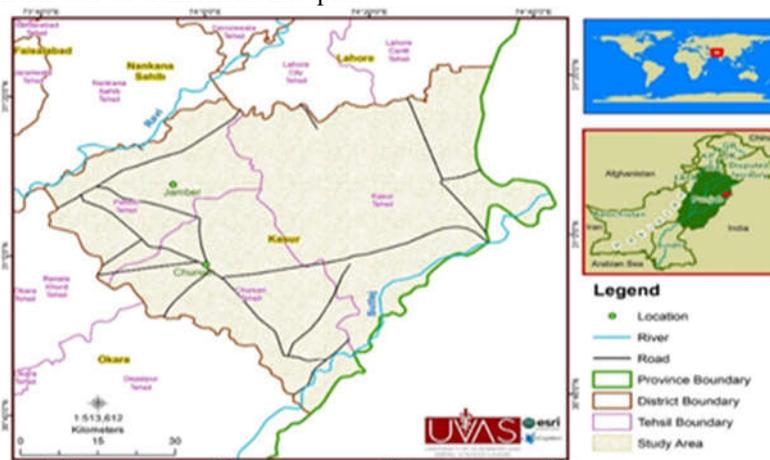


Fig 1 The sampling sites in District kasur

**Collection and analysis of water samples:** Water samples were collected from each location of the study area in pre-cleaned high-density plastic bottles. These bottles were cleaned with soap and soaked with 10% HNO<sub>3</sub> and finally deionized with water Chary et al., (2008). All the samples were stored at 4C<sup>0</sup> for further processing.

**Collection and analysis of soil samples:** Soil samples were also collected from each irrigated place by digging a monolith of 10. 10. 15 size with the help of plastic scooper. Non-soil particles e.g. stones, wooden pieces, rocks, gravels, organic debris were removed from soil. Samples were brought to the laboratory for oven dried. Dried soil was sieved through a 2 mm sieve and stored in the laboratory with labeled polythene sampling bags Lei et al., (2008).

**Collection and analysis of vegetables samples:** Vegetables samples were collected from located area

and stored in the polythene bags and brought to the laboratory. They were washed with tap-water to remove the dust and attached soil content. Vegetables (edible part) were kept in air dry oven and dried vegetables were grind into powder to make plant digests Jamali et al., (2009). Following vegetables were used during the experiment. Potato *Solanum tuberosum* Radish (*Raphanus sativus*), Carrot (*Daucus carota*), Fenugreek (*Trigonella foenum-graecum*), Spinach (*Spinacia oleracea*), Tomato (*Solanum lycopersicum*), Onion (*Allium cepa*), Turnip (*Brassica rapa*), Cauliflower (*Brassica oleracea*), Pangalo (*Benincasa fistulosa*).

**Digestion of soil and vegetables:** Acid mixture (HNO<sub>3</sub> 20ml, HCL 8ml) was added into 5g of sample and then digested at 80-100 C<sup>0</sup> until a transparent solution was attained Allen et al., (1986). The solution was cooled down and digested sample were filtered through

whatsman filter paper. The filtrate sample was maintained to 50ml with distilled water.

*Digestion of water samples:* The irrigated water samples (50ml) were digested with 10ml of concentrated HNO<sub>3</sub> at 80C<sup>0</sup> until the transparent solution formed (APHA, 2005). The solution was filtered through whatsman filter paper and cooled. The total volume was maintained to 50ml with distilled water.

*Statistical analyzing of heavy metals:* Statistical analysis of data was done by using SPSS Software for descriptive statistics and for evaluating the significant differences between heavy metals concentration in the vegetables, soil and water samples.

## RESULTS AND DISCUSSION

*Level of heavy metals in water samples:* Four sample sites were selected from the study area of Jamber and Chunian. Figure 2 and 3 shows the mean concentration of zinc, lead and chromium in water samples of Jamber and Chunian respectively. The levels of heavy metals in the water were highest followed by Zn, Pb, and Cr. Concentration of heavy metal Zinc in water samples of Jamber 1, 2, 3 and 4 having Means±SD was

18.5459±0.0042, 21.2148±0.0041, 16.3961±0.0035 and 24.2266±0.0048 respectively, while Zinc concentration in water samples of Chunian 1, 2, 3 and 4 having Means±SD was 13.1248±0.0104, 16.2008±0.0021, 15.4268±0.0104 and 12.4319±0.0032 respectively. Zinc concentration in water samples was higher in Jamber as compared to Chunian. Concentration of heavy metal Lead in water samples of Jamber 1, 2, 3 and 4 having Means±SD was 18.2577±0.0006, 14.1215±0.0008, 12.2507±0.0010 and 17.2527±0.0005 respectively, while Lead concentration in water samples of Chunian 1, 2, 3 and 4 having Means±SD was 14.5432±0.0004, 17.0342±0.0007, 11.4535±0.0012 and 13.3454±0.0050 respectively. Lead concentration in water samples was higher in Jamber as compared to Chunian. Concentration of heavy metal Chromium in water samples of Jamber 1, 2, 3 and 4 having Means±SD was 14.5211±0.0007, 17.2594±0.0005, 10.4222±0.0006 and 32.9275±0.0006 respectively, while Lead concentration in water samples of Chunian 1, 2, 3 and 4 having Means±SD was 15.4532±0.0003, 16.3452±0.0004, 11.3424±0.0016 and 22.3455±0.0009 respectively. Chromium concentration in water samples was higher in Jamber as compared to Chunian.

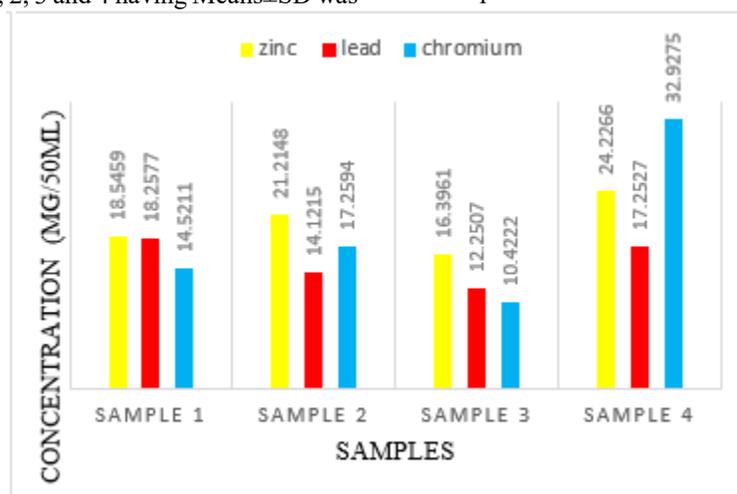


Fig 2 Concentration of heavy metals in water samples of Jamber

Discharge of wastewater without pretreatment is one the major cause of contamination of water resources Ashfaq et al., (2017). Using the same water for irrigation of crops causes the accumulation of heavy metals in food Clemens and Ma (2016). In Pakistan usually surface water or stream or river water being used for irrigation Qadir et al., (2008). Dumping the domestic, urban and industrial wastewater into surface water is a common practice in Pakistan Murtaza et al., (2017). These common practices not only contaminating the drinking water resources but also contaminating the food resources Clemens and Ma

(2016). Jamber is one of the most industrial area as compared to the Chunian and located near Lahore (Farooqi, 2015). High amount of water being used in industries and then discharged without prior treatment. Discharged water contains good amounts of metals like zinc, lead, chromium and mercury. However, in the present study concentrations of Zn from the water samples of Jamber and Chunian were found within the acceptable limits for heavy metals in irrigation water set by FAO, 2001, i.e. 5.0-10.0ml/l (250 µg/50ml). These finding also agree with the studies of Mahakalkar and Miss 2013 and Mahmood and Malik

2014. On the other hand, Pb from the water sample of Jamber and Chunian were found dramatically higher than the acceptable limits for heavy metals in

irrigation water according to FAO, 2001 i.e. 0.1ml / (5µg/50ml).

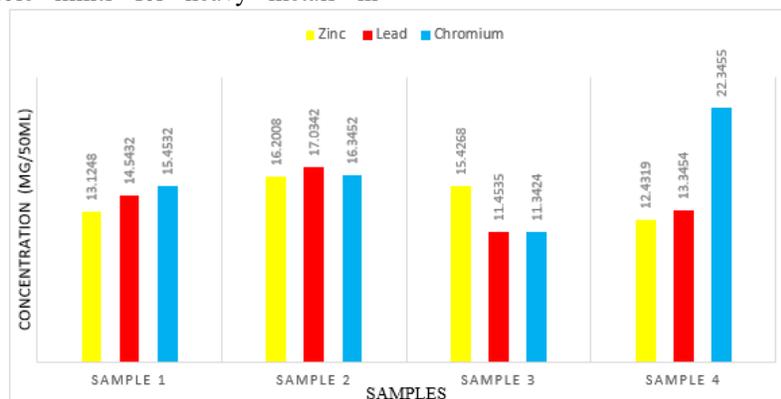


Fig 3 Concentration of heavy metals in water samples of Chunia

These findings coincide with the findings of Mahakalkar and Miss, 2013 who also observed the Pb range i.e. 0.23 mg/L beyond the FAO range from water sample collected from Nag River at Mahalgaon, India. Samples taken from the industrial cities of Sialkot and Wazirabad, Pakistan also showed the concentration of lead i.e.  $5.03 \pm 1.59$  mg/ml, beyond the limits set by FAO Khan et al., (2013). Chromium concentration varied with the sample site and from the water sample of only one site of Jamber showed the concentration of Cr higher than the limits that are  $27.5 \mu\text{g}/50\text{ml}$  (FAO, 2001). But the Cr concentration we found in this study contradicts the finding of Khan et al., (2013) who found the Cr concentration i.e.  $4.74 \pm 4.43$  mg/L greater than the FAO limits in all the water samples collected from Sialkot and Wazirabad, Pakistan and it was concluded that the most prominent contaminant was Pb and then Cr which agree with the present observation.

**Level of heavy metals in soil samples:** Four samples of soil were collected from selected areas of Jamber and Chunian. Mean concentration of zinc, lead and chromium in soil samples of Jamber and Chunian in soil samples. Data was analyzed and compared. Concentration of heavy metal Zinc in soil samples of Jamber 1, 2, 3 and 4 having Means±SD was  $68.7388 \pm 0.0066$ ,  $62.1469 \pm 0.0025$ ,  $55.1989 \pm 0.0042$  and  $79.8233 \pm 0.0037$  respectively. While Zinc concentration in soil samples of Chunian 1, 2, 3 and 4 having Means±SD was  $52.8744 \pm 0.0052$ ,  $47.5647 \pm 0.0018$ ,  $52.7867 \pm 0.0037$  and  $42.5435 \pm 0.0025$  respectively. Zinc concentration in soil samples was greater in Jamber as compared to Chunian. Concentration of heavy metal Lead in soil samples of Jamber 1, 2, 3 and 4 having Means±SD was  $34.2458 \pm 0.0007$ ,  $28.7235 \pm 0.0009$ ,  $26.0228 \pm 0.0008$  and  $39.7898 \pm 0.0006$  respectively. While Lead concentration in soil samples of Chunian 1, 2, 3 and 4

having Means±SD was  $21.7646 \pm 0.0009$ ,  $18.8978 \pm 0.0004$ ,  $20.7554 \pm 0.0002$  and  $18.6567 \pm 0.0010$  respectively. Soil samples of Jamber had more amount of metals accumulation than Chunian. Concentration of heavy metal Chromium in soil samples of Jamber 1, 2, 3 and 4 having Means±SD was  $50.7275 \pm 0.0051$ ,  $48.0088 \pm 0.0035$ ,  $42.0077 \pm 0.0022$  and  $57.3207 \pm 0.0009$  respectively. While Lead concentration in soil samples of Chunian 1, 2, 3 and 4 having Means±SD was  $41.4653 \pm 0.0021$ ,  $39.0031 \pm 0.0027$ ,  $42.0077 \pm 0.0031$  and  $45.3207 \pm 0.0006$  respectively. Chromium concentration in soil samples was greater in Jamber as compared to Chunian. Heavy metals in soil irrigated with wastewater were in the order of  $\text{Zn} > \text{Cr} > \text{Pb}$  with concentrations ranges from 55.19 to 79.82, 26.02 to 39.78 and 42.00 to 57.32 µg/5g for Jamber and 42.54 to 52.87, 18.89 to 21.76, 39.00 to 45.32 µg/5g for Chunian. All the observation for soil samples were under the limits set by FAO i.e. for Zn, Cr, Pb permissible level is 300, 100, 100 µg/g respectively (FAO, 2001). Khan et al., (2013) found concentration range of Cr and Pb 31.65 to 61.65 and 18.33 to 66.78 respectively. Our studies coincide with the studies of Khan et al., (2013) for soil samples metal concentration but highly contradict with the results of Mahakalkar and Miss 2013; Mahmood and Malik 2014; who found wastewater irrigated soil samples highly contaminated with heavy metals. However, soil samples of Jamber showed more heavy metal concentration than the soil samples of Chunian. The reason of metal accumulation in soil could be the wastewater of industries and sewage. Wastewater of Jamber contains high amount of metals from experimented place. Although the heavy metal concentration in soil samples was found within the permissible range in this study.

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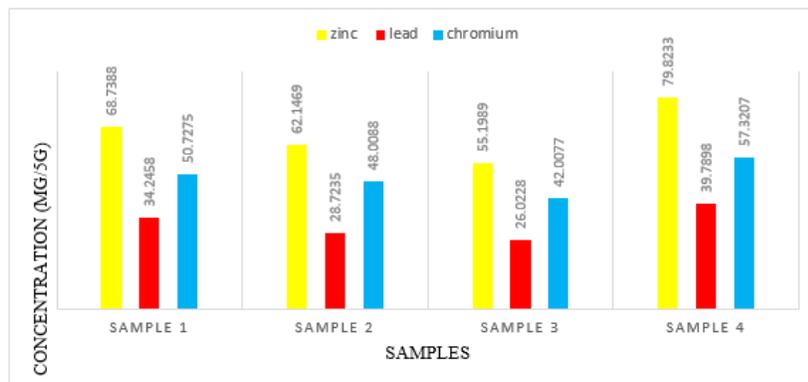


Fig 4 Concentration of heavy metals in soil samples of Jamber

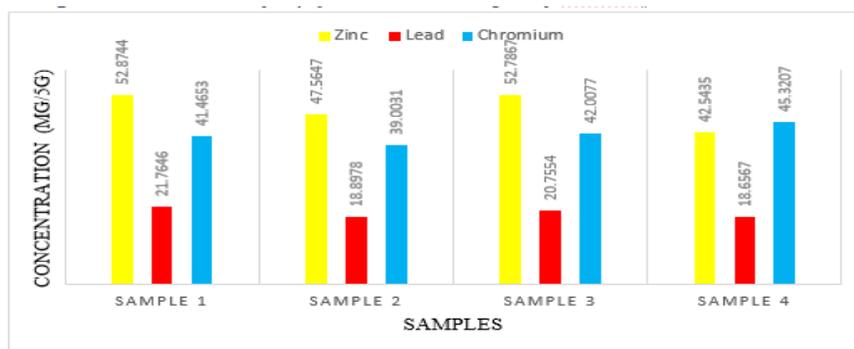


Fig 5 Concentration of heavy metals in soil samples of Chunian

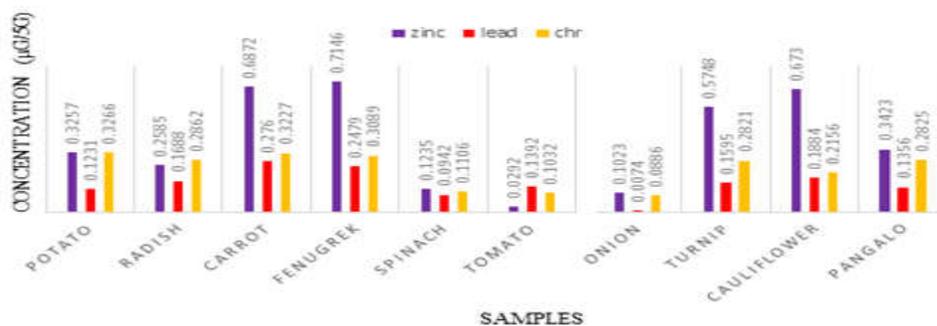


Fig 6 Concentration of heavy metals in vegetable samples of Jamber

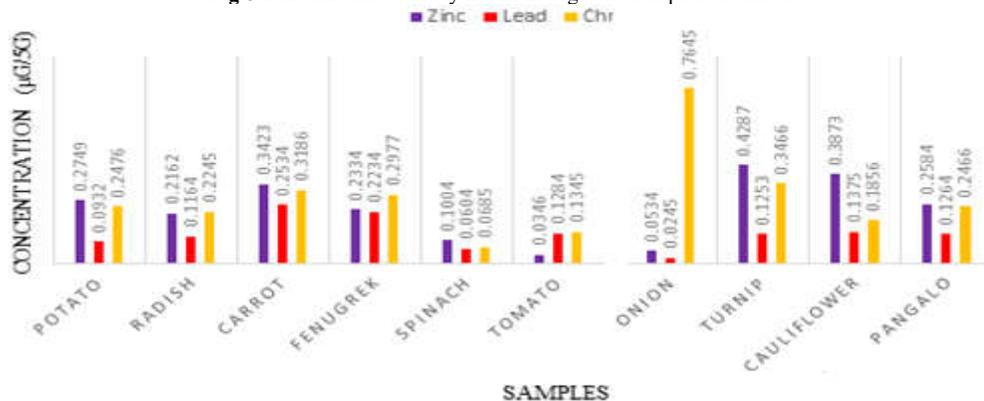


Fig 7 Concentration of heavy metals in vegetables samples of Chunian

*Level of Heavy Metals in Vegetables:* The concentration of heavy metals was varied in different vegetables in Jamber and Chunian. Eventually the metal concentration was greater in Jamber than Chunian. Figure 6 and 7 gathers the data of heavy metals concentration in Jamber and Chunian respectively. Heavy metals in all the vegetables observed in this study were found within the permissible limits. However, in Jamber, vegetables fenugreek, cauliflower, turnip and carrot showed high amount of Zinc. Lead concentration was found greater in fenugreek, cauliflower, turnip and carrot. Chromium concentration was greater in potato, radish, carrot, fenugreek and pangalo. While the concentration of heavy metals varied in vegetables of Chunian. Zinc was found greater in turnip, spinach, potato and cauliflower. Lead concentration was found slightly same in all the vegetables except fenugreek, but chromium was in high amount in carrot, onion and turnip. The metal content was found significantly higher in vegetables of Jamber as compared Chunian. It has many reasons of accumulation as Jamber is highly industrial area and broad open sewage system. Their wastewater released and used in the irrigation fields. It contains trace elements in high amount due to un-proper disposal of industrial wastewater. They get mixed in soil and accumulated in it. Plant uptakes water from soil, the metals also absorbed by roots of plants. These metals reached and get accumulated in different parts of plants like root, shoot and leaves. But these vegetables are good dietary sources for essential trace metals as the levels of metals are within the permissible limit set by FAO, 2001 i.e. for Zn, Pb and Cr the limits are 100, 0.30 and 0.05 µg/g respectively. But ingestion of these metals beyond the safe level causes deadly and fatal effects like cardiovascular diseases, liver damage, sight problem, chronic diseases, kidney problems and bronchitis (Mahurpawar, 2015).

*Conclusion:* Results of the current study determined that Zn, Pb and Cr contents were found higher in wastewater used for irrigation than agricultural water standards show depletion in growth due to changes in their physiological and biochemical activities in Jamber and Chunian district, Kasur. In addition, study recommends the constant inspection of heavy metals present in wastewater, soil and vegetables to avoid accumulation in the food chain and thus avoid human health risks.

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