Evaluation of Transfer of Lead (Pb) in Soil Plant Animal System Assessment of Consequences of its Toxicity

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Abstract

The instant endeavor was undertaken for determination of lead (Pb) in water, soil, forage and cow's blood domesticated in contaminated area of heavy automobiles' exhaust in Sahiwal town of district Sargodha Pakistan. Water samples showed that the concentration of lead (Pb) ranged from 1.14 mg kg^{-1} to 0.44 mg kg^{-1} at all sites. It was maximum at site 5 and minimum at site 2. Soil samples showed the concentration of Pb at all sites ranged from 1.58 mg kg^{-1} to 0.279 mg kg^{-1}. It was maximum in soil where *Avena sativa* was grown at site 5 and was found minimum in soil where *Zea mays* was grown at site 2. While among samples of forage, the concentration of Pb ranges from 0.048 mg kg^{-1} to 2.002 mg kg^{-1}. The highest Pb amount was found in *Brassica campestris* at site 1 and the minimum was recorded in *Trifolium alexandrinum* at site 2. Finally, the blood samples of cow depicted that concentration of Pb ranged from 4.468 mg kg^{-1} to 0.217 mg kg^{-1}. It was maximum at site 1 and minimum at site 3.

Introduction

Although transport sector has made life luxurious all over the world, but also unfortunately it brought few problems with it. When coming to their roadside effects, one of the hazardous effects noted is that animal forages are contaminated with emission of pollutants from automobiles. Different studies have shown that the blood and meat samples of cattle grazing and domesticated on such contaminated forage were found with different heavy metals including lead (Pb). Lead enters in cattle and animals from water, they drink and forage, they eat. It is found that more are heavy automobiles on the roads or highways more is the toxic smoke released into the atmosphere. The vehicular smoke is found associated with Pb and Pb is raising contamination of environment.

In Pakistan a relatively short food web of soil + water nutrients / contaminants → forage → cow → milk and meat may be hazardous for the consumers as Codex Alimentarius Commission (CAC) has given allowable limits of lead (Pb) in meat of cattle, sheep and poultry (ML 0.05 mg kg^{-1}; lead range 0-0.1 mg kg^{-1}; (CAC 1997–1999). Exposure to high levels of lead is found hazardous to human body, particularly infants and kids who are more susceptible to the detrimental impacts of lead, which can affect their brain development.

Earlier studies have shown that the contents of different metals including Pb, Cu, Zn, Fe, Mn and Cd in soils and grass grown on roadside were on higher levels in both kinds of samples of soil and grass collected from thirty-six sites on the Hong Kong Island. By analyzing linear regression among the logarithmic concentration of the metals under study and the logarithmic traffic flowing volume at those sites expressed that, other than Cd contents of soil, the two were found significantly related (variance ratios' P values < 0.001), hence confirming that the auto vehicles were main source of the above heavy metals near the highway. In roadside samples of soil and grass area wise presence of Pb & Cu was on higher sides, due to contamination mainly occurring in the thickly populated and urbanized part of city with high number of the traffic vehicles were transported. Seemingly, soil and grass samples, both could be indicators to depict the deposition extent of metals aerially on roadside (Ho and Tai, 1988).

Anwar et al. (2020) reported that the plants growing on roadside are deeply contained with heavy metals caused by vehicles' smoke pollution, hence certain physiological disorders and diseases may occur by consumption of vegetation infested with vehicular smoke pollution.

Liu et al. (2020) reported that concentration of Pb fluctuated from 0.28 to 1.12 mg kg^{-1} and 0.31 to 0.83 mg kg^{-1} in cows and buffaloes respectively. Amongst the three organs tested, the highest level of Pb (0.64–0.83 mg kg^{-1}) was found in spleen trailed by Pb (0.28–1.12 mg kg^{-1}) in lungs and (0.36–0.87 mg kg^{-1}) in bones. Additionally, older animals exhibited a significant increase of Pb in them. It was established that Pb accumulation was higher than the standard limit of 0.1 mg kg^{-1} in both age groups of animals. The above bioindicators showed environmental pollution a result of presence of hazardous levels of Pb in cattle and apparent risks for human health. Sound management of hazardous waste is needed in Sargodha district due to its high lead concentration in edible commodities. It obviously indicated to address Pb contamination as well as its probable route of entry into the forage of the domestic animals. Nadeem et al. (2020) reported that the quantities for pollution load index were less than legal value in respect of Pb and Zinc. Similarly, their transfer had less contents indicating that antagonistic effect of metals in soil or plants were resistant to Pb and Zn. Although the metals' daily intake of had lower contents, health risk index values were higher than the legal value that indicated that Pb & Zn were not useful for grazing animals on site of collected samples. EF values were found in order of Pb > Zn and less than standard ones. The results of study showed that irrigation of waste water increased the concentration of both metals at sites of sampling. Jankowski et al. (2019) found that the highest levels of Pb were taken up by *A. pratensis* L. (3.843 mg kg^{-1} DM), and the minimum by *A. elatius* L. (2.523 mg kg^{-1} DM). Among these species of plants, the maximum quantity of Cd (0.286 mg kg^{-1} DM) was found amassed by *D. glomerata* L., further found that root parts accumulated higher contents of Pb & Cd of the grass than leafy ones. It indicated that substantial contents of Pb and Cd exhausted by highway automobiles polluted the soil. Maximum contents of Pb & Cd were accumulated in the grass germinating at five-meter distance from the highway edge, and it was applicable on all parts, whether underground or aboveground. Miclean et al. (2019) reported a noncarcinogenic hazardous impact showed that milk consumption has no risk for human health brought from local markets, but the average cancer risk was potentially existed. Bhuiyan et al. (2016) studied results of vehicle smoke on the environment as many researchers had been already working upon it. The extended vehicle smoke affect used to be observed on Malabar spinach plant and specific forages. Sajid et al. (2017) found that the strength of pathologic adjustments was without delay and associated to the quantitative accumulation of Pb in a range of organs of the animals. The minerals were related with each existence functioning by the manufacturing of hormone, enzymes and alter metabolism due to their movements as coworker. The complexities associated to mineral diet and metabolism might be based on the cure of a mineral connected disorder (Khan et al., 2006, 2007).

Nazir et al. (2015) found that industries manufacturing, mining, farming and transportation sectors resulting from human activities had been releasing high quantities of toxic heavy metals on soils and drinking and irrigation water and eventually to the environment. People drinking contaminated water such cases has to get through certain ailments including of kidney, hair and gastrointestinal tract. Pb had direct function in metabolism, however, it has created toxicity when exceeded from its necessary levels as properly as due to the deficiencies of other hint elements (Farmer and Farmer, 2000; Bibi et al., 2014).

Barik et al. (2014) found that due to vehicular emissions soil porosity diminished upto 10% whilst aggregate ability lowered upto 23%. Zhang et al. (2013) found that roots hold most of the heavy metals that a plant absorbs. Foliage of a plant was once believed to accumulate lead and it might get transferred to different components of plant.

Khan et al. (2013) reported that Pb amounts were found from 1.2 to 3.5 mg kg^{-1} in soil, 0.33 to 0.70 mg kg^{-1} in forage and it was from 0.018 to 0.050 mg L^{-1}, in milk. Its intensity gradually reduced in samples of soil, forage and milk with increasing intervals of sampling. Pb amounts were lower than the allowable limits in both soil and forage as compared to as reported in some studies. Pb amount in cow milk was slightly more than the allowable limit that could be risky for human health and to the health of animal's calves. Mostly. perhaps due to environmental pollution including water, air and soil.

Among the heavy metals released from combustion chromium, zinc and lead are the most common. Lead sulfate is the form of lead found along the roads. The plants found near the road are adversely affected by air pollutants as they are under the continuous exposure of smoke of heavy traffic on the roads (Gupta et al., 2012).

Phillips et al. (2011) found that exposure time to Pb had not affected its proportional absorption ($P = 0.26$) as maximum of Pb was defaecated in faeces or it was accumulated in spleen or bones and excretion of urinary Pb was increased ($P < 0.01$) after a lengthier exposure of six or nine weeks. However, after 6 and 9 weeks of exposure to Pb increased proportional absorption of Cd, as related to three weeks ($P < 0.01$). Afterward longer interval of 9 weeks exposure to Pb, Cd was reduced in kidneys while improved in blood serum. Finally, they resolved that period of Pb exposure had not affected its absorption, and no evidence was existed of protective mechanisms, however, prolonged exposure caused enlarged collection of Cd which resulted in renal amounts higher than the permissible limits. Udiba et al. (2012) found that acceptable restriction for residential areas acquired increased levels due to expanded soil copper and lead amounts around drinking water sources. He additionally found the impact of a range of heavy metals like nickel, zinc and lead alongside with their contrast the forage grasses and different plants, used to be the principal goal of this study. This kind of food regime if taken consistently may want to motive of death. Most poisonous environmental pollution had been cadmium and lead as they lack any particular function in residing our bodies and they accumulate there. Udiba et al. (2012) evidenced that air pollution of ecosystem and environment used to be a major trouble and it was once being more suitable through the extended industrialization, greater use of fertilizers, natural procedures and mining etc. These poisonous chemicals get entered into meal chain. Animals have been studied widely in this regard as they are supposed to be more conveniently affected with the aid of such pollution. Animal get right of entry to protected forage or fodder was very important as it is related to their fitness alongside with the health of human beings feed on animal's milk and meat etc. Kodrik et al. (2011) studied the impact of heavy metals on cow milk and cheese and the metals included were As, Cd, Cr, Cu, Fe, Mn, V, Ni, Pb and Zn. They noticed that Cr, Cu, Fe, V, Mn, Cd, As and Pb levels were higher in the milk collected from areas of concentrated automobiles traffic than the milk originated from unpolluted green regions. While, Cu, Cr, Fe and Pb levels were significantly found higher in cheese samples collected from the highway side as compared to those in non-polluted green area cheese samples. Ahmed and Bibi (2010) suggested the absorption and accumulation of Pb in animals by using feeding on contaminated forage. Thus, heavy metal in this way gets entry into food chain. Kaplan et al. (2010) investigated that now not only under-developed nations appeared sufferer of chemical toxicities however the developed areas of the world additionally cry on the damages that these toxicants reason to them. Pollution in the surroundings ought to be indebted to a variety of elements in which anthropogenic activities play a significant role. Some of these things to do include fossil gas burning with the aid of man, expanded industrialization leading to more production of poisonous wastes, urbanization had improved the use of cars which emit toxic smoke, and mining strategies also performed its part. Most important thing to concern about is the persistent nature of toxic chemical compounds emitting from above cited resources. Saikachout et al. (2009) studied in the Wisconsin State on different forages that were used as feed for the cows and buffalos showed the increased concentrations of the arsenic, chromium, zinc, lead and copper etc. The analysis of forage in another study confirmed the excessive concentrations of lead in the forage samples. Among the entire plant the toxicants have been located greater gathered in the leaves. When the contaminated forages are consumed by animals, they get affected badly by it as by the contaminated forage heavy metals got entered in the cattle body and with the passage of time these metals get accumulated in their bodies (Wagh et al., 2006).

Mor (2006) found that the contents of Cd and Pb contaminated the cattle manures less (who were fed in the far areas from industries, traffic or urbanization), than the cattle manures who were fed nearer to heavy traffic and industries. The highest contents of metals were originated in manure of cattle collected from the heavy traffic region, trailed by the region of industries and the rural areas. Among the livestock feeds studied in the endeavor, the maximum Pb concentration was in grass while the minimum lead was found in the straw samples. Zn along with Pb and Cd disturbed the uptake of the essential nutrients in the plants like Mn. Its higher concentration was accountable to the disturbance of reproduction as well as growth (Rattan et al., 2005).

Viard et al. (2004) found that the expressway tempted the pollution of the nearby environment, and it was found near to 320 meters, and the highest contamination was detected 5–20 m. The amounts calculated in plants in the neighborhood of the expressway were found 2.1 mg Pb kg^{-1} DW, 0.06 mg Cd kg^{-1} DW, 62 mg Zn kg^{-1} DW and the amounts calculated among snails were found 21.3 mg Pb kg^{-1} DW, 5.7 mg Cd kg^{-1} DW, 510.8 mg Zn kg^{-1} DW. The concentrations were found with decreasing trend with distance increasing away from the expressway. The results of the three above metals showed that Pb was appeared the finest metal for contamination evaluation or pollution caused by road transport. Parkpian et al. (2003) showed their findings that plants growing adjoining the expressway were exposed frequently to more accumulations of heavy metal than the plants grown away from the expressway. However, their analysis confirmed that improved farm management practices resulted in substantial reduction of Pb & Cd levels in soil and green forage and ultimately to reduce the Pb and Cd contents in the milk. Lokhande and Bathe (2001) investigated that the waste water application and the vehicle smoke have brought on soil air pollution of two the heavy metals which change the houses of soil. The changed houses of soil motive easy mobility of heavy metals into the plants. Farmer and Farmer (2000) discovered that heavy metals entered into our bodies and milk of the cattle by means of the water they drink and fodder they eat. Fodder acquired contaminated by way of the application of more than a few fungicides, fertilizers, industrial effluents etc. Pirkle et al. (1998) found that various disorders of health were associated with this lead contamination. Most affected part of body damaged by excessive lead was reproductive system. Kidney and liver are the home of these toxicants inside the bodies of organisms and they pose their adverse effects on them. Radostits et al. (1994) found that soils having adequate concentrations of lead were suitable for growth of plants. By using canal water unlike sewage and industrial effluents for the irrigation of various soil products. Hence, forage grown on such soil were not accumulate lead in them and thus pose no risk to consumers taking them as food. But when soil was irrigated continuously by sewage or industrial effluent lead get accumulated in it thus getting mobilized to plants and ultimately to animals and humans. Lead increased concentrations in soil may be due to lead contaminated air, excessive application of industrial effluents, smoke from vehicle and automobiles. And as a result, an excessive concentration of lead gets accumulated in animals' body and also in that of humans. Animals feeding on pastures situated near industrial units, mining communities and road sides get more exposed to heavy metals. Airborne lead and lead taken up by roots of plants affect grazing animals. Major risk on soil contaminated plants was dust from roadside rather than metal uptake.

The current endeavor was designed to determine lead concentration in soil, cow forage, water and cow's blood serum of cows domesticated near automobile transportation and to correlates its results with biochemical and hematological parameters in Sahiwal District Sargodha, Pakistan, with objective to evaluate addition and transfer of Pb in water, soil, forage and animals' blood.

Materials And Methods

The study area was selected Sahiwal, district Sargodha Pakistan. This is an agricultural area where most important crops are grown. The forage chosen for learn about had been *Zea mays, Avena sativa, Trifolium alexandrinum* and *Brassica campestris.* Samples of water, soil, forage and cow's blood were collected.

Collection of samples

Water Samples

All of the samples of water measuring 100 ml were collected by following the method given by AFNOR (1997).

Forage samples

Total one hundred twenty samples of 4 forages had been composed of Maize, Oat, Berseem and *Brassica* from winter season. The sampling procedure was executed as 4 replicates of every forage from each place. Samples of Maize, Berseem, Oat and *Brassica* were collected from the roadsides of Dera Jara, Radhan, Majoka, Sial Sharif and Nehang. The samples from the distant avenue had been amassed from Vijh. All of the samples of forages were subjected to air drying followed by oven drying at 70-75°C for 7 days. From these samples about 2g (Nascimento et al. 2014) with the objective to decide Pb availability in the soil and forage by the use of the Mehlich 1, DTPA, and USEPA 3051 and 3052 methods of extraction. The weighed sample were saved for the additional procedure (Zhang et al. 2010). Forage (0.5 g) used to be digested by means of the usage of 5 mL of HNO_3 (70%) and 1.5 mL of $HClO_4$ (60%). It was heated until the evaporation of brown fumes (Jones, 1991).

Soil Samples

The samples of soil were amassed as two hundred and forty replicates of soil from six websites along with 120 samples from winter season. Each of these (1 kg sample of soil) had been gathered in polythene luggage by digging soil about 15-30 cm deep with the help of shovel. Followed by way of series of samples about 10 g of each sample was once air dried. After air drying samples were followed oven dried for about 70-75^{0}C. From the oven the soil samples were eliminated and after 7 days and till then all the moisture contents from the soil samples have been removed. Then these samples have been beaten using pestle mortar and about 2 g of every sample used to be saved for the additional technique after sieving of all samples. Total contents of heavy metals in soil samples were studied after the digestion of samples. Approximately, 2.5 ml nitric acid, 0.5 ml hydrogen peroxide (30%) and 7.5 ml of hydrochloric acid were applied (Kilburn, 2000).

Blood samples

Total 60 cow blood samples were collected, 12 from Radhan, 12 from Nehang, 12 from Dera Jara, 12 from Majoka, and 12 from Sial Sharif facet. Samples had been gathered in 16×150 mm sealed test tubes. Blood samples of cow have been collected from the major veins of cow in standing condition by using sanitized needle. After collection, blood was positioned in heparinized Na-citrate viols quickly for halting clotting. Blood serum was separated from plasma by using a centrifuge running at 3000rpm for 15 to 30 minutes. The serum was used placed in small labeled viols and stored in freezer at 200°C.

All blood serum samples were organized by wet digestion according to the process of Richards (1968). Briefly, 0.5 ml of serum was used for digestion with 10 ml focused nitric acid in a hundred ml digestion flask initiating at low temperature for 15 to 20 minutes until the contents were clear and followed with 5 ml perchloric acid for 15 minutes. Resultant in the flask was heated strongly until 2-3 ml colorless solution was obtained. After cooling, the contents were diluted to 20 ml bu adding redistilled water in volumetric flask and finally preserved for further analysis.

Apparatus and chemicals and Instrument

Measuring cylinder of 10 ml, salts, pipette of 10ml, volumetric flask of 1000 ml and 100ml, beakers of 500 ml and salts. The chemical substances used in this manner have been of MERCK Company. The digestion of the forage, soil and blood samples used to be followed by using the heavy metal analysis of samples. This analysis was performed after the samples have been diluted the usage of freshly prepared distilled water. Heavy metal analysis used to be performed via the use of Flame Atomic Absorption Spectrophotometer AA 6300 Shimadzu Japan. The atomic absorption spectrophotometry was utilized in the determination of lead concentrations in the samples.

Statistical analysis

Analysis of Variance and correlations was observed by SPSS (Special program for social sciences) software program model No. 20. Variance for lead in soil, feed and water was found through making use of two-way ANOVA. Correlations with Pb concentrations of forage and soil were accounted with Mean value was at 0.05, 0.001 and 0.01 chance stages represented by Steel and Torrie (1980).

Results

ANOVA showed a non-significant impact of sites on the Pb concentration in soil grown with all forages maize, oat, berseem and brassica, and blood and water samples while significant influence of sites was detected on the concentration of Pb in maize (Table 1). Water samples showed Pb concentration in all sites that was ranged from 1.14 mg kg^{-1} to 0.44 mg kg^{-1}. Pb contents were maximum at site 5, and minimum at site 2 Table 2& Fig. 1). Soils samples of all the forages also recorded Pb concentration at all sites and it ranged from 1.58 mg kg^{-1} to 0.279 mg kg^{-1}. The concentration was maximum in Avena sativa grown at site 5, and it was minimum in Zea mays at site 2 (Table 3& Fig. 2). Samples of forages were also contained concentration of Pb and it ranged from 0.048 mg kg^{-1} to 2.002 mg kg^{-1}. The maximum value of concentration of Pb was in Brassica campestris at site 1, while the minimum value of concentration of Pb was in Trifolium alexandrinum at site 2 (Table 4& Fig. 3). Similarly, samples of cow blood showed Pb concentration at all sites that was ranged from 4.468 mg kg^{-1} to 0.217 mg kg^{-1}. Pb concentration was maximum at site 1, while it was minimum at site 3 (Table 5 & Fig. 4).

Table 1
Analysis of Variance of Lead (Pb) in Water, Soil, Forages and cow's Blood at all six sites of sampling

Source Of Variation	Degree Of Freedom	Water	Soil				Forage				Blood
			Z. mays	A. sativa	T. alexandrinum	B. campestris	Z. mays	A. sativa	T. alexandrinum	B. campestris	
Sites	5	0.255ns	0.535ns	0.335ns	0.646ns	0.053ns	0.01*	0.136ns	0.282ns	1.216ns	10.831ns
Error	18	0.124ns	0.219ns	0.497ns	0.440ns	0.361ns	0.017*	0.278ns	0.171ns	0.978ns	10.486ns

Table 2
Mean of Concentrations of Lead (Pb) in Water samples at all six sites

Sites	Mean
1	0.647 ± 0.038
2	0.44 ± 0.056
3	0.54 ± 0.043
4	0.598 ± 0.056
5	1.14 ± 0.034
6	0.832 ± 0.045

Table 3
Mean Concentrations of Lead (Pb) in Soil samples at all six sites

Sites	Soil of *Zea mays*	Soil of *Avena sativa*	Soil of *Trifolium alexandrinum*	Soil of *Brassica campestris*
1	0.703 ± 0.231	1.20 ± 0.264	0.835 ± 0.288	0.515 ± 0.304
2	0.279 ± 0.14	1.05 ± 0.32	1.57 ± 0.045	0.72 ± 0.265
3	0.56 ± 0.223	0.891 ± 0.27	0.967 ± 0.305	0.694 ± 0.323
4	0.897 ± 0.346	0.749 ± 0.152	1.48 ± 0.269	0.741 ± 0.327
5	1.37 ± 0.041	1.58 ± 0.333	0.575 ± 0.237	0.724 ± 0.306
6	0.656 ± 0.289	1.19 ± 0.168	1.40 ± 0.081	0.873 ± 0.269

Table 4
Mean Concentration of Lead (Pb) in forages at all six sites

Sites	*Zea mays*	*Avena sativa*	*Trifolium alexandrinum*	*Brassica campestris*
1	0.322 ± 0.075	0.415 ± 0.135	0.363 ± 0.272	2.002 ± 1.071
2	0.690 ± 0.239	0.277 ± 0.192	0.048 ± 0.011	0.895 ± 0.240
3	0.395 ± 0.185	0.714 ± 0.343	0.422 ± 0.037	0.617 ± 0.321
4	0.092 ± 0.024	0.745 ± 0.299	0.803 ± 0.213	0.576 ± 0.304
5	0.262 ± 0.081	0.589 ± 0.203	0.694 ± 0.343	0.558 ± 0.088
6	0.343 ± 0.105	0.435 ± 0.335	0.431 ± 0.132	0.829 ± 0.238

Table 5
Mean of Concentrations of Lead (Pb) in Cow Blood at all six sites

Sites	Mean
1	4.468 ± 0.044
2	0.322 ± 0.024
3	0.217 ± 0.032
4	0.869 ± 0.058
5	0.503 ± 0.092
6	0.764 ± 0.064

Pollution Load Index (PLI):

PLI for Pb at six sites of irrigation in all forages ranged from 0.03 to 9.19. It was maximum for Avena sativa at site 4, while minimum for Zea mays at site 2. The descending order of PLI at site 1 in all the given forages was Brassica campestris < Zea mays < Trifolium alexandrinum < Avena sativa. The descending order of PLI at site 2 was Zea mays < Brassica campestris < Trifolium alexandrinum < Avena sativa. For site 3, the order of PLI was Zea mays < Brassica campestris < Trifolium alexandrinum < Avena sativa. For site 4, the order of PLI was Brassica campestris < Zea mays < Trifolium alexandrinum < Avena sativa. The order of PLI at site 5 was Trifolium alexandrinum < Brassica campestris < Zea mays < Avena sativa. The order of PLI at site 6 was Zea mays < Brassica campestris < Trifolium alexandrinum < Avena sativa (Table 6)

Table 6
Pollution Load Index (PLI) for Lead (Pb) at all six sites

	Soil of *Zea mays*	Soil of *Avena sativa*	Soil of *Trifolium alexandrinum*	Soil of *Brassica campestris*
Site 1	0.09	1.47	0.1	0.06
Site 2	0.03	1.29	0.19	0.09
Site 3	0.07	1.09	0.12	0.08
Site 4	0.11	9.19	0.18	0.09
Site 5	0.17	1.94	0.07	0.08
Site 6	0.08	1.45	0.17	0.11

Bio Concentration Factor (BCF):

BCF for Pb at six sites of irrigation in all forage samples ranged from 0.03 to 9.95. It was found highest for Avena sativa at site 4 of irrigation, while it was lowest for Trifolium alexandrinum at site 2. The order of BCF for Zea mays at different sites was site 4 < site 5 < site 1 < site 6 < site 3 < site 2. For Avena sativa, BCF at different sites was in the order site 2 < site 1 < site 6 < site 5 < site 3 < site 4. The order of BCF for Trifolium alexandrinum at different sites was in the order site 4 < site 2 < site 3 < site 1 < site 5 < site 6. For Brassica campestris, order of BCF at different sites was site 5 < site 4 < site 3 < site 6 < site 2 < site 1 (Table 7).

Table 7
Concentration of Bio Concentration Factor (BCF) for Lead (Pb) in soils of different forages at six sites

	Zea mays-soil	*Avena sativa-soil*	*Trifolium alexandrinum-soil*	*Brassica campestris-soil*
Site 1	0.46	3.46	0.43	2.85
Site 2	2.47	2.63	0.03	1.73
Site 3	0.71	8.01	0.44	0.89
Site 4	0.10	9.95	0.54	0.78
Site 5	0.19	3.72	1.21	0.77
Site 6	0.52	3.67	0.31	0.95

Daily Intake of Pb (DIM) & Health Risk Index (HRI)

DIM was the highest for Brassica campestris at site 1 while it was the lowest for Zea mays at site 1, 2, 4 and 6 for Avena sativa at site 1, 2, 3 and 6, for Trifolium alexandrinum, 2, 3, and 6, and for Brassica campestris at site 1, 3, 5, and 6. HRI was the highest for Brassica campestris at site 1, while it was the lowest for Zea maysat site 4. The order of health risk index (HRI) for Zea mays at different sites were4 < site5 < site1 < site6 < site3 < site2. For Avena sativa, DIM at different sites was in the order 2 < site1v6 < site5 < site3 < site4. For Trifolium alexandrinum at different sites the order2 < site1 < site3 < site6 < site5 < site4. For Brassica campestris, order of DIM at different sites was5 < site4 < site3v6 < site2 < site1.

Table 8
Concentration of Daily Intake of metals & Health Risk Index for Lead (Pb) in soils of different forages at six sites

Study Sites	Daily Intake of metals & Health Risk Index	*Zea mays-soil*	*Avena sativa-soil*	*Trifolium alexandrinum-soil*	*Brassica campestris-soil*
Site 1	DIM	0.01	0.01	0.01	0.03
	HRI	0.18	0.24	0.21	0.84
Site 2	DIM	0.02	0.01	0.01	0.02
	HRI	0.39	0.16	0.03	0.51
Site 3	DIM	0.01	0.02	0.01	0.02
	HRI	0.23	0.41	0.24	0.35
Site 4	DIM	0.01	0.02	0.02	0.01
	HRI	0.05	0.42	0.46	0.33
Site 5	DIM	0.01	0.01	0.02	0.01
	HRI	0.15	0.34	0.4	0.32
Site 6	DIM	0.01	0.01	0.01	0.02
	HRI	0.2	0.25	0.25	0.47

Discussion

To keep protection against exposures of lead, the Codex has framed latest limits of contamination of lead found in food. Exposure to high levels of lead is hazardous to human body, particularly infants and children are susceptible to the detrimental effects of lead, which can impact their brain development. In Pakistan a relatively short food web of soil + water nutrients / contaminants → forage → cow → milk and meat may be hazardous for the consumers as Codex Alimentarius Commission (CAC) has given permissible limits of lead in meat of cattle, sheep and poultry (ML 0.05 mg kg^{-1}; lead range 0-0.1 mg kg^{-1}; (CAC 1997–1999). The instant endeavor has given Pb values to higher sides in blood of cow as compared to CAC which can be associated with meat of cow. However, it depends on the daily intake of the meat. Hence care is mandatory to keep avoid risks to human health.

Additionally, most of the results were in conformity with the earlier work with few exceptions, conducted by above authors viz., Viard et al. (2004), Mor (2006), Parkpian et al. (2003), Kodrik et al. (2011), Miclean et al. (2019) and Liu et al. (2020).

Conclusion

Lead found in current study is the hazardous metal for human and animal health but luckily its contents are below the dangerous levels on the basis of daily intake as described by CAC. However further studies are imperative to investigate harmful effects of Pb transferred from animals and their products in local conditions.

Declarations

Ethical Approval:

Ethical approval was taken from Department Ethical Review Committee to conduct study as animals were involved in this study So ethical approval was very essential

Consent to Participate:

Informed consent was taken from formers to conduct the study and to collect the samples. They were briefed about the research plan in details.

Consent to Publish:

Written consent was sought from each author to publish the manuscript.

Authors Contributions:

Tasneem Ahmad, Zafar Iqbal Khan and Kafeel Ahmad conceived and designed the study and critically revised the manuscript and approved the final version. Zunaira Munir executed the experiment and compiled data. Muhammad Nadeem statistically analyzed the data and help in chemical analysis. Ijaz Rasool Noorka interpreted the results and wrote manuscript. Sonaina Nazar critically edited and revised the manuscript. Ifra Saleem Malik ,Mudasra Munir and Asma Ashfaq helped in sample collection and chemical analysis

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Competing Interests:

There is no competing interest in the publication of this manuscript.

Availability of data and materials:

Data and material is available for research purpose and for reference.

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Figures

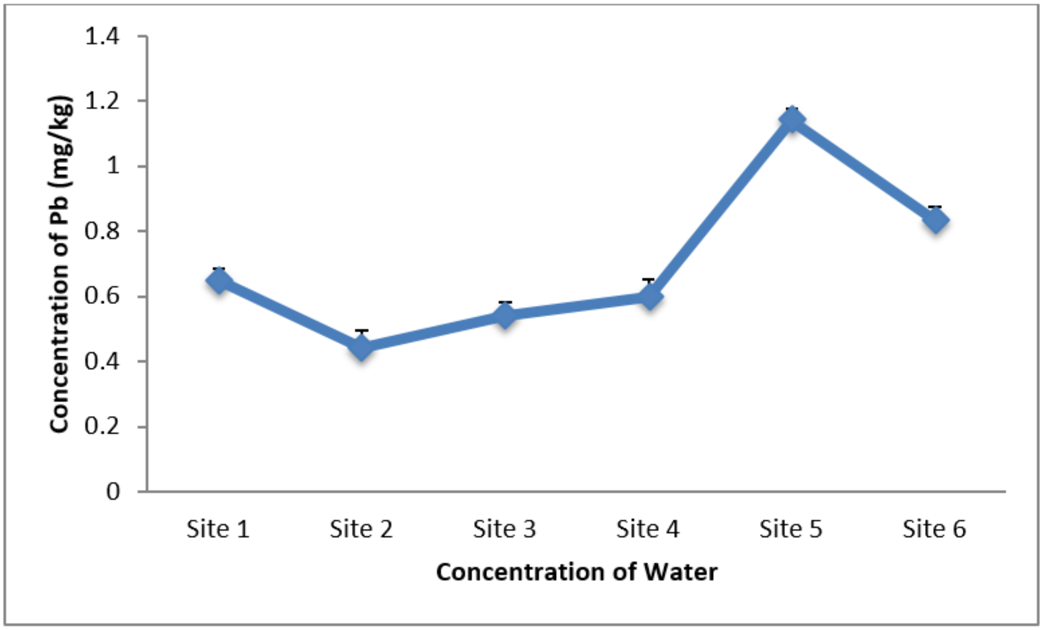

Figure 1

Lead (Pb) Concentration in Water at all six sites of sampling

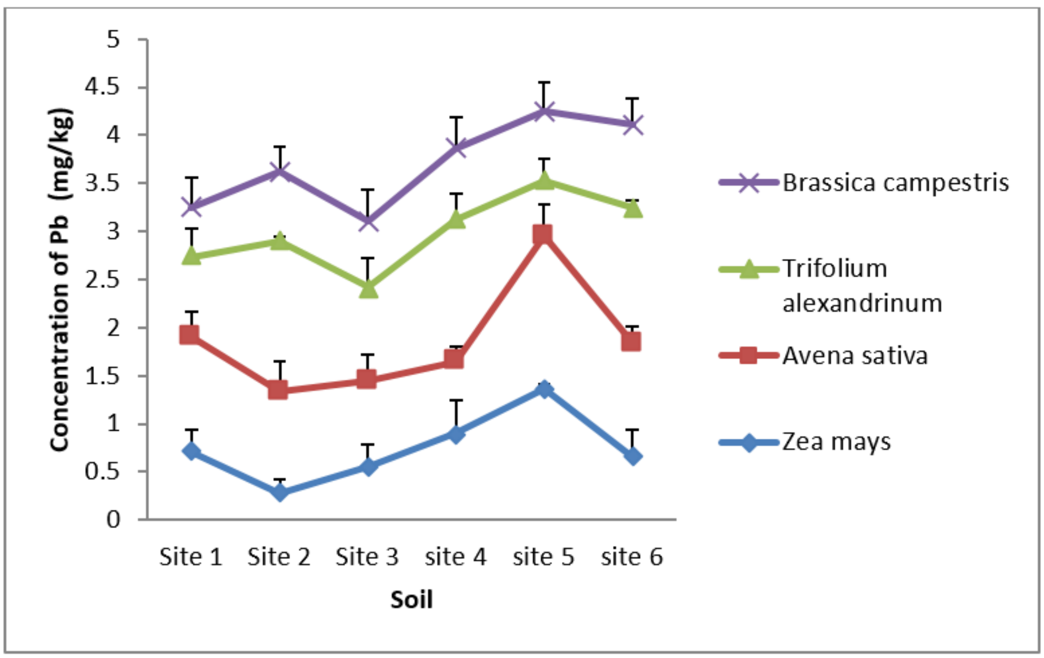

Figure 2

Lead (Pb) Concentration in Soil at all six sites of sampling

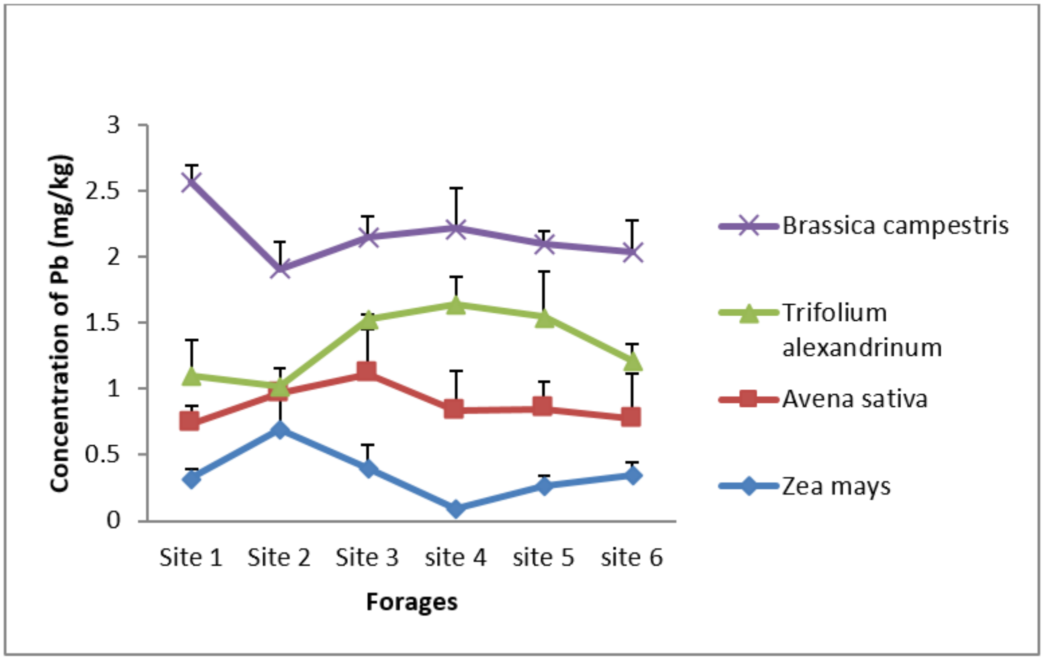

Figure 3

Lead (Pb) Concentration in Forages at all six sites of sampling

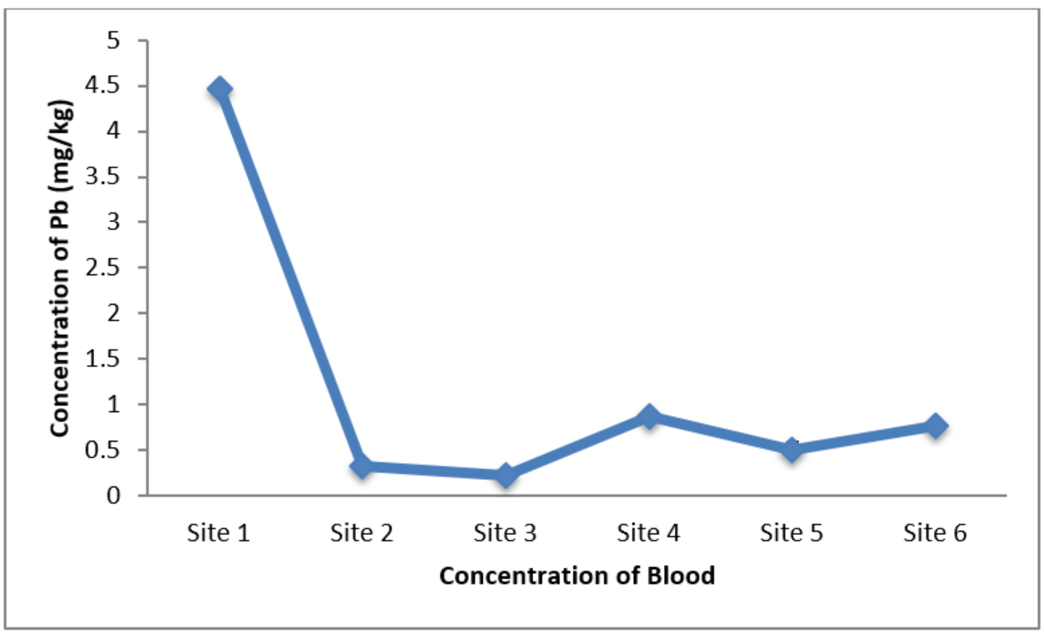

Figure 4

Lead (Pb) Concentration in Cow Blood at all six sites of sampling