Assessment of Chromium and Nickel in Common Members of Cereals

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Summary: The present study is conducted to determine the concentration of Chromium and Nickel accumulation, in soil and cereals near industrial areas, where untreated mixture of industrial effluents and sewerage is used. Chrome compounds are included in the category of heavy metals derivatives and thus a part of a group, which must kept out of the environment. Excessive accumulation of these metals in agricultural soils may not only result in environmental contamination, but elevated metals uptake by crops may also affect food quality and safety. Assessment of these toxic metals is probably the most useful aspect. That in the future, we may find even better ways to measure, treat, and prevent this dangerous heavy metal contamination. The Atomic Absorption technique was applied for the estimations of chromium and nickel conducted on the samples collected from different areas. It is concluded that the high levels of chromium and nickel found in cereals, which was irrigated by industrial waste and sewage water.

Introduction

Many factors determining the health both of individual and communities in which they live include personal hygiene, health care, quality of food and environment [1].

Today through urbanization and growth of population or by introduction of industries and employment of auxiliary means in agriculture have disturbed or even destroyed the natural quality of water bodies. These water bodies have become unsuitable for many beneficial uses for which they were utilized earlier [2].

Contaminated drinking food and water [3-4] has direct effect on human beings while sewerage; canal water and industrial effluents have indirect effect on crops, vegetables and cereals irrigated with polluted water, which become harmful to humans and animals.

Toxic metals are widely found in our environment. Human are exposed to these metals from numerous sources, including contaminated air, water, soil and food [5]. Heavy metals include both essential and toxic minerals. It is well known that an essential metal becomes toxic at sufficiently high intakes [6]. It is therefore necessary to test community water for harmful toxic metals [7].

Chrome compounds are included in the category of heavy metals derivatives and thus a part of a group, which must be kept out of the environment. It particularly in the hexavalent state is toxic to man and produces lung tumors when inhaled and readily induces skin sensation [8]. Chromium occurs in some food, in air including cigarette smoke and in some water supply [9] due to passage of corrosive water through steel pipes or plumbing containing chromium. The toxicological end points of chromium are categorized into (i) organ toxicity (ii) reproductive toxicity (iii) genetic toxicity and (iv) carcinogenicity [10].

In the course of recent years, proposals for chrome substitution and also chrome saving have been made again and again for many research groups of tanners but nevertheless nothing have been accepted in practice [11].

Cr is an essential nutrient for plant and animal metabolism (glucose metabolism, amino nucleic acid synthesis). However, when accumulated at high levels, it can generate serious trouble and diseases (nausea, skin ulceration, lung cancer) and as concentration reaches .0.1mg/g or 100 ppm body weight, it can become lethal [12-13].

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The major sources of Chromium are steel works, chrome plating, leather tanning industries [14]. Chromium(III) is poorly absorbed, regardless of the route of exposure, whereas chromium(VI) is more readily absorbed. Humans and animals localize chromium in the lung, liver, kidney, spleen, adrenals, plasma, bone marrow, and red blood cells (RBC) [15-16].

Nickel is one of the essential trace element for human an animal health. It is present in body tissues even before birth. In living system, it is associated with DNA and RNA molecules are a regulatory element for the various enzyme systems [17]. These biochemical requirements of Ni are however, small and excessive intakes Ni produce deleterious effects. It causes blindness and respiratory tract disorder both in human and animals [18].

Nickel mainly used in the production of stainless steel and nickel alloys, is possibly carcinogenic in metallic form. However, where water that has stood for an extended time in water pipes, the nickel contribution from water may be significant [19].

This investigation was undertaken to assess the build up of chromium and Nickel in water, soil and plants. Moreover, to educate the local people, based mainly on the effect of heavy metals on soil, water quality, human health, crop yield and quality.

Results and Discussion

The present study was carried out to determine the concentration of Chromium and Nickel in water, Soil and cereals samples. Tables 1-4 present the concentration of Chromium and Nickel in cereals collected from different areas of Lahore and Kasur(selected because of the different irrigation categories of water i.e. under ground, canal, sewage and industrial) based on the sources of irrigation. The sampling places (Map) are shown in Fig 1.

Table 1 gives the concentrations of Chromium and Nickel in the cereals irrigated by strictly under ground water. Minimum concentration of Chromium and Nickel was in Water samples, which were 0.052 and 0.02 respectively. Maximum concentration was in the soil that is 124.03 of Cr and 26.17 of Ni in *Triticum aestivum* and *Hordeum vulgare.* As for as plant is concerned roots show maximum uptake of 107.53 Cr, 17.4 Ni in *Triticum aestivum* and 115.0 Cr, 13.0 Ni in *Hordeum vulgare*, indicating that *Triticum aestivum* absorb more than *Triticum aestivum.*

Table 2 gives the concentrations of Chromium and Nickel in the cereals irrigated by strictly canal water. The results are same as in category A, Minimum concentration is in water samples 0.495 Cr and ND Ni. Maximum concentration was in soil samples, which are 196 Cr and 47.3 Ni. And the root samples appeared to be richer in Chromium and Nickel contents when compared with the other parts of plant.

Table 3 shows the metal concentration in water, soil and plant samples irrigated by sewage water waste. The maximum concentration was noted in the soil sample, which was 551.66 Cr and 52.2 Ni

Table 1: Cr and Ni Concentrations (ppm) in Soil, Water and Cereals of Category A.

Sr. No.	Sample I Sample	(Triticum Conc. Cr(ppm)	aestivum) Conc. Ni(ppm)	Sample II Sample	(Hordeum Conc. Cr(ppm)	vulgare) Conc. Ni(ppm)
1	Water	0.052	0.02	Water	0.052	0.02
2	Soil	124.03	26.17	Soil	124.03	26.17
3	Root	107.53	17.4	Root	115.0	13.0
4	Stem	85.44	14.95	Stem	90.05	9.0
5	Leaves	76.25	15.6	Leaves	41.3	14.0
6	Grains	I04.35	8.05	Grains	51.71	3.74

Table 2: Cr and Ni Concentrations (ppm) in Soil, Water and Cereals of Category B.

Sr. No.	Sample I Sample	(Triticum Conc. Cr(ppm)	aestivum) Conc. Ni(ppm)	Sample II Sample	(Hordeum Conc. Cr(ppm)	vulgare) Conc. Ni(ppm)
1	Water	0.495	ND	Water	0.6495	ND
2	Soil	196.0	47.3	Soil	196.0	47.3
3	Root	154.54	39.25	Root	155.05	12.15
4	Stem	137.05	28.0	Stem	143.08	8.9
5	Leaves	188.74	28.04	Leaves	145.0	11.32
6	Grains	182.18	37.6	Grains	120.32	10.4

Table 3: Cr and Ni Concentrations (ppm) in Soil, Water and Cereals of Category C.

Sr. No.	Sample I Sample	(Triticum Conc. Cr(ppm)	aestivum) Conc. Ni(ppm)	Sample II Sample	(Hordeum Conc. Cr(ppm)	vulgare) Conc. Ni(ppm)
1	Water	1.247	0.901	Water	1.247	0.901
2	Soil	410.73	297.20	Soil	410.73	297.20
3	Root	197.95	63.55	Root	332.46	63.55
4	Stem	166.12	29.90	Stem	176.0	29.90
5	Leaves	188.74	29.90	Leaves	195.9	29.90
6	Grains	127.54	14.95	Grains	146.38	26.17

Table 4: Cr and Ni Concentrations (ppm) in Soil, Water and Cereals of Category D.

Sr. No.	Sample I Sample	(Triticum Conc. Cr (ppm)	aestivum) Conc. Ni(ppm)	Sample II Sample	(Hordeum Conc. Cr (ppm)	vulgare) Conc. Ni(ppm)
1	Water	1.521	1.03	Water	1.521	1.03
2	Soil	551.66	52.22	Soil	551.66	52.22
3	Root	410.3	42.05	Root	212.0	41.9
4	Stem	332.46	40.95	Stem	153.0	38.6
5	Leaves	351.40	46.8	Leaves	156.89	38.7
6	Grains	316.25	49.81	Grains	186.46	41.12

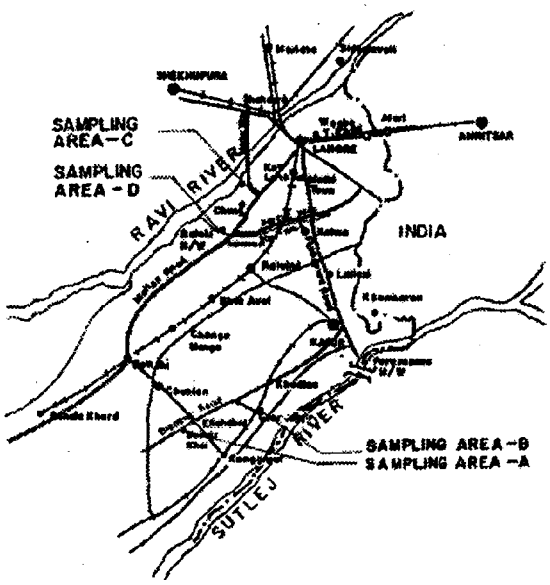

Fig 1: Map of Sampling Area

being the highest of all samples of category C. In addition, the minimum concentration was noted in the water sample (1.427 Cr and 0.90 Ni). And the root samples appeared to be richer in Chromium and Nickel contents when compared with the other parts of plant.

Table 4 shows the metal concentration in water, soil and plant samples irrigated by industrial water waste. The maximum concentration was noted in the soil sample, which was 551.66 & 52.22 of Chromium and Nickel. Moreover, the minimum concentration was noted in the water sample, which was 1.521 and 1.03 of Cr and Ni. The concentration of Cr and Ni in the grain samples were 316.25and 49.81 in *Triticum aestivum* and 186.46 &41.12 in *Hordeum vulgare.*

Graph 1 (Fig 2) indicating the content of Cr and Nickel in irrigation water ranges from 0.05 to 1.521 ppm and 0.02 to 1.03 ppm respectively. WHO standard for Cr is 0.05 ppm and according to U.S.EPA 1975 0.1 ppm in drinking water. In the rural areas, people use same water for irrigation as well as for drinking purpose. The people who use water-containing Chromium in excess over many years could experience many problems. WHO standard for Ni is 0.02ppm in drinking water.

Experimental

Selection of Sampling Locations

Four categories, providing a mixture of communities, were selected across Lahore and kasur .Selection was based on sources of irrigations. These categories are

Category A under ground water
Category B canal water
Category C sewage waste water and
Category D industrial wastewater

Triticum aestivum and Hordeum vulgare were selected for analysis as they are commonly used

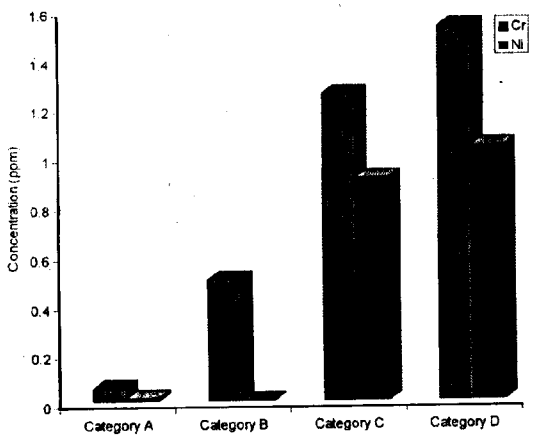

Fig 2: The concentration of Cr and Ni in irrigation water.

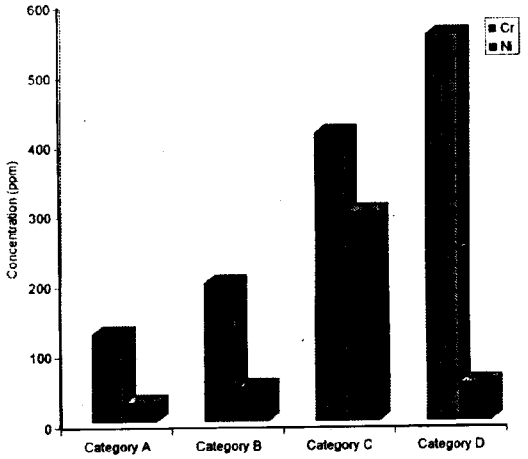

Fig 3: The concentration of Cr and Ni in Soil.

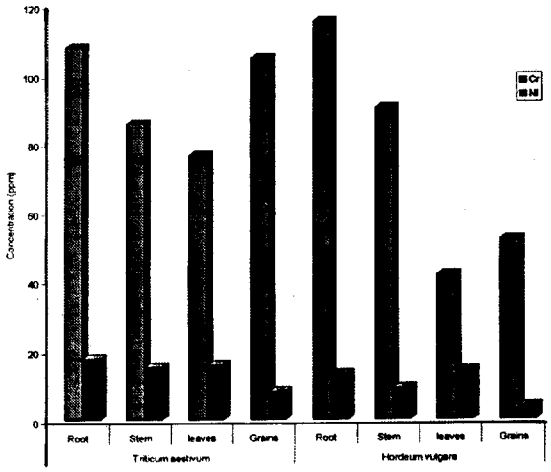

Fig 4: Concentration of Cr and Ni in cereals of category A

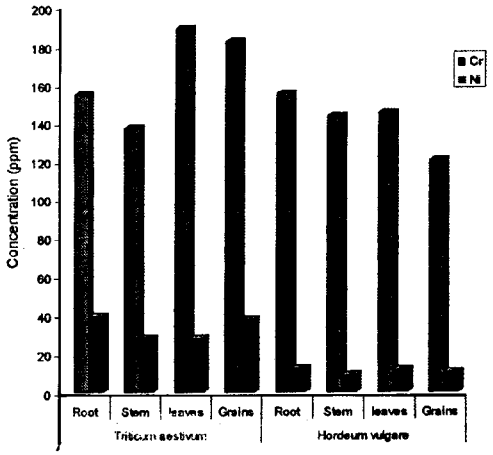

Fig 5: Concentration of Cr and Ni in cereals of category B

cereals in daily routine. All the samples were collected during day and were stored in a polythene bags. Samples of cereals were washed with distilled water. The roots, stems and leaves of cereals were then cut with knife and collected separately. The separated portions were further chopped to small slices or pieces in order to dry them properly.

The chopped samples were dried in electric oven at 90°C with constantly weighing till the evaporation of water content from them. The soil samples were also dried at the same temperature. The dried samples were packed in glass bottles. Dried cereal samples were grinded by electric grinder. After grinding, the samples were saved in sample tubes.

Digestion and Solution Preparation

The dried, grinded samples were digested by means of Wet Digestion method, in order to estimate the concentration of essential and toxic elements.

Procedure

2 g of dry grinded cereals (root, stem, leaves and grain s) water and soil samples separately were

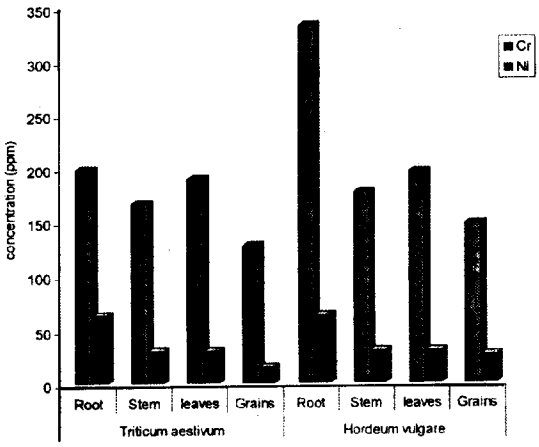

Fig 6: Concentration of Cr and Ni in cereals of Category C.

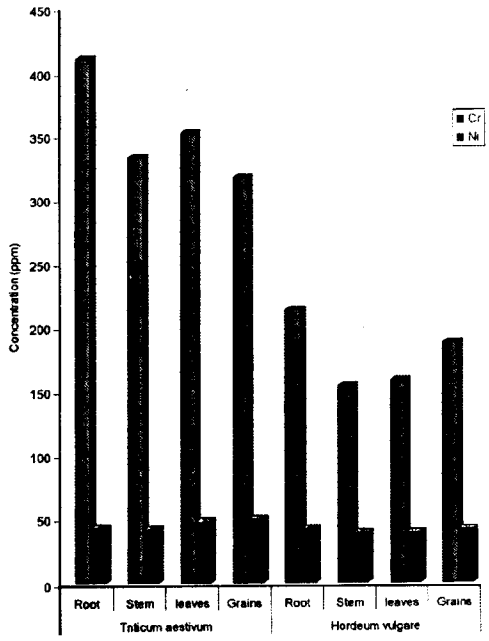

Fig 7: Concentration of Cr and Ni in cereals of Category D

taken in a china dish, 15 ml of concentrated Nitric Acid was added into the sample in china dish and is placed on sand bath with in a fuming cupboard. The samples were then boiled in this nitric acid for about 1.5 hour until thick slurry or gummy mass of sample was formed. The slurry was then cooled and poured into 50 ml cold distilled water in a beaker. The contents in the beaker were shaken well and filtered. The volume of filtrate was made 100 ml by distilled water in 100 ml measuring flask. [13]

The solutions made by this method were poured into 100 ml measuring flasks for future analysis on UNICAM-969 Atomic Absorption Spectrophotometer.

Conclusions

Results showed that soil contain maximum deposits of Ni and Cr as compared to water samples. In plants maximum conc. was found in root samples[(Category A Sample I-107.53ppm, Sample II-115.0ppm), (Category B Sample I-154.54ppm, Sample II-155.05ppm), (Category C Sample I-197.95ppm, Sample II-332.46ppm), (Category D Sample I-410.3ppm, Sample II-212.0ppm)] as compared to the other part of the plants. Cr is maximum in soil sample of Category D[Sample I-551.66ppm, Sample II-551.66ppm], which was industrial waste and then in Category D, which was sewage waste. While Ni was maximum in sewage waste water. Comparison graphs for the conc. of Ni and Cr for water, soil and cereal samples are given in Fig 2 to 7. Fig. 1 gives the comparison in the concentration of Ni and Cr in irrigation water, it show that Cr is in high conc. in all of the categories as compared to Ni, in category A both Cr and Ni are in small amounts but in category D both are in large amounts. But in soil sample Ni is present in small amount but Cr is again in high concentration, in category C both are in high conc. In cereal samples Cr was in high concentration (given in Fig. 4).

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