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Heavy Metal Ions Concentration in Wheat Plant (*Triticum aestivum* L.) Irrigated with City Effluent

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Pakistan lies under arid and semi arid zones. There is shortage of water for irrigation. Farmers near being cities raise crops by diverting the city effluent towards their fields. It contains heavy toxic metal ions like cadmium, chromium, cobalt and nickel, which may accumulate in the edible portion of crops and cause clinical problems to human being. The concentration of metal ions in the effluent and effluent irrigated wheat (*Triticum aestivum* L.) was determined by Atomic Absorption Spectrophotometer. Heavy metal ions (Cd, Cr and Co) mean concentrations were found above the permissible limits recommended for irrigation water. In the grains of wheat plant concentration of Cd, Cr and Co was found above the permissible levels recommended by World Health Organization (WHO) for foodstuff.

Key words: Wheat plant, *Triticum aestivum* L, City effluent, Toxic metal, Atomic absorption spectrophotometer.

Introduction

The climate of Pakistan is mainly subtropical arid to semiarid in more than 90% of the total geographical area. Annual rainfall is variable, with less than 10 cm in some parts of the country and more than 50 cm near the foothills of the Himalayas. Average annual rainfall in the arid and semiarid areas is around 20 cm, which is not sufficient for growing any crops of economic importance. In order to overcome this situation, city effluent is used for raising crops around big cities (Khan *et al* 1994).

City effluent contains heavy metals like cadmium, chromium, cobalt and nickel, along with a source of irrigation and nutrients (Ghafoor *et al* 1994). These heavy metals may accumulate in the edible portion of the crops and enter the human food chain causing different clinical problems. This all is due to effluents coming from various industries situated in the urban areas. Usually, a few industries are equipped with satisfactory operating treatment plants (Nabi *et al* 2001). City effluent, which carries heavy metals when used for raising crops, may cause environmental threat.

Many industries dispose off effluent via the open and covered routes into the main channels, which also carry domestic water. Farmer's fields near these channels are irrigated with this polluted effluent for raising crops (Ghafoor *et al* 1994). The object of study was to know the level of heavy metals in liquid effluents being used as an irrigation source. By the study awareness among the people would be raised, involved in discharging city and industrial effluents.

Presently, much work has not been done in Pakistan for the metal ion contamination of crop raised by utilizing city effluent for irrigation. Study was carried out in order to evaluate the metal ion concentration and its suitability for the irrigation purposes. Level of metal ions in the crop grown was also evaluated for its suitability for human consumption.

Materials and Methods

The city effluent samples were taken from open channel flowing alongwith Satiana Road out of Faisalabad city for analysis. Four localities were selected where farmers grow wheat (*Triticum aestivum* L.) by irrigating fields with city effluent from more than 15 years due to shortage of canal water and poor quality of under ground water (i.e. they mixed city effluent with canal water if available or cyclic use one irrigation with city effluent and other with canal water but from more than 5 years they are mostly depending on city effluent for irrigation). Mean pHs (Saturated paste pH) from all four sites was 7.80, 7.90 and 8.03 at 0-15 cm, 15-30 cm and 30-60 cm depth, respectively. The selected fields were located in the vicinity of Gandakhue, Mulkhanwala, Awanwala and Kanuwala areas. The effluent being used for irrigation at a particular site was sampled on weekly basis for six weeks. The effluent samples were analysed for toxic metal ions namely Cd, Cr, Co and Ni on Varian AA-1445 series Atomic Absorption Spectrophotometer (AOAC 1984).

On maturity stage of crop grain, straw were separated in wheat (*Triticum aestivum* L.) plant. Samples were digested in di-acid mixture (10 ml concentrated HNO_3 + 5 ml of $HClO_4$). Concentrations of above mentioned heavy metals were determined by a Varian AA-1445 series Atomic Absorption Spectrophotometer (AOAC 1984).

Table 1
Heavy metal ions concentration (ppm) in effluent

Area	Cd		Cr		Co		Ni	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Gandakhu	0.01 - 0.04	0.02	0.30 - 0.54	0.41	0.06 - 0.21	0.12	0.07 - 0.21	0.14
Malkhanwala	0.01 - 0.04	0.02	0.30 - 2.14	1.00	0.08 - 0.21	0.13	0.02 - 0.25	0.14
Awanwala	0.01 - 0.05	0.02	0.07 - 0.88	0.38	0.09 - 0.23	0.14	0.07 - 0.26	0.15
Khanuwala	0.01 - 0.03	0.02	0.16 - 1.29	0.60	0.08 - 0.24	0.15	0.03 - 0.26	0.16

Table 2
Heavy metal ions concentration (ppm) in wheat (*Triticum aestivum* L.) plant by effluent irrigation

Area	Cd		Cr		Co		Ni	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Gandakhu	0.50	0.50	13.50	32.00	2.50	5.00	8.00	9.50
Malkhanwala	1.00	1.00	13.50	32.00	2.50	2.50	6.00	16.50
Awanwala	0.50	1.00	9.00	36.50	4.00	3.00	5.00	9.50
Khanuwala	0.50	0.50	9.00	30.00	2.50	2.00	8.00	5.00

Results and Discussion

Cadmium. Major sources of Cd in effluents are industries related to electroplating, pigments for plastics and paints, plastic stabilizer and batteries (Brady 1996).

Cadmium mean concentration in effluent was 0.02 ppm (Table 1). As shown in Fig 1, in all samples Cd concentration was at or above the critical level of 0.01 ppm for irrigation water suggested by FAO (Ayres and Westcot 1985).

In the case of wheat plants, Cd concentration was found at same level in both straw and grains except in the case of wheat plant sampled from one site where higher concentration (1.00 ppm) was accumulated in grain as compared to straw (0.50) ppm) as shown in Table 2. In the grains, concentration was found above the critical level of 0.01 ppm for foodstuff (WHO 1996).

It was observed from the results that concentration of Cd was higher in the crop irrigated by city effluent. Similarly, Cd concentration in foodstuff was sufficiently high to cause clinical problems like severe nausea, salivation vomiting, diarrhoea, abdominal pain and neuralgia (Prasad 1978; WHO 1996).

Chromium. Major sources as in the city effluent are from the tanning industry, manufacture of catalyst, pigments/paints, fungicides, ceramics, glass, photography chrome alloy/metal production/plating and corrosion control (WHO 1996).

The mean concentration of Cr in effluent samples was in the range of 0.38 to 1.00 ppm (Table 1). As illustrated in Fig 2, almost samples had Cr concentration above critical level of 0.10 ppm recommended for irrigation by FAO (Ayres and Westcot 1985).

Chromium concentration in straw was in the range of 30.00 to 36.50 ppm, while in case of grains it was in range of 9.00 to 13.50 ppm taken from all four sites (Table 2). Higher concentration was accumulated in the leaves. Its mobility from leaves to grain was low. In the grains, its concentration was found higher than permissible level of 1.30 ppm in food stuff (WHO 1996).

In general, Cr (VI) salts are more soluble than those of Cr (III) making Cr (VI) relatively mobile. This salt causes different diseases like lung cancer, gastrointestinal upsets, hepatitis, ulcer, edema when comes into human food in excessive quantity (Prasad 1978; WHO 1996).

Cobalt. The dominant form of cobalt in water is Co^{+2}. Cobalt compounds are mostly used in industries related to ceramics, glass, varnishes, ink, pigments, fabrics, paints and electroplating (Kirk - Othmer 1964).

Cobalt means concentration in effluent samples was 0.12, 0.13, 0.14 and 0.15 ppm from four respective sites (Table 1). Cobalt concentration in all samples as illustrated in Fig 3 was found higher than critical level of 0.05 ppm given by FAO (Ayres and Westcot 1985).

Cobalt concentration in straw taken from all four sites was in the range of 2.00 to 5.00 ppm while in case of grains it was in order of 2.50 to 4.00 ppm (Table 2). It was found above critical level of 0.01 ppm suggested for foodstuff (WHO 1996).

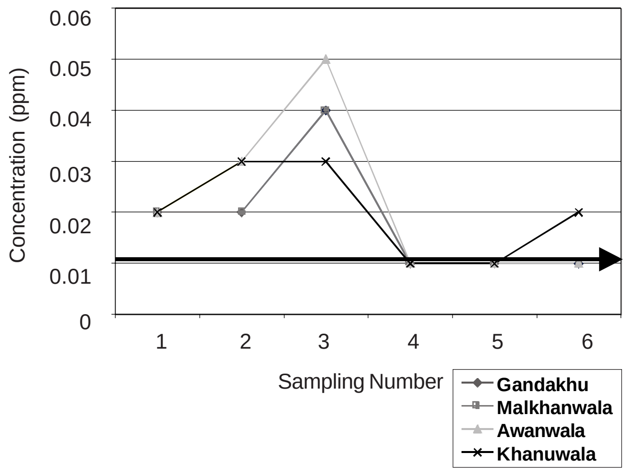

Fig 1. Trend of cadmium concentration in effluents.

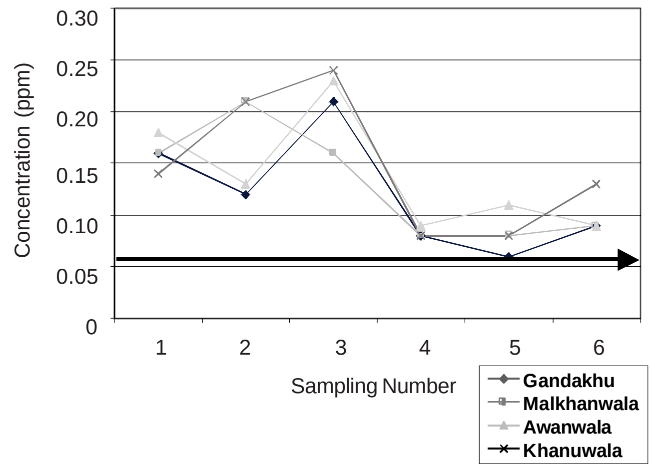

Fig 3. Trend of cobalt concentration in effluents.

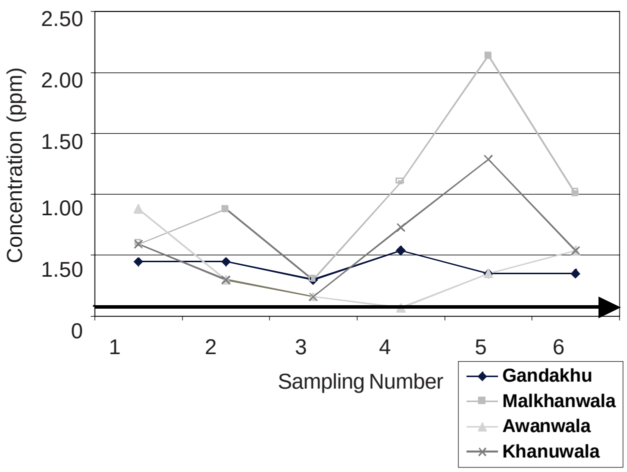

Fig 2. Trend of chromium concentration in effluents.

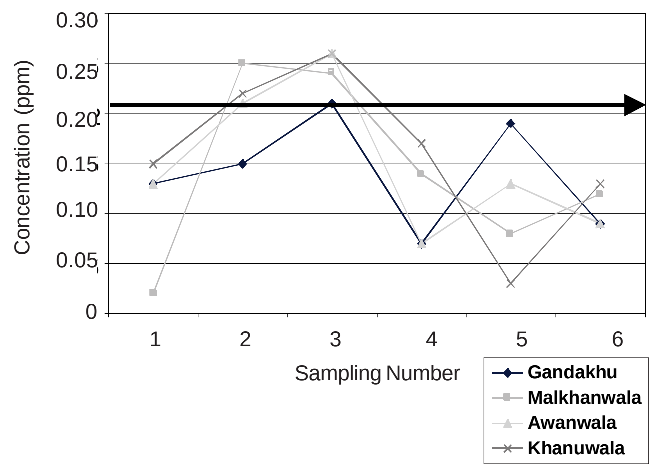

Fig 4. Trend of nickel concentration in effluents.

It causes different diseases like vomiting diarrhoea, blood pressure, giddiness and damage to nerves when comes into human food in excessive amount (Asthana and Asthana 2001).

Nickel. Major sources of Ni are combustion of coal, gasoline was well as industries related to oil, alloy manufacturing, electroplating and batteries (Brady 1996).

Concentration of nickel in effluent was 0.14, 0.14, 0.15 and 0.16 ppm from four sites, respectively (Table 1). Most of the effluent samples have concentration below critical level (0.20 ppm) as shown in Fig 4 suggested by FAO (Ayreas and Westcot 1985).

Nickel concentration in the wheat samples was in the range of 5.00 to 16.50 ppm in straw and 5.00 to 8.00 ppm in the grain sampled from four sites (Table 2). Nickel was found below the permissible level of 10.00 ppm given for food-stuff (WHO 1996).

It can cause different diseases like nausea, vomiting, abdominal discomfort, diarrhoea, giddiness, headache, cough and shortness of breath if come into human food chain in excessive concentration (Prasad 1978; WHO 1996).

Conclusion

City effluent is not suitable for raising crops because it is heavily loaded with metal ions, which through food cause different disease. Unsuitability of city effluent is due to the industrial water, which is drained out in the domestic sewage water without treatment. Industrial water should be treated before disposed off in the domestic sewage channels and along with this zero-effluent system should be adopted in industries.

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