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Original Research Paper

Impact of City Effluent on Agricultural Land at Sharafi Goth, Malir – Karachi

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ABSTRACT

It is a common experience in Pakistan that untreated city effluent is generously used to grow vegetable in urban areas to provide fresh vegetables to the inhabitants of bigger cities. By keeping this fact in view a research study was conducted in Sharafi Goth, Malir, Karachi, Sindh–Pakistan to ascertain the quality of city effluent used for irrigation and simultaneously its effect on soil and vegetables. Effluent samples from site was regularly collected from October 2012 to April 2013 along with soil samples at 0-6, 6-12, 12-18, 18-24, and 24 – 30 inches soil depths. Likewise, vegetables samples (leaves and fruits) were also collected separately. All the samples were analyzed for physical and chemical properties and detection of heavy metals was also carried out. The standard of irrigation water was adjudged keeping in view Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), and Residual Sodium Carbonate (RSC). It is detected that all these factors found beyond allowed limits. The results achieved from the chemical analysis of the samples revealed that heavy metals concentration was found in higher side at Sharafi Goth. Cadmium, Arsenic and Lead were found in samples collected from the city effluent beyond the specified limits. It was revealed that the heavy metal accumulation on the edge of increase in leaves as compared to respective fruits, Pb deposit were more prominent as compared to Cd and Ar. The amount of Cd and Ar used to decrease with increase in soil depth. The injudicious use of untreated sewage water for irrigation purpose may constitute serious repercussion, that is, consumption of subject crops is a great hazard to animal and human health which necessitate to stop it immediately.

Key words: City Effluent, Agriculture, Heavy Metals, Vegetables, Irrigation, Water Quality, Malir, Karachi.

INTRODUCTION

In developing countries like Pakistan, generally untreated city effluent is used to irrigate the urban land around big cities in order to grow forest, vegetables, and fruits, etc. Knowingly that contaminated effluent is rich in metal pollution due to which toxicity of metals ions become the integral part of different cultivated commodities (Zafar *et al.,* 2015). The severity of situation is neglected at both ends by farmers and concerned quarters which take it as

Figure 1. Map of Sharafi Goth, Karachi, Sindh – Pakistan.

viable option for disposal of waste water. Ensuing fertility of soil, quality of crop and above all the health of the people is at stake (Kafeel *et al.,* 2014). The current industrialization is adding in the pertinent context with a greater vigor and velocity as industrial waste is far more dangerous as it contains diverse pollutants (Maria *et al.,* 2007). These pollutants are very rich in Mn, Cu, Zn, Pb, Cr, Ar, Ni, Cd, and Co, when the polluted water is used regularly to grow vegetable, these heavy metals ions are accumulated in a phenomenon known as phytotoxic concentration which becomes unfit for human health (Sharma *et al.,* 2009). At this stage ample information are available, however the present research work has open new doors to proceed ahead and enhance expertise to ensure safe healthy cultivation of vegetables taking into account Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), and Residual Sodium Carbonate (RSC) and heavy metals and their adverse effect on soil and cultivated crops.

MATERIALS AND METHODS

In Pakistan, untreated contaminated city effluent is disposed through open and covered drainage channels. Simultaneously, this contaminated water is provided to farm to irrigate their land to grow vegetables. For subject research, the agricultural lands which were irrigated by waste water for more than 25 years were selected. The sampling fields were situated in Sharafi Goth, Malir, Karachi District, Pakistan (Figure 01). Samples of irrigating water, soils and plants were collected to carry out research during the span of October 2012 to April 2013. Soil characteristics, metal ions concentration in soil were analyzed, which need more research in subject area.

Effluent Sampling

Samples from subject area channels supplying effluent were collected for test regularly after 7-10 days. Various laboratory tests were carried out to find out EC, SAR, RSC, pH, Cd, Ar, and Pb. All these parameters were analyzed by U.S. Salinity Lab. Staff standards.

Soil Sampling

Soil samples were drawn on composite basis from different agricultural fields of Sharafi Goth at 0-6, 6-12, 12-18, 18-24, and 24 – 30 inches. Samples were air-dried in plastic bags and sent to Qualitest Lab for testing different parameters that is, pH, EC, SAR, Cd^{2+}, Ar^{2+}, Pb^{2+}. pH, EC and SAR were calculated by using (U.S. Salinity Lab. Staff Standards, 1954). Metal ions concentration was determined by the help of atomic absorption spectrophotometer.

Plant/Fruit Sampling

Samples of leaves and fruits of various vegetables that is,

Figure 1(a). Effluent channel used for irrigating agricultural fields at Sharafi Goth, Malir.

Figure 1(b). Pumping of sewage water from nearby drainage channel.

Figure 1(c). Temporary Storage of Effluent.

Sugar beet, Tomato, Spinach, and Coriander from concerned area were collected. Plants samples were thoroughly washed with 1% HCL, 3-4 washing with distilled water to get rid of foreign materials. The collected samples were then placed on a clean paper and ultimately oven-dried at 60-70^{o}C. The results obtained from soil and vegetable are indicated on dry weight basis. Figures 1(a) – 1(d) described the pictorial view of the research study.

Figure 1(d). Tomato production from untreated city effluent in Sharafi Goth, Malir.

RESULTS AND DISCUSSION

City Effluent Analysis

The subject research was carried out to check the impact of city effluent on agricultural land at Malir, Karachi. The outcome of the study revealed that effluent samples were having RSC in between 4.68 – 10.647 mmol/l. (Table I). Likewise, the effluent samples were having EC in between 5.01 – 6.62 ds/m. It is a fact that use of low quality subsoil water along with city effluent might have increased the EC (electrical conductivity) of water. The sources of this increase in EC may be detergents, cosmetics, textile ashes and factory wastes as Malir is surrounded by many small and large textile industries. The SAR values of effluent ranged from 15.23 - 20.71. Therefore, this range of SAR is considered unsafe for soil and plants growth. On the basis of results obtained it has been concluded that at Sharafi Goth the effluent quality was unsuitable for irrigation as it is saline and sodic in nature and high in EC, SAR and RSC. The weather conditions, summer and winter were not having any effect regarding metal concentration in effluent. Continuous and long use of effluent for irrigation purpose may exercise effect of metal accumulation in soils, which can touch upto toxic height which is ultimately dangerous for soil, crops, and health. These results are in agreement with (Ghafoor, 2004) for the same nature of study for soils and vegetables.

Soil Samples Analysis

Inconsistent variation in pH value at various soil depths was observed. pH ranged 7.5 to 8.2 in the top 0-6 inches soil depth. pH was not a problem as vegetable plants are shallow rooted and therefore, 6 inches was manageable due to addition of organic compounds. The EC was ranging from 2.1 – 6.5 dS/m at 0-6 inches soil depth. EC value tends to decrease with the increase in soil depth. High value on the upper layer of soil may be due to salt presence in effluent. It may also tantamount to capillary action due to agro-ecological conditions of the study area

Table I. Irrigation Quality and Metal Ion Concentration (mg/l) in the city effluent of Sharafi Goth, Malir.

Site	Parameter	Results Range	Mean	S.D
Sharafi Goth	EC (ds/m)	5.01 – 6.62	3.82	0.09
	SAR (mmol / L) $^{1/2}$	15.23 - 20.71	17.38	1.61
	pH	7.7 - 8.5	8.11	0.21
	RSC (mmol / l)	4.68 - 10.647	6.55	1.28
	Cd (mg/l)	0.021 - 0.107	0.072	0.03
	Ar (mg/l)	0.003 - 0.015	0.010	0.04
	Pb (mg/l)	0.37 - 0.61	0.477	0.09

as Malir belongs to an arid region of the country where rainfall is very less. The obtained results showed that SAR ranged from 7.4 to 16.5. The value of SAR drastically decreased with the increase in soil depth. As the cultivation of vegetables in Sharafi Goth with city effluent is been cultivated for continuously three decades therefore, high SAR clearly indicates that land is salinated and Sodicated which may result in serious repercussion in case of prolonged use of contaminated water for irrigation purpose.

The land irrigated with city untreated effluent contains Cadmium “Cd” between 0.626 - 0.916 mg/kg which was above the permissible range 0.31 mg/kg during the subject research work. It is also observed that no regular pattern of Cd^{+2} in soil exist. Moreover, in upper layer in soil Cd^{+2} presence is variable but it tends to decrease with the increase in soil depth. Likewise, Pb^{2+} in soil was observed between 217.3 - 660.5 mg/kg. The upper layer of soil uptill 0-6 inches contains maximum amount of Mn, and it decrease as the soil depth increased. In various samples the amount of Pb content we found beyond permissible limits that is, 12 mg/kg as per WHO standards (1996). Furthermore, the results revealed from the soil samples showed that ArsenicAr^{2+} ranges from 0.431 - 0.809 mg/kg which was high. This may be due to solubility factor of Ar^{2+} at alkaline pH. Concentration goes on declining with increasing depth of soil. These results are in agreement with (Murtaza *et al.,* 2003) for the same nature of work for vegetables. The detailed results are elaborated in Table 2, respectively.

Plant/Vegetable Sample Analysis

Maximum amount of Cd^{2+} was found in leaves of Spinach between 0.069 - 0.780 mg/kg which was beyond the prescribed limits by (WHO, 1996). These results are in agreement with (Murtaza *et al.,* 2003) for Spinach. The overall results for leaves indicates that in ascending order Cd^{2+} amount in vegetable may be indicated as Coriander<Sugar beet<Tomato<Spinach and in fruit it can be indicated as Tomato<Sugar beet, respectively. The overall metal concentration was found on higher side >0.01 mg/kg. Likewise, different ratio of Ar^{2+} that is, 0.014 - 0.079 mg/kg was found in diverse plant parts. However maximum concentration in Sugar beet fruit was found and Coriander leaves was having very less concentration, in ascending order it may be indicated as Coriander<Spinach<Sugar beet<Tomato. The overall results revealed that Ar^{2+} was found beyond the permissible limit of 0.01 mg/kg as per WHO standards (1996) in all cases. Similarly, in different parts of plant different values of Pb^{2+} was found ranging from 6.10 – 172.5 mg/kg. Maximum Pb^{2+} was found in the leaves of Spinach 79.9 - 172.5 mg/kg. The amount of Pb^{2+} in ascending leave wise can be represented as Coriander<Sugar beet<Tomato<Spinach, while in fruit it can be represented Tomato<Sugar beet. In all samples the amount of Pb^{2+} was beyond the safe limits prescribed by WHO (1996). These results are in agreement with (Murtaza *et al.,* 2000). The detailed results are elaborated in Table 3, respectively.

Conclusions

As a consequence of subject study it can be concluded that the city untreated effluent used for irrigating agricultural land to grow vegetables was totally unfit with respect to EC, SAR, pH and RSC aspects. In addition to this quantity of Cd^{2+}, Ar^{2+}, and Pb^{2+} in the effluent was also found beyond the safe limits as prescribed by WHO. Likewise, pH, EC and SAR were also on higher side at 0-6 inches soil depth. These values tend to decrease with increase in soil depth due to salinization or sodication process. The quantity of heavy metals that is, Cd^{2+}, Ar^{2+}, and $Pb^{2+}$was found beyond the specified range. Generally, metal concentration in vegetable leaves was higher than the fruits. Pb concentration was found much higher than Cd^{2+} and Ar^{2+}. All this research implies that injudicious use of untreated sewage water for irrigation purpose may constitute serious repercussion that is, consumption of subject crops is a great hazard to animal and human health which necessitate to stop it immediately. Whereas, the farmers and the growers look down the outcomes of this research work. They just only desire to maintain money. As the use of this effluent, untreated, unclean, unhygienic water increases their production manifold which further boost their income and

Table 2. Chemical Characteristics and Metal Ions Concentration (mg/kg) in Soils Irrigated with City Effluent at Sharafi Goth, Malir.

Soil Depth	Parameters	Results Range	Mean	S.D
0 - 6 Inches	pH	7.5 - 8.2	7.9	0.3
	ECe (dS/m)	2.1 - 6.5	3.7	1.5
	SAR (mmol/L)	7.4 - 16.5	12.1	3.2
6 - 12 Inches	pH	7.4 - 8.1	7.8	0.3
	ECe (dS/m)	2.2 6.3	3.6	1.2
	SAR (mmol/L)	7.2 - 16.1	11.8	2.9
12 - 18 Inches	pH	7.4 - 8.0	7.8	0.3
	ECe (dS/m)	2.0 - 6.2	3.5	1.1
	SAR (mmol/L)	7.1 - 15.7	11.2	2.7
18 - 24 Inches	pH	7.2 - 7.9	7.7	0.3
	ECe (dS/m)	1.7 - 4.2	3.5	1.1
	SAR (mmol/L)	6.8 - 15.1	10.9	2.5
24 - 30 Inches	pH	7.3 - 7.9	7.7	0.3
	ECe (dS/m)	1.4 - 3.7	3.5	1.1
	SAR (mmol/L)	6.3 - 14.7	10.1	2.2
Heavy Metals				
0 - 6 Inches	Cadmium	0.626 - 0.916	0.81	0.19
	Arsenic	0.431 - 0.809	0.65	0.19
	Lead	217.3 - 660.5	208.2	9.1
6 - 12 Inches	Cadmium	0.060 - 0.115	0.79	0.19
	Arsenic	0.030 - 0.107	0.66	0.19
	Lead	115.2 - 457.7	124.1	5.7
12 - 18 Inches	Cadmium	0.051 - 0.111	0.78	0.19
	Arsenic	0.029 - 0.105	0.64	0.19
	Lead	55.9 - 117.5	81.6	4.9
18 - 24 Inches	Cadmium	0.049 - 0.109	0.75	0.19
	Arsenic	0.019 - 0.107	0.63	0.19
	Lead	47.1 - 116.8	56.8	5.3
24 - 30 Inches	Cadmium	0.045 - 0107	0.73	0.19
	Arsenic	0.015 - 0.103	0.61	0.19
	Lead	15.3 - 71.1	47.9	5.5

Table 3. Metal Ions Concentration (mg/kg) in Vegetables (Leaves and Fruits) Irrigated with City Effluent at Sharafi Goth, Malir.

Leaves	Parameters	Results Range	Mean	S.D
Sugar beet	Cadmium	0.064 - 0.071	0.058	0.0019
	Arsenic	0.034 - 0.067	0.031	0.014
	Lead	62.2 - 101.1	86.9	19.46
Tomato	Cadmium	0.065 - 0.112	0.084	0.031
	Arsenic	0.021 - 0.071	0.041	0.021
	Lead	58.4 - 154.4	112.2	52.57
Spinach	Cadmium	0.069 - 0.780	0.182	0.261
	Arsenic	0.014 - 0.065	0.049	0.018
	Lead	79.9 - 172.5	125.88	47.05
Coriander	Cadmium	0.062 - 0.068	0.065	0.039
	Arsenic	0.059 - 0.064	0.061	0.039
	Lead	52.1 - 78.41	55.25	5.54

(**Table 3.** Cont'd)

Fruits				
Sugar beet	Cadmium	0.077 - 0.093	0.081	0.009
	Arsenic	0.031 - 0.079	0.051	0.031
	Lead	6.11 - 12.21	9.25	3.64
Tomato	Cadmium	0.077 - 0.079	0.062	0.041
	Arsenic	0.025 - 0.061	0.045	0.029
	Lead	6.10 - 13.30	8.7	4.22
Spinach	Cadmium	-	-	-
	Arsenic	-	-	-
	Lead	-	-	-
Coriander	Cadmium	-	-	-
	Arsenic	-	-	-
	Lead	-	-	-

reduces their expenditure as the sewage water is rich in fertility due to human waste and other nutrients. It is therefore, suggested that government must evolve measures to stop this practice forthwith as it is posing a serious threat to the human beings, groundwater resources, fertility of land, and the farmers must be educated in this regards to apprehend the situation in their own interest and inhabitants of the area who are the ultimate consumers.

REFERENCES

Ghafoor A (2004). Metals ion in city waste effluent and Effect of application on soil and vegetables. Tech. Report of ARF project funded by Pakistan Agric. Res. Council, Islamabad.

Kafeel A, Zafar IK, Sumaira Y, Muhammad A, Asma I (2014). Accumulation of Metals and Metalloids in Turnip (*brassica rapa l*.) Irrigated With Domestic Wastewater In The Peri-Urban Areas Of Khushab City, Pakistan. Pak. J. Bot., 46(2): 511-514.

Maria M, Amanullah B, Farmanullah K (2007). Concentration of Metals in Sewage and Canal Water Used For Irrigation in Peshawar. Sarh. J. Agric. Vol. 23(2).

Murtaza G, Ghafoor A, Qadir M, Rashid MK, (2003). Accumulation and bioavailability of Cd, Co and Mn in soils and vegetables irrigated with city effluents. Pak. J. Agric. Sci. 40 (1-2): 18-24.

Murtaza G, Ghafoor A, Qadir M, Rashid MK, (2000). Concentration of Cd, Co, and Mn in Soils and Vegetables Irrigated with City Effluent. National Seminar on Drainage in Pakistan held at MUET, Jamshoro, August 16-18.

Sharma RK, Agrawal M, Marshall FM, (2009). Heavy metals in vegetables collected from production and market sites of a tropical urban area of India. Food Chem. Toxicol., 47: 583-591.

U.S. Salinity Laboratory Staff, (1954). Diagnosis and Improvement of Saline and Alkali Soils. USDA Agric. Handbook 60. U.S. Gov. Print. Office, Washington, DC, USA.

WHO, (1996). Trace Elements in Human Nutrition and Health. World Health Organization, Geneva.

Zafar IK, Kafeel A, Muhammad A, Rukhsana P, Irfan M, Ameer K, Zahara B, Nudrat AA (2015). Bioaccumulation Of Heavy Metals And Metalloids In Luffa (LUFFA CYLINDRICA L.) Irrigated With Domestic Wastewater in Jhang, Pakistan: A Prospect for Human Nutrition. Pak. J. Bot., 47(1): 217-224.