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Short Communication

Evaluation of Physicochemical Properties and Metallic Contents in Vegetables Irrigated with Water from Different Sources

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Abstract

This study focuses on the assessment of health risk potential by quantifying some selected metals (Cd, Cr, Fe, Cu, Mn, Zn, Ni, Pb) in vegetables and soil irrigated with different sources of water. The physicochemical parameters of irrigating water were within the safe limits except for SAR in sewage water (18.723 mg/kg) and industrial wastewater (40.332 mg/kg). The Mn (19 mg/kg) was higher than the safe limit in vegetable and soil irrigated with tube well water. The sewage water irrigated vegetable had high level of cadmium (1.557 mg/kg), lead (2.307 mg/kg) and chromium (3.566 mg/kg) than safe limits. The canal water had high level of cadmium (0.286 mg/kg) and lead (0.569 mg/kg). The vegetable irrigated with tube well water was best for human health while vegetable irrigated with sewage water, canal water, and industrial wastewater was of poor quality and unfit for human health due to high level of toxic metals.

Keywords: heavy metals, wastewater, vegetables, soil, pollution

Introduction

Rapid industrial revolution and urbanization pollute the soil and water sources by releasing the metallic and toxic chemicals [1-3]. Due to the lack of proper sewerage system, the wastewater from the houses, hotels, markets, hospitals and industries is directly released into the water channels [4, 5]. It is estimated that 10% world population irrigate food crops with wastewater. Developing countries use the industrial and municipal sewage water for irrigation [6, 7]. Undoubtedly, wastewater contain plant nutrients which make up the deficiency of fertilizers. On the other hand, it has health and environmental risks due to the

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presence of synthetic chemicals, pathogens and heavy metals [8].

The most important parts of human diet are the vegetables because they contain protein, vitamins, minerals, carbohydrates and trace metals [8-10]. Vegetable crops are at high risks for uptake of toxic heavy metals on irrigation with polluted wastewater [11]. Plants have the capacity to accumulate heavy metals from the contaminated soils. Plants use various ways including rhizo-filtration, phytoextraction and phyto-stabilization to eliminate the contaminants from the water and soil as well [12]. Heavy metals cause wilting of leaves, enzyme system inactivation, decrease the plant height, and affect photosynthesis and respiration [13]. The plants uptake the toxic metals via roots and it is transferred to human through food chain. Toxic heavy metals cause dangerous effect in the living ones due to nonbiodegradable nature [14]. Moreover, the majority of heavy metals are poisonous due to their water solubility and cause various diseases [15] by damaging immune system, malnutrition and gastrointestinal cancer [16]. The objective of this research work is to assess the potential of metal toxicity of some selected metals like Cd, Cr, Fe, Cu, Mn, Zn, Ni and Pb in vegetable (*Abelmoschus esculentus*) and soil using different water sources.

Materials and Methods

Samples of soil (0.5 kg) were collected with the help of pre-cleaned sampler from the four different locations (Burewala, Vehari). The sampling site was selected based on different irrigation sources (tube well water, canal water, sewage water and industrial wastewater). The samples of soil were dried under shade and then placed in oven at 72ºC for 6 h. These dried samples were ground to fine powder using pestle mortar, sieved through 2 mm mesh size and packed in pre washed polythene bags. Samples of water were collected (500 mL) with the help of water sampler from the depth of 10-15 cm of water surface. These samples were stored in cleaned plastic bottles and 3 mL of conc. HNO_3 was added in each sample bottle to prevent microbial activity. Vegetable samples (0.5 kg) were collected from the above-mentioned sites and washed using de-ionized water to remove the dust particles. These samples were placed under shade for 7 days and oven dried at 73ºC for 3 days. The samples were ground to fine powder, passed through 1mm sieve and stored in cleaned polythene bags.

1g soil sample was weighed after mixing and 5 mL aqua regia was added in it. It was digested on the hot plate under fume hood unless the fumes color changed from brown to off white. After cooling, 15 mL of de-ionized water was added, filtered off the sample and made up filtrate to 50 mL by distilled water. 1 g sample of vegetable was digested on the hot plate by adding the 5 mL mixture of sulfuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2) with 1:2 ratio. The digestion had been continued till the solution became clear. Atomic absorption spectrophotometer was used to determine quantity of heavy metals in the samples using the respective hallow cathode lamp.

Results and Discussion

The rapid industrial revolution and urbanization have a great impact on the quality of the environment [17]. The selected toxic metals like Ni, Cd, Cr, Pb Cu, Fe, Zn and Mn were observed in tube well water irrigated vegetables. All these values were found lower than permissible limits [18]. All the data is given in Table 1. These results are found in accordance to the previous report from Bahawalpur Pakistan [19]. The similar reports was also recorded by Attock and Mardan [11, 13]. The mean content of these metals in tube well water irrigated soil were recorded as 0.108, 0.004, 0.006, 0.180, 6.350, 16.272, 4.330 and 19.004 $mgkg^{-1}$ respectively and are within the permissible limits. All these values were lower than safe limits except Mn, but the other researcher found these results less than permissible limits [13, 19]. The average values of physio-chemical parameters like pH, EC, SAR, Na, Ca^{2+} Mg, HCO_3^{-1}, CO_3^{-2} and Cl^{-1} of tube well water was 7.141, 2.504 µS/cm, 15.594 meq/L, 8.850, 9.388, 11.041, 3.423 and 1.542 mgL^{-1} respectively. These values were observed lower than safe limits and were found similar to the previous report.

These selected metals were also observed in sewage water irrigated vegetables. The level of Pb, Cr and Cd are found more than safe limits in the current study. Previous study reports the concentration of Pb a little higher than the safe limit [20]. At higher concentrations than the safe limits causes impairment kidney, nervous cancer, liver, cardiovascular, poor immune system, disabilities of malnutrition, growth retardation and gastrointestinal cancer [11]. Previous studies report that contaminated water irrigated vegetables had higher metal contents than uncontaminated water treatment [19, 21].

The mean contents of metals in sewage water irrigated soil are 20.478, 2.283, 4.080, 9.567, 22.958, 353.120, 20.270 and 72.710 $mgkg^{-1}$ respectively. The Cd and Mn contents crossed the safe limits in current study [19]. Previous study reports the higher metals content in sewage water soil than freshwater irrigated soil [21]. The mean values of physio-chemical parameters in sewage water are 7.652, 3.133 µS/cm, 18.723 meq/L, 8.933, 8.783, 12.112, 2.558 and 1.529 mgL^{-1} respectively [22]. The value of SAR crossed the safe limit in the current study. The high level of SAR causes to minimize the permeability of the soil [23].

The canal water vegetable has the mean values of metals as 0.234, 0.286, 0.366, 0.569, 0.216, 1.174, 1.231 and 0.884 $mgkg^{-1}$ respectively. In these samples

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Table 1. Metal contents in treated vegetables and soil and physicochemical parameters (Mean±SE).

Vegetables					
Metals	Tube well water	Sewage water	Canal water	Industrial water	Permissible limits (mg/kg)
Ni	0.038±0.269	5.284±0.171	0.234±0.205	2.192±0.045	67.00
Cd	0.001±0.433	1.557±0.123	0.286±0.110	0.046±0.515	0.10
Pb	0.034±0.167	2.307±0.134	0.569±0.109	0.626±0.533	0.30
Cr	0.035±0.145	3.566±0.141	0.366±0.137	0.820±0.124	2.30
Cu	0.016±0.333	2.914±0.040	0.216±0.116	0.714±0.061	73.00
Zn	0.011±0.430	1.109±0.023	1.231±0.037	0.406±0.147	100.00
Fe	0.063±0.176	1.234±0.036	1.174±0.054	2.466±0.132	425.00
Mn	0.016±0.328	1.743±0.195	0.884±0.047	0.511±0.163	6.610
Soil					
Ni	0.108±0.186	20.478±0.029	0.854±0.086	39.146±0.015	50
Cd	0.004±0.303	2.283±0.128	0.410±0.044	4.997±0.030	0.31
Pb	0.180±0.103	9.567±0.078	0.900±0.062	11.316±0.004	100
Cr	0.006±0.270	4.080±0.014	0.557±0.090	5.776±0.104	8.0
Cu	6.350±0.013	22.958±0.046	0.927±0.038	40.014±0.024	100
Zn	4.330±0.39	20.270±0.023	1.353±0.004	35.850±0.017	300
Fe	16.272±0.008	353.120±0.025	1.622±0.026	312.597±0.012	50000
Mn	19.004±0.009	72.710±0.015	1.604±0.144	69.914±0.032	12
Physicochemical parameters					
pH	7.141±0.011	7.652±0.007	7.902±0.014	8.277±0.020	9.2
EC	2.504±0.209	3.133±0.044	0.258±0.196	280.111±0.092	1500µS/cm
SAR	15.594±0.092	18.723±0.008	2.436±0.162	40.332±0.037	18meq/L
Na	8.850±0.034	8.933±0.016	1.518±0.078	7.363±0.206	200ppm
Ca, Mg	9.388±0.042	8.783±0.028	4.790±0.025	2.024±1.060	500ppm
HCO_3^{-1}	11.041±0.013	12.112±0.005	2.971±0.114	17.092±0.064	600 ppm
CO_3^{-2}	3.423±0.074	2.558±0.020	0.477±0.030	14.909±0.239	180ppm
Cl	1.542±0.109	1.529±0.036	0.251±0.149	12.200±0.018	600ppm

the level of Cd and Pb crossed the safe limits. Overall, all the metals except Pb were under the safe limit reported in previous studies [20]. It may also lead to the carcinogenic, vomiting, cramps, loss of consciousness, respiratory difficulties, nausea, liver dysfunction, teratogenic and neurotoxin [19]. The mean contents of these metals in canal water irrigated soil are 0.854, 0.410, 0.557, 0.900, 0.927, 1.622, 1.353 and 1.604 $mgkh^{-1}$ respectively [20]. The mean values of physio-chemical parameters in canal water were 7.902, 0.258 µS/cm, 2.436 meq/L, 1.518, 4.790, 2.971, 0.477 and 0.251 mgL^{-1} respectively. All these parameters were found under the safe limits [24].

The industrial watered vegetable has metal contents as 2.192, 0.046, 0.820, 0.626, 0.714, 2.466, 0.406 and 0.511 $mgkg^{-1}$ respectively. These metals were found lower than safe limits except Pb, it crossed the safe limit in the current study and recorded these metals higher than safe limits [13]. The content of Pb may be increased by the incineration of waste material. For instance, in children exposure of lead causes lower IQ, hyperactivity, mental deterioration, shortened attention span. Lead has significant risk in children under six years of age. In adults, Pb causes anorexia, loss of memory, failure of reproduction, irritation, insomnia, nausea, decreased reaction time and producing tumors [25]. The mean content of these metals in industrial water irrigated soil are 39.146, 4.997, 5.776, 11.316, 40.014, 312.597, 35.850 and 69.914 $mgkg^{-1}$ respectively. In the industrial water soil the content of Cd and Mn crossed the safe limits and the other metals were under the safe limits [13]. Cd is generated from fossil fuels,

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lead refining, motor oil, by-product of zinc and sewage sludge [26]. When water with high level of SAR is used to irrigate the soil, it reduces the permeability of soil. Previous research in Pakistan had also reported the same results [27].

Concluions

Vegetable irrigated with tube well water has low level of metals than permissible limits. On the other hand, sewage sewage water irrigated vegetable has high level of Pb, Cr and Cd than safe limits, the canal water irrigated vegetable has slightly higher level of Pb and Cd than safe limits and industrial water vegetable has high level of Pb than permissible limits. Sewage water vegetable was the found the most toxic but tube well water vegetable was found the best for human health. It is suggested to use tube well water for irrigation purposes in the studied area.

Conflict of Interest

The authors declare no conflict of interest.

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