

Impact on Vegetables Irrigated with Municipal and Industrial Wastewater from Korangi Drain near IoBM, Karachi

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ABSTRACT

The present study was conducted to assess the Impact on vegetables irrigated with municipal and industrial wastewater from korangi drain near iobm, karachi. Some vegetables are grown using sewage and industrial wastewater laden with alarmingly high levels of heavy metals and bacteriological contamination. Maximum concentration of lead was found in spinach 8.20 mg/l as against safe limits of 0.01 mg/l and maximum Nickel concentration was found in banana 3.114 mg/l as against 0.02 mg/l whereas all vegetables were invariably bacteriologically contaminated much beyond safe limits. Appropriate legislations in Sindh and competent manpower for rigorous monitoring to gage the harmful impact on vegetables grown with untreated municipal and industrial wastewater to effectively combat the problems of growing vegetables. The emptying of untreated municipal and industrial wastewater through korangi drain in fresh water bodies into Karachi coast should be banned to save the coast becoming hypoxic causing irreparable loss to marine life.

Keywords: Concentration; Hypoxic; Wastewater; Vegetables

INTRODUCTION

Vegetables are far and wide used throughout the world as part of food and feed for the human being and livestock. In Pakistan, for example, turnip in Punjab is exclusively grown for use as animal feed. Like rest of the world in Pakistan also vegetables constitute a major part of food consumption and are consumed in both raw and cooked form. Generally vegetables are grown from fresh water, but due to scarcity of water and rapid industrialization it is often irrigated with untreated sewage and industrial waste water and it has become a common practice adopted for cultivation in underdeveloped countries. Karachi is the largest and biggest industrialized city of Pakistan. According to World Population Review Karachi, accessed on September 22, 2014 has an estimated population of over 23.7 million people as of 2014 [1].

Present study was carried out to determine the impact of heavy metals on vegetables grown on a farm located in an area of Karachi behind IoBM, Korangi. This farm is using the water of IoBM Drain ('Nallah') for the irrigation of vegetables. Ali M et al. [2] reported that this drain produces foul gases including

Hydrogen sulphide and many other gases, which are poisonous and dangerous to human health. The growing problem of water scarcity has significant negative influence on economic development, human livelihoods, and environmental quality throughout the world. Rapid urbanization and industrialization releases enormous volumes of waste water, which is increasingly utilized as a valuable resource for irrigation in urban and peri-urban agriculture. It drives significant economic activity, supports countless livelihoods particularly those of poor farmers, and substantially changes the water quality of natural water bodies [3].

Seemingly there appears to be an increasing trend in Karachi that vegetables are grown using sewage and industrial wastewater which is of great concern for human health. An observation was made that behind IoBM there are several farms including the farm which we have selected for this research study extracting waste water from Drain ('Nallah'). The only source of water in this farm is industrial wastewater hence the vegetables grown using this untreated industrial wastewater contains a high level of heavy metals. They send these vegetables directly to Bangali Market

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which is then purchased and consumed by the communities in Karachi city and ultimately contaminates the food chain which is then intake by local population.

Hence vegetables grown around the city of Karachi with sewage and wastewater is of great concern. The main aim of present study is to investigate the uptake of heavy metals in vegetables grown near IoBM which lies in the largest industrial area of Karachi and to identify their source and cause of contamination. Therefore, it has become very necessary to monitor the concentration of heavy metals present in the vegetables grown in this particular vicinity in order to avoid serious health hazards and to spread the awareness to general public. It is for this reason that this study has been conducted to gage as a part of service to society.

A study conducted indicated that this drain water has heavy metals content and the present study also reveals that it has heavy metal contents in a large amount, which includes various heavy metals like Zn, Cu, Pb, Mn, Ni, Cr, Cd, depending upon the type of activities [3]. Continuous irrigation of agricultural land with sewage and industrial wastewater may cause heavy metal accumulation in the soil and vegetables [4]. Wastewater of the urban areas in the underdeveloped countries is being used to irrigate vegetable crops in the vicinity of cities since long time. Waste and sewerage water after treatment is considered most rich in plant nutrients and organic matter. In many cities and towns the sewerage water is sold and it is a good source of income to municipalities. However, the situation is changed now. With the establishment of industries in suburban area, the wastewater is mixed with industrial effluents and big culverts are coming out from the cities. These culverts and drains not only contain heavily polluted water but also give noxious and off smell gases due to anaerobic digestion. The polluted water even then is still used for growing vegetables in the nearby area of the cities without knowing their adverse impact on the life of consumers. A study conducted in Faisalabad showed that soil and plants contained many toxic metals, that received irrigation water mixed with industrial effluent having adverse impact on the life of consumer [4]. Similarly found many fish containing higher concentrations of heavy metals in the area of southeast arabian sea where polluted industrial water is thrown though Malir river [5]. The industrial effluent produced in several industries in Korangi area is dumped in Malir river and finally it leads to arabian sea. The heavy metals uptake by plants through grimy soil and water gets accumulated and it causes potential risk on human population.

The contamination of vegetables due to the presence of heavy metals cannot be underestimated as these vegetables are important component of human health. It was therefore felt necessary that effluent mixed wastewater, which is also used in the Korangi area for irrigation purposes, might contain toxic metals. Hence, present study was taken in hand to estimate the concentration of Cu, Zn, Cd, Ni, Pb and Cr in the irrigation of vegetables. The scope of the study is:

- The study will find out the existing levels of heavy metals

and bacteriological contamination present in vegetables and its impact on human.

- The present study will provide the valuable information on the direct usage of IoBM drain water on vegetables which will serve the purpose of service to society.

The objective of a study relates

- To examine the levels of heavy metals and microbiological contaminants in vegetables.
- To examine the uptake of heavy metals in vegetables and its possible impact on human health.

MATERIALS AND METHODS

Measuring tape

In this research study measuring tape was used in order to measure the size of vegetables which includes the length and width of the vegetable samples.

Plastic containers

To collect the vegetable samples, five sterilized plastic colored containers of 1 kg capacity each were used. The core reason of collecting the samples in sterilized sample is to protect the samples from solar radiation and against external microbial contaminants.

Study site

The study was conducted at a farm located in the area of Korangi near IoBM in the city of Karachi, Pakistan. The total area of the farm is approximately 15 acres. For the last 20 years untreated municipal wastewater and industrial wastewater was being used for the vegetables production. The history of farming on this piece of land is 20 years old. The leaser rented it at an amount of Rs 2 Lakhs per annum. At that time the texture of soil was sandy due to the continuous use of sewage (organic component) comprising of municipal solid waste and industrial waste effluent. With the passage of time the soil has become sandy loam and over the passage of twenty years it has become a well-developed farm. The renter has informed that the farm is now sold. The 3/4 area of the farm has been sold to shauk at khanum memorial research center and approximately 1/4 area has been sold out to Iqra University. Hence, after twenty years of agricultural practices the soil quality of the land has now become very good productive land full of greenery [6-8].

Quality of water

The water quality of the IoBM drain has been fully tested which is one of the part of the overall Research Study.

Vegetables sampling

Five fresh vegetable samples in a quantity of 1 kg each were collected from the farm which exclusively uses the IoBM drain water. These vegetables were transported for laboratory testing within a time frame of four hours. The vegetables collected for analysis were

- Spinach (*Beta vulgaris L.*)
- Green chilies (*Capsicum annum L.*)
- Lady Finger/Okra (*Abelmoschus esculentus L.*)
- Green beans (*Phaseolus vulgaris.*)

- Banana (*Musa acuminata.*)

Size of vegetables harvested

The details of different size of vegetable samples are given below in a tabulated form Table 1 and Table 2. The pictorial presentation of vegetables under study is given below in Figures 1-5.

Table 1: Size of vegetable samples.

S. No	Name of vegetables	Size in cms
1	Spinach	25
2	Green chilies	5
3	Okra	8
4	Green beans	7
5	Banana	11

Table 2: Results of chemical analysis of vegetables.

S. No	Parameters (mg/l)	Spinach	Okra	Chilies	Beans	Banana
1	Ni	0.41	3.8	BDL	2.31	3.114
2	Pb	8.2	0.023	0.2	0.24	2.132
3	Cu	0.3	0.62	BDL	0.021	1.414
4	Cr	0.027	0.033	BDL	BDL	0.78
5	Cd	0.031	0.037	BDL	BDL	1.68
6	Zn	0.22	3.8	0.039	3.28	2.54

Note: BDL: Below Detectable Limit

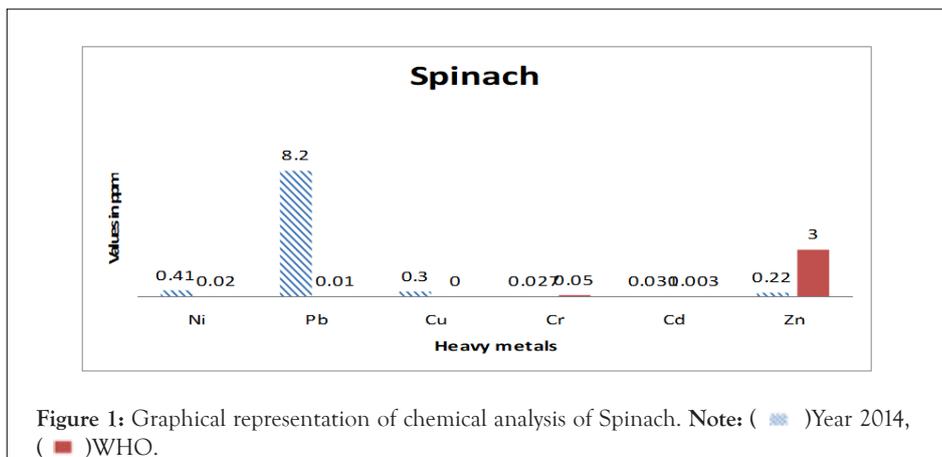


Figure 1: Graphical representation of chemical analysis of Spinach. Note: (■)Year 2014, (■)WHO.

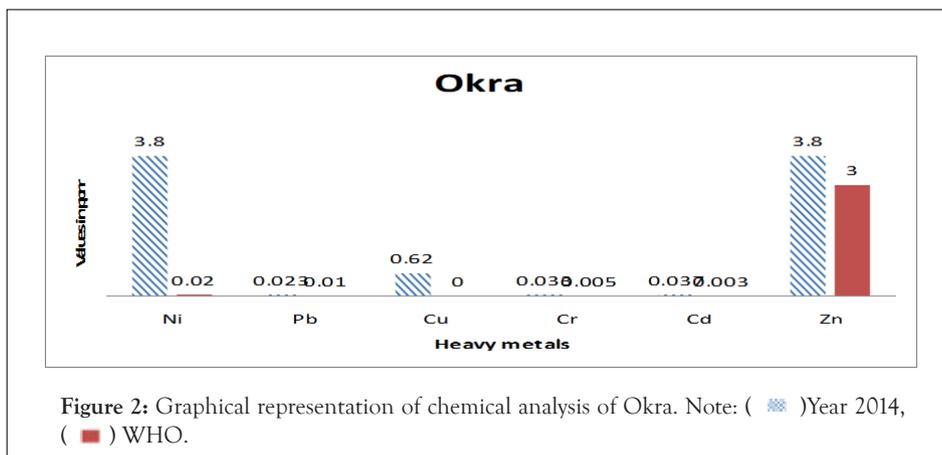


Figure 2: Graphical representation of chemical analysis of Okra. Note: (■)Year 2014, (■)WHO.

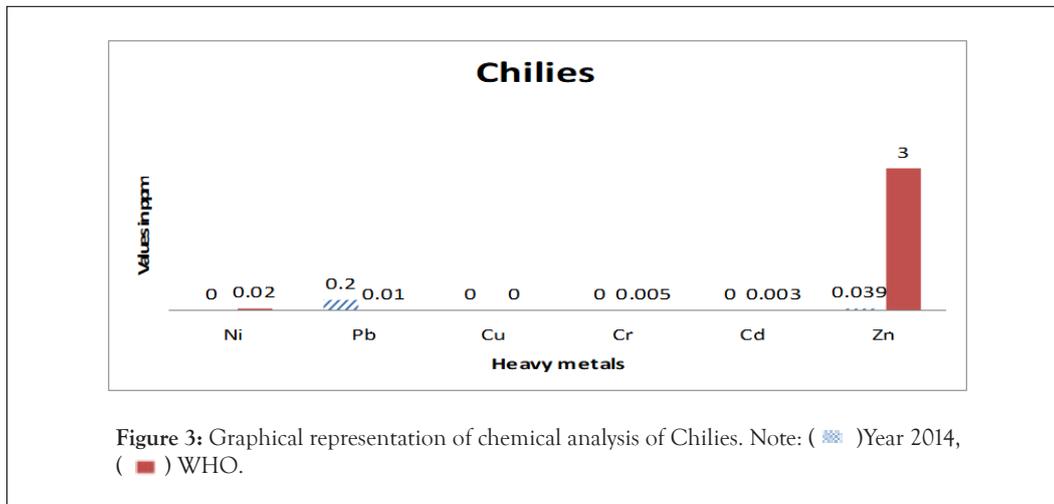


Figure 3: Graphical representation of chemical analysis of Chilies. Note: (▨)Year 2014, (■) WHO.

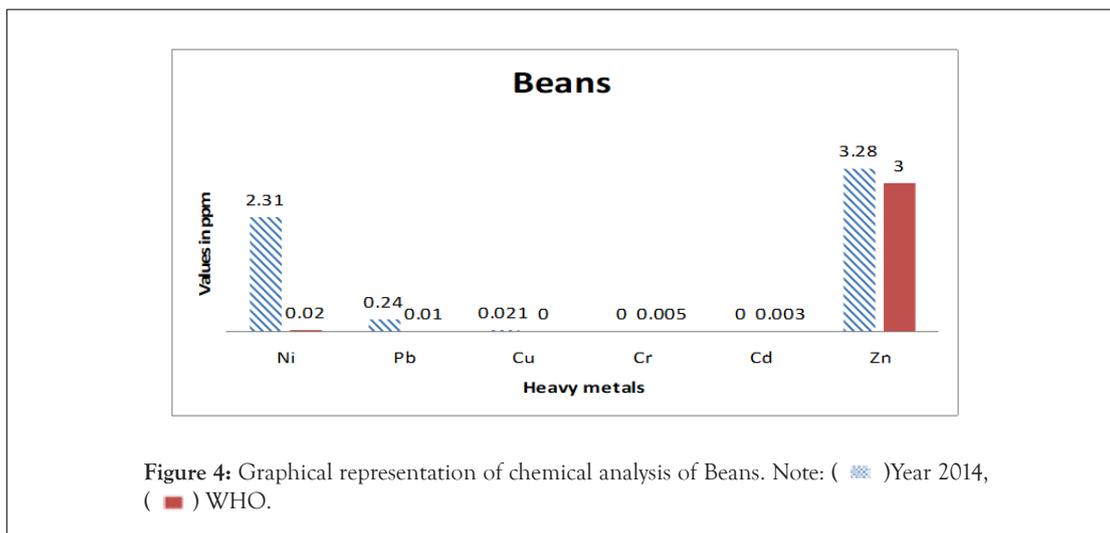


Figure 4: Graphical representation of chemical analysis of Beans. Note: (▨)Year 2014, (■) WHO.

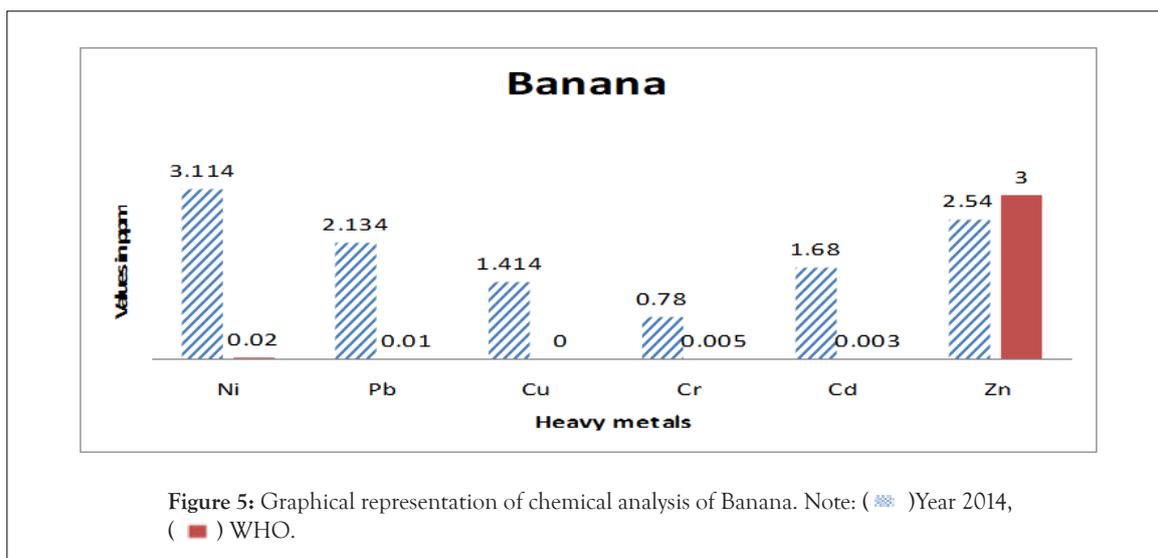


Figure 5: Graphical representation of chemical analysis of Banana. Note: (▨)Year 2014, (■) WHO.

Chemical analysis of heavy metals

Concentrations of Cd, Cu, Pb, Zn, Ni and Cr in the filtrate of digested soil, water, plant and samples were estimated by using an atomic absorption spectrophotometer.

Bacteriological analysis of vegetable samples

Bacteriological analysis of vegetables were carried on commonly edible vegetables in order to know the level of Total Coliform Count (TCC), Total Faecal Coliform Count (TFC), And Total Faecal *Streptococci* Count (TFC).

Laboratory analysis

In this study for the purpose of laboratory analysis we have used laboratory of Karachi University. Since we do not have established laboratory here at IoBM. Therefore for complete testing the samples were analyzed at Institute of Environmental Studies (IES).

Precautions during sampling

For the successful conducting of the study it was advised by the supervisor that during the collection of samples precautionary measures such as wearing of gloves, mouth masks must be undertaken. Moreover after conclusion of sampling washing of hands at least three times and use of sanitizer should be exercised.

Limitations of study

The limitations of the present study are as follows:

- This study is not Karachi wide.
- The farmer who is the leaser of the farm land agreed upon giving the information on a condition that this data is not going to be used against them.
- It was planned to collect tomatoes as one of the vegetable samples, but due to delay in initiation of the study, tomatoes were already harvested.

RESULTS AND DISCUSSION

Chemical analysis

Vegetables: Present study was carried out to determine the concentration of heavy metals in vegetables grown with Korangi

Drain water at a vegetable farm located in the area of Korangi, Karachi. Five vegetables which includes spinach, okra, beans, chilies, and banana grown at the farm were analyzed for Ni, Pb, Cu, Cr, Cd and Zn. Table 3 and Figure 5 indicate the results of chemical analysis of heavy metals concentration in vegetables [9-11].

Nickel: The Maximum concentration of Nickel (Ni) was found in banana (3.114 mg/l), whereas the lowest was found in green chilies which was below detectable level. In the remaining vegetables the amount of Ni was successively in the order of okra (3.8 mg/l), beans (2.31 mg/l) and in Spinach it was found (0.410 mg/l) all of these concentration were higher than the permissible levels recommended by WHO.

Lead: The maximum concentration of Lead (Pb) was found in Spinach (8.20 mg/l), whereas the second lowest was found in banana (2.132 mg/l), then in beans it was (0.24 mg/l), in okra the value was found (0.23 mg/l) and in chilies it was found (0.020 mg/kg) all of these concentration were higher than the permissible levels recommended by WHO.

Zinc: The maximum concentration of Zinc (Zn) was found in okra (3.80 mg/l), if we see the Table 3 the second lowest was found in Beans (3.28 mg/l), the third lowest was found in banana (2.54 mg/l) which was within the permissible recommended levels of WHO, similarly in spinach (0.22 mg/l) and in chilies (0.039 mg/l) was detected which was also within the recommended level.

Copper: The maximum concentration of copper (Cu) was found in banana (1.414 mg/l), the lowest was found in chilies which was below the detectable level, whereas in okra it was found (0.62 mg/l), in spinach it was (0.300 mg/l) and in beans it was found (0.021 mg/l).

Chromium: In chromium (Cr) the maximum concentration was found in banana (0.78 mg/l), whereas in Beans and chilies it was below the detectable level, In okra it was found (0.033 mg/l) and in Spinach it was (0.027 mg/l), these two parameters were detected within the recommended levels of WHO.

Cadmium: The maximum level of Cadmium (Cd) was found in banana (1.68 mg/l), whereas in chilies and beans it was below the detectable level (Table 3). In okra (0.037 mg/l), and in spinach (0.031 mg/l) it was detected above the recommended levels of WHO.

Table 3: The results of bacteriological analysis.

S. No	Parameters MPN/100 ml × 10 ⁴	Spinach	Okra	Green chilies	Green beans	Banana	Recommended WHO standard (mg/l)
1	Total Coliform Count (TCC)	>2400	1100	240	240	>2400	3
2	Total Faecal Coliform count (TFC)	>2400	40	<3	<3	>2400	3
3	Total Faecal <i>Streptococci</i> count (TFS)	>2400	<3	<3	<3	210	3

Hence, the aforementioned results indicate that all the parameters are exceeding the permissible limits of WHO expect for Cr in spinach and okra, and zinc in bananas, spinach and chilies. This indicate that results are in conformity with the study of William's in which he found that this industrial waste causes major health hazards due to the presence of heavy metals like Cu, Cd, Pb, Zn. Similarly according to FAO (1999) found that metals such as lead, which is accumulated in the leaves when absorbed by roots of plants and it is investigated that heavy metals concentration are found more in leafy vegetables such as lettuce. In this study we have also seen compliance in the results of our Spinach sample. Moreover, the concentrations of most studied heavy metals are detected above the permissible standard levels of WHO, hence it is a matter of great concern for the human consumers especially in this area of Korangi, Karachi [12-14].

Bacteriological analysis of vegetables

The vegetables were also analyzed bacteriologically by total coliform count, Total Faecal Coliform count and total faecal *streptococci*. Various pathogens were identified from the surface of these vegetables. Table 3 shows that in spinach amount of Total Coliform Count (TCC) was found >2400, the concentration of Total Faecal Coliform (TFC) count was also >2400 and the amount of total faecal *streptococci* count (TFS) was also the same i.e >2400 in Spinach, according to the WHO recommended standards the permissible level is 3; Hence it is above the permissible level. In Okra amount of Total Coliform Count (TCC) was found 1100, the concentration of Total Faecal Coliform (TFC) count was 40 and the amount of total faecal *streptococci* count was found >3 according to the WHO recommended standards the permissible level is 3, hence it is above the permissible level.

In chilies amount of Total Coliform Count (TCC) was found 240, the concentration of Total Faecal Coliform (TFC) count was <3 and the amount of total faecal *streptococci* count was found <3, according to the WHO recommended standards the permissible level is 3, hence it is above the permissible level.

In Beans the amount of Total Coliform Count (TCC) was found 240, the concentration of Total Faecal Coliform (TFC) count was <3 and the amount of total faecal *streptococci* count was found <3, according to the WHO recommended standards the permissible level is 3; hence it is above the permissible level.

In banana amount of Total Coliform Count (TCC) was found >2400, the concentration of Total Faecal Coliform (TFC) count was also >2400 and the amount of total faecal *streptococci* count was found 210, according to the WHO [6,15,16] recommended standards the permissible level is 3, hence it is above the permissible level.

Similarly as in chemical analysis, the concentrations of the aforementioned bacteriological parameters are also detected above the permissible standard levels of WHO, therefore it is a matter of great concern for the human consumers especially in this area of Korangi, Karachi [17].

A Perusal of the bacteriological analysis indicates that from human consumption point of view all the vegetables studied (spinach, okra, chilies, beans and bananas) contained higher contaminants than the safe limits established by WHO. As a rule, regarding human consumption safety standards of WHO all the bacteriological parameters TFC, TFS and TCC must be less than 3. Moreover, if any one parameter (TFC, TFS and TCC) if any one parameter exceeds 3 that vegetable becomes unfit for human consumption. Therefore, it is advisable that for consumption purpose regular monitoring should be conducted in order to detect the increasing levels of heavy metals in the vegetables.

CONCLUSION

The vegetables analysis indicates that untreated wastewater mixed with municipal and industrial effluent contained heavy metals and bacteriological contamination in excessive. As a result of growing of vegetables in municipal and industrial waste effluents vegetables were found heavily contaminated with heavy metals except for Zinc in bananas, spinach and chilies, Chromium in spinach and okra only. In addition the bacteriological analysis showed that all the parameters were above the permissible levels of WHO.

Due to the scarcity of water resources, farmers in underdeveloped countries, including Pakistan as well have increasingly started using untreated wastewater for irrigation of vegetables and crops. The soil quality texturally has become good after 20 years of the continuous use of untreated wastewater, though the vegetable yield has increased and also these vegetables looked appealing in texture, but they are lethal for human health. Vegetables and food crops should no longer be grown using wastewater for irrigation as they intake high level of heavy metals and bacteriological contamination. The government should impose the restrictions on cultivation of food crops grown using untreated municipal and industrial wastewater. As part of awareness campaign, the public should be advised to refrain from using vegetables grown with untreated sewage and industrial wastewater. Moreover, it is not just the vegetables that are contaminated with heavy metals but the people involved in such farming will also get infected due to the excessively high levels of bacteriological concentration.

The Government, NGO'S and the people associated with civil rights should embark upon a program to develop awareness about the harmful impact of vegetables grown with untreated municipal and industrial wastewater and suggest legislative barriers for farming with untreated municipal and industrial waste. The present study has satisfied the scope and objectives of the study by analyzing the chemical and bacteriological concentration of heavy metals found in vegetables. This study provided the valuable information on the harmful impact of direct usage of IoBM drain water for the irrigation of vegetables. These two findings will best serve the purpose of service to society.

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