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Physico-chemical analysis of waste water used for agricultural purpose in surrounding of Hyderabad, Sindh, Pakistan

Ghulam Murtaza Mastoi[1], Khalid Hussain Lashari[2], Zameer Ali Palh[2, *], T. Jabeen Ursani[3], Anila Naz Soomro[2], Zulfiqar Ali Laghari[3], Abdul Waheed Mastoi[1]

[1]Centre for Environmental Sciences, University of Sindh, Jamshoro, Sindh, Pakistan
[2]Department of Fresh Water Biology and fisheries, University of Sindh, Jamshoro, Sindh, Pakistan
[3]Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan

Email address:
zameer_ali110@hotmail.com (Z. A. Palh)

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Abstract: Irrigation with sewage is common practice of the farmers living in surrounding areas of urban colonies in Pakistan. Sewage contains a complex mixture of impurities. Waste water used for agricultural purpose without any treatment though it contains lot of the harmful impurities. During this study three villages were selected around the Hyderabad city and 12 samples were collected. Various characteristics of the sewage samples were determined such as total residues, total fixed residues, volatile residues, salinity, alkalinity, TDS, temperature, color, pH, conductivity, etc. Aim of this study was to evaluate the quality of waste water. It was found that waste water had moderate to increased hardness and salinity. Moreover, these water samples contained from 300 to 1800 mg/L of total residues. Nevertheless the pH-value was normal, in the range 6.7-7.0, that is suitable for water used for irrigation. Further investigations are required to determine toxicity of the waste water, as well as content and accumulation of heavy metals.

Keywords: Sewage Waste Water, Irrigation, Agricultural Effects

1. Introduction

Use of waste water for agricultural purpose without any treatment is common practice in Pakistan [5-7]. The waste mixture was discharged from households, industrial, commercial and domestic sources. Different treatment technologies of waste water have been used over the world [8-13]. The treatment method depends on the type of waste water. The world health organization highly recommends the treatment of waste water before any desirable use [1-3].

Main volumes of waste water are treated by treatment plants, which include the physical, chemical and biological treatment processes. However, the use of septic tanks, in which water is stored for biodegradation, is widespread in rural areas and wetlands [14, 15]. Some crops, and especially the vegetables, grown on such type of waste water contain toxic elements [16, 17. The crops, grown on untreated waste water, are very harmful for consumers due to high quantity of toxic substance accumulated in their tissues [18, 19]. The toxic substances are not biodegradable and accumulate in big amounts, which are used by second and third level of consumers [20]. These toxic elements cause sharp problems, when they accumulate in living bodies [21]. Different studies were conducted to investigate the affects of untreated waste water on biota. It was found that the food crops irrigated with waste water in Beijing, China were highly contaminated with toxic and trace elements; moreover, the concentration of these toxic and trace elements greater than permissible level of WHO [22]. Other researchers found that accumulation of heavy metals in plants depend on plant species: some species absorb a great amount, but other species lesser amount of the heavy metals [23].

According to this study, waste water should be used only for those plant species which absorb less toxic substances.

Furthermore, the accumulation of toxic and trace elements in body can deplete the essential elements from body that leads to serious diseases [24].

Some researchers worked with effluents of tannery in order to determine the concentration of heavy metals in soil and to find the access of the metals to soil [25]. A comprehensive study was conducted to investigate the accumulation of Cd, Cu, Cr, Ni, Pb and Zn in different vegetables, grown on agricultural soil and irrigated with untreated domestic waste water in the surrounding area of Hyderabad [26]. The waste water that is used in agriculture generates vector borne human diseases [27]. The sewage along with irrigation system based on water gives a permanent water source for vector mosquitoes in semi-arid countries like Pakistan. This study was conducted to determine the pollution degree of waste water served for irrigation of the fields to grow the different types of vegetables, which are used daily in the diet of the peoples of Hyderabad. Aim of this study was to investigate pollution degree of waste water and predict the effect of untreated waste water on the contamination degree of the growing vegetables.

2. Materials and Methods

The sampling location was between river Indus and latifabad, unit No10. The area covers about 2000-2500 acres of the land. The 90 percents of the land are irrigated with waste water and only 10 percents are irrigated with the river water. Besides about 150 small industries decided disposing off their effluents using of about 30 acre reserved by municipal authority for collection of the waste water. Many farmers of this area draw aside their channels from the main drain channel to use them for irrigation. Main agriculture of this area is vegetables that are delivered to the nearest vegetable market in Hyderabad (Sabzi Mandi).

A well mixed sample of waste water was collected from each point from the channels, which irrigates the land. The water sample was collected from the each location in the clean 2.5 L glass bottle. Before sample collection the bottle was rinsed three times with the sample water.

The first set of four samples was collected from village Hajjo Khan Lagari, 0.25 km away from latifabad. Second set of four samples was collected from village Narba Kolhi, 1 km away from latifabad. Third set of four samples was collected from the village Choudgry Sadaq, 0.5 km away from latifabad.

pH-value, conductivity, salinity and total dissolved solids (TDS) were determined by the FAO methods [28]. The samples were brought to the Excellence laboratory of Center for Environmental Sciences for further analysis.

2.1. Determination of Total Residue

For the determination of total residue, 100 ml mixed water was transferred to a clean pre-weighed beaker, and water was evaporated gently to dryness at 103-105^{0}C, cooled in a deccicator and weighed. The amount of total residue was calculated as:

$$\text{Total Residue} = \frac{(\text{A} - \text{B}) \times 1000}{100 \text{ ml of samples}}$$

where A= weight of the sample and beaker; B= weight of beaker.

2.2. Determination of Volatile and Fixed Residues

For the determination of volatile and fixed residue, a total residue was ignited at temperature of 550 ± 50^{0}C, in a muffle furnace for 1 h. The beaker was cooled partially in air, transferred to a deccicator, cooled and weighed. The loss on ignition is reported as a total volatile residue in the total residue, while the residue remaining in a beaker corresponding to fixed residue. Calculation was done as follows:

$$\text{Total volatile residue} = \frac{(\text{A} - \text{B}) \times 1000}{100 \text{ ml of sample}}$$

where A = weight of sample and beaker (or filter) before ignition; B = weight of beaker (or filter) and residue after ignition.

$$\text{Total fixed} = \frac{(\text{B} - \text{C}) \times 1000}{100 \text{ ml of sample}}$$

where B = weight of beaker (or filter) and residue after ignition; C = weight of beaker (or filter).

The determination of alkalinity and hardness were performed by titration method.

3. Results and Discussions

The temperature is important parameter, which affects the biological activity and concentration of oxygen dissolved in water [29, 30]. The temperature of water samples was in the range of 11 to 26^{0}C, and it was lower than the temperature of surrounding air. According to Paul and White, there is strong relationship between ecological activity and temperature: high temperature hinders the metabolic activity of unwanted microbes generated in aquatic system, which further could decrease the water quality from bad to worst [31].

Acidity or alkalinity, which was measured by pH-meter, has a great ecological importance because the behavior of ions and organic compounds is directly related with the pH-value. It was found that the pH-value of three sampling station was normal about 7 and suitable for irrigation. Increase in pH-value can be connected with a reduced rate of photosynthesis [32].

The term residue refers to an amount of floating, suspended, settable and dissolved solids present in water. The residue may affect the water quality. Water having high contents of total residue has an elevated density and reduced oxygen solubility. Such water inferior in palatability.

Regarding the investigated water samples, the total residue was 320-860 mg/l in samples from Haji Khan Laghari village, 760-1760 mg/l from Narba Kolhi village and 560-1580 mg/l from Choudhry Sadaq village, respectively. The volatile residue of three sampling stations was 40-240 mg/l, 60-180 m/l and 40-380 mg/l respectively. The variation of all residuals was given in figure 1.

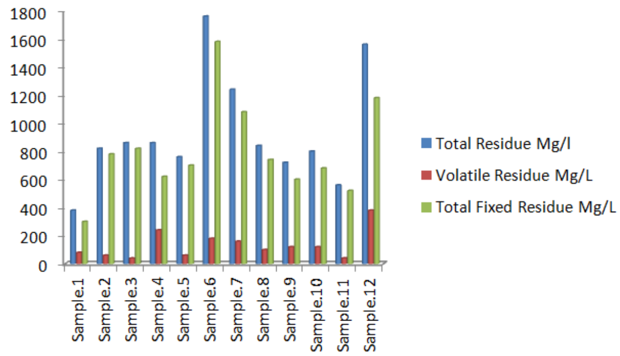

Figure 1. *Content of residues in water samples*

Electrical conductivity of the water samples for three locations was: 1265-1285 µS/cm for samples from Haji Khan Laghari village; 1148-1212 µS/cm from Narba Kolhi village and 1131-1212 µS/cm from Choudhry Sadaq village, respectively.

Salinity of the water became sharp problem: excess of salts in the root zone hinders water absorption from surrounding soil and affects negatively on the plant growth. Besides, the presence of salt in water impels the plant to expend more energy to extract water from the soil.

High amount of TDS may produce aesthetically displeasing taste, color and odor. In this study, the following amount of TDS was found: 615-625 mg/l for samples from Haji Khan Lagari village, 552-591 mg/l from Narba Kolhi village and 550-590 mg/l from Choudhry Sadaq village, respectively.

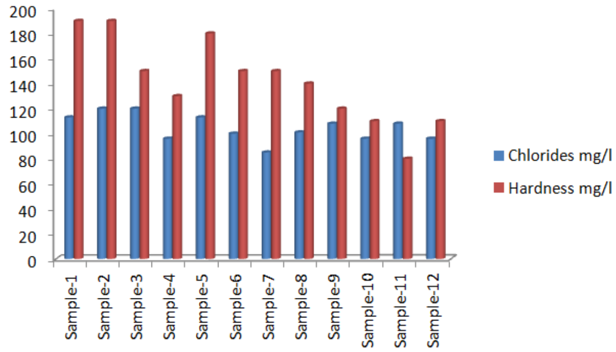

Figure 2. *Concentration of chlorides and hardness of water sample*

As known, water with hardness less than 75 mg/l is classified as soft; 75-150 mg/l as moderately hard; 150-300 mg/l as hard and greater than 300 mg/l as very hard. Hardness of water sample from Haji Khan Lagari village was 130-190 mg/l; from Narba Kolhi village was 140-180 mg/l and from Choudhry Sadaq village was 80-120 mg/l (Fig.2). Chlorides in waste water were found in concentration 96-113 mg/l for samples from Haji Khan Lagari village, 85-113 mg/l from Narba Kolhi village and 96-108 mg/l from Choudhry Sadaq village.

4. Conclusion

The investigated samples of waste water were characterized by moderate to high hardness and salinity. Moreover, these samples contained from 300 to 1800 mg/L of total residues. Nevertheless the pH-value was normal, in the range 6.7-7.0, that is suitable for water used for irrigation. Further investigations are required to determine toxicity of the waste water, as well as content and accumulation of heavy metals.

Table 1. *Results of analysis*

Sampling site	**Haji Khan Lagari Village**				**Narba Kolhi Village**				**Choudhry Sadaq Village**			
Samples No.	1	2	3	4	5	6	7	8	9	10	11	12
pH-value	6.66	6.68	6.68	6.69	6.80	6.81	6.82	6.86	6.87	6.95	6.98	6.92
Conductivity µS/cm	1265	1278	1271	1285	1148	1212	1190	1195	1195	1131	1143	1212
TDS mg/L	615	622	619	625	552	591	580	582	582	550	557	590
Salinity, mg/L	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total residue mg/L	380	820	860	860	760	1760	1240	840	720	800	560	1560
Volatile residue mg/L	80	60	40	240	60	180	160	100	120	120	40	380
Total fixed residue mg/l	300	780	820	620	700	1580	1080	740	600	680	520	1180
Alkalinity, mg/L	423	366	410	400	393	400	410	400	393	383	393	400
Chlorides, mg/L	113	120	120	96	113	100	85	101	108	96	108	96
Hardness, mg/L	190	190	150	130	180	150	150	140	120	110	80	110

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