Contamination of Agro-Ecosystem and Human Health Hazards from Wastewater used for Irrigation

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Summary: The use of untreated/inadequately treated wastewater for irrigation in agriculture has been practiced for many years in arid zones of industrialized as well as developing countries. Farmers mostly use wastewater for growing the vegetables and fodders in urban areas because of unavailability of enough suitable water, wastewater's high nutrient value, reliability and proximity to urban market. Wastewater is loaded with salts, heavy metals and disease causing micro organism. Continuous use of untreated city effluents for growing vegetable may result in soil degradation, accumulation of heavy metal in soil in phyto-toxic concentrations and contamination of soil-water-plant system with pathogens. The intake of contaminated vegetables may lead to public health risks of transmission of enteric diseases. Also excessive intake of heavy metal ions may result in human health hazards due to their toxic effect. This review paper, therefore, discusses heavy metal and pathogen load in wastewater and their contribution towards pollution of agro-ecosystem and their consequent impact on human health.

Introduction

Pakistan is the 6th most populated country in the world with approximately 160 million inhabitants [1]. Most of the country's land area (68 %) falls in arid and semiarid region where water is becoming an increasingly scarce resource. With increasing population at rate of 2 % annually, the country's demand for house hold and agricultural use is growing substantially. Land area of the country under irrigated agriculture is about 16 m ha compared to 4.5 m ha under rainfed agriculture [2]. Rainfall in the country is limited, uncertain and erratic and for all of its agricultural demands it almost depends on Indus River and its tributaries. The country's increasing population, saline groundwater, a poorly performing irrigation distribution system, pollution of large amount of water through urban house hold and industrial effluents and recurrent droughts have accentuated the water scarcity.

Under scarcity of irrigation water, the use of untreated urban wastewater for agriculture has become a common and a widespread practice. Wastewater is being used in many countries as attractive means of treatment and disposal especially in peri-urban agriculture near big urban settlement [3]. Waste water has been used in agriculture for decades and even centuries in countries like Mexico, Vietnam and China [4]. It is now receiving renewed recognition as a potential water source under the conditions of increased fresh water scarcity in Saudi Arabia, Jordan, India and Israel [5]. In United States alone, more than 3400 water reuse projects have been recorded. In China more than 1 million farming hectares depend upon wastewater irrigation. In Israel, Egypt, Tunisia, Greece, South Africa, Japan and growing number of Latin America countries, waste water reuse provide a substantial resource for agriculture production. The most compelling reasons for wastewater reuse include more and better crops and less frequent use of chemical fertilizers [6, 7].

Wastewater irrigation, however, poses a number of potential risks to human health *via* the consumption of or exposure to pathogenic micro-organisms, heavy metals, harmful organic chemical such as endocrine disrupting compounds and pharmaceutically active compounds [8]. Of these, heavy metals and pathogens are considered great threat to human health. Wastewaters are potential source of heavy metals [9-11]. Their uses not only pollute the soil [12], but also pollute the vegetables being grown under wastewater and industrial effluent irrigation [13]. Pathogens in municipal city wastewaters pose greatest risk to human health. A

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wide variety of microorganisms are found in wastewater, including bacteria, viruses, protozoan and parasitic worms. The symptoms and diseases associated with such infections are also diverse including typhoid, dysentery, gastroenteritis diarrhea, vomiting, and Malabo sorption. Estimates suggest that less than 5 % of all sewage effluent in developing countries receive any treatment before it is discharge into the environment [14]. Wastewaters generally contain high concentration of excreted pathogen, especially in countries where diarrhoeal diseases and intestinal parasites are particularly prevalent.

The scientific disposal of untreated wastewaters has resulted in accumulation of heavy metals in land and water bodies. Use of such wastewater for growing vegetables around big cities may also contaminate the soil with pathogens. Heavy metal accumulation in soil may get entry into the human and animal food chain through vegetable and other crops grown on such soils. Such crops are also likely to be contaminated with pathogens. These heavy metals and pathogens may lead to public health risk through consumption of contaminated vegetables. This review paper discusses some aspect of heavy metal and pathogen contaminations in the agriculture environment and their impacts on human health.

Quantity of Wastewater Available in Pakistan

The information compiled by FAO regarding the availability of wastewater produced and flow in major citifies of Pakistan (Table-1) indicate that total wastewater produced amounts to 116590 mg/d [15]. Bigger the city, greater the amount of wastewater produced. Highest quantity (44492 mg/d) is produced by Karachi, followed by Lahore (34432 mg/d), Faisalabad (7909 mg/d), Multan (4730 mg/d) and Peshawar (4742 mg/d). The main sources of wastewater are city sewage effluents and industrial effluent. These effluents are mostly untreated.

Table-1: Wastewater flow in major cities of Pakistan [15].

City	Sewage flow(mg*/d)	City	Sewage flow(mg/d)
Islamabad	3660	Peshawer	4742
Karachi	44492	Quetta	1793
Lahore	34432	Sargodha	1457
Faisalabad	7909	Sialkot	1503
Multan	4730	Sukkur	1317
Hyderabad	4605	Mardan	978
Gujranwala	4499	Kasur	773
Total	116590		

* Million gallons

Heavy Metal Pollution due to Wastewater Irrigation

Heavy Metals in Waste Effluents of Different Industries

Heavy metals concentration in waste effluent of different industries from Faisalabad, Pakistan is given in Table-2. As is evident from the data, Fe, Mn, Zn, Cu, Ni concentration in the waste effluents of different industries is lower than the permissible values of different industries. Similarly the Pb concentration in majority of the effluents was below the permissible limits except for chemical industry.

Heavy Metals in Canal Water and Wastewater

Data in Table-3 provides comparison of heavy metal concentration in canal water and wastewater used for irrigation in Haroonabad. As is evident from the data concentration of Mn, Pb, Ni, Co, Cd in wastewater was lower than their concentration in canal water. However, concentration of Cr, Cu and Fe was higher in wastewater than the canal water.

Heavy Metals in Wastewater of Small Town and Large Industrialized City

Table-4 provides comparison of heavy metal concentration in wastewater of Haroonabad and Narwala, Faisalabad. Haroonabad is small town

Table-2: Heavy metal contamination ($mmol^{-1}$) in waste effluent of different industries, Faisalabad, Pakistan

Heavy Metal.	Vegetable Oil Indy	Dying Ind.	Textile Ind.	Flour/feed Ind.	Tanning Ind.	Chemical Ind.	Permissible value*
Fe	1.00	0.58	1.06	2.39	ND	0.90	2.0
Mn	0.83	0.31	0.35	0.25	ND	0.32	1.5
Zn	0.41	0.13	0 33	0.00	035	0.17	5.0
Cu	0.16	0.16	0.19	0.00	0.03	0.32	1.0
Pb	0.28	0.10	0.15	0.00	0.01	0.55	0.5
Ni	0.29	0.16	0.18	0.00	ND	0.00	1.0
Cd	0.00	0.12	0.00	0.00	0.00	ND	-

*Permissible values are those reported by the Punjab Engi. Academy, Lahore, Pakistan, Ind.- Industry [16].

Table-3: Heavy metals (mgL^{-1}) in canal water and wastewater used for Irrigation, Haroonabad, Pakistan.

Heavy metal	Canal water	Wastewater
Manganese	0.12	0.07
Chromium	0.03	0.23
Lead	0.13	0.04
Nicle	0.17	0.14
Copper	0.12	0.35
Cobalt	0.09	0.06
Cadmium	0.02	0.01
Iron	0.01	0.22
Zinc	0.10	n.d

Source: [17]

Table-4: Heavy metals (mgL^{-1}) in wastewater used for irrigation in Haroonabad and Narwala, Faisalabad, Pakistan.

Heavy metals	FAO & WHO Guidelines	Haroonabad	Narwala, (Faisalabad)
Manganese	0.20	0.07	0.14
Chromium	0.10	0.23	0.05
Lead	5.0	0.04	0.24
Nickle	0.20	0.14	0.03
Copper	0.20	0.35	0.09
Cobalt	0.05	0.06	0.08
Cadmium	0.01	0.01	0.00
Iron	5.0	0.22	0.16
Zinc	2.0	n.d	0.14

Source: [18]

without industry, whereas Faisalabad is large industrialized city. Concentration of Mn, Pb, Co, and Zn, in wastewater from Narwala, Faisalabad was slightly higher than their concentrations in wastewater of Haroonabad. However, concentration of Cr, Ni, Cu, Cd and Fe in wastewater from Haroonabad was higher than their concentration in wastewater from Faisalabad. Concentration of Zn, Fe, Cd, Ni, Pb, and Mn in wastewater of both sites was lower than the FAO and WHO guide lines.

Heavy Metal Pollution of Soil with Wastewater Irrigation

Heavy metal loaded wastewater when used for irrigation of crops also contaminates the soil with heavy metals. Concentration of Cu, Mn, Ni, and Pb was found to be much higher in soil under wastewater irrigation as compared to canal irrigation. However, there was no difference in concentration of Co and Cr in soil under wastewater and canal water irrigation (Table-5).

Data in Table-6 gives similar information. Here the concentration of Fe, Mn, and Zn, was higher in soil under canal irrigation as compared to under soil water sewage drain irrigation. However concentration of Cu and Pb was higher in soil under sewage drain irrigation compared to under soil under canal irrigation. In general concentration of the heavy metals was higher in the top 0-15 cm as compared to15-30 cm depth.

Heavy Metal Contamination of Crops under Wastewater Irrigation

We grow all plants in soil. Therefore, soil contaminated with heavy metal ions is likely to effect the plant growth and crop quality. This aspect is very important and deserves our special attention in areas where food crops, especially vegetable are grown on heavy metal contaminated soil [20]. On such soil, vegetable and other crops grown will surely have

Table-5: Heavy metal concentration in top soil under wastewater, conjunctive water use and canal water irrigation, Haroonabad, Pakistan

Type of irrigation supply	Heavy metal content in soil ($mg\ kg^{-1}$)					
	Co	Cr	Cu	Mn	Ni	Pb
100% wastewater	11.6	70.4	66.8	223.6	29.0	16.3
Conjunctive water use	12.7	46.5	55.0	246.4	27.1	9.2
Canal water	11.4	69.7	39.9	196.8	22.2	6.6

Source: [17]

Table-6: Heavy metal concentrations ($mg\ kg^{-1}$) in soil (0-15 cm) under canal and sewage drain Irrigation.

Heavy metals	Source of irrigation	
	Canal	Sewage drain
Fe	11.32	8.02
Mn	10.78	3.95
Cu	1.00	9.82
Zn	14.20	8.36
Pb	0.84	9.04

Source: [19]

higher concentration of heavy metals. Metal ion uptake is not only affected by plant species and physico-chemical characteristics of soil but also climatic condition (mainly temperature and rainfall). Plants grown in a warmer environment (25°C) accumulated substantially higher concentration of heavy metals than those raised in relatively cooler environment (15°C). Concentration of Cd, Cr, Ni and Zn in spinach, fenugreeks and bitter gourd, irrigated with city effluent was always higher than their

Table-7: Heavy metal ions concentration (mg kg^{-1}) in vegetables irrigated with city effluents in Faisalabad areas.

Name of Vegetable	Edible Portion	Heavy metal ions concentration (mg kg^{-1})			
		Cd	Ni	Zn	Cr
Spinach	Leaves	0.04	5.36	12.34	8.72
Fenugreek	Leaves	0.03	6.32	11.35	7.69
Bitter Gourd	Fruit	0.04	3.25	10.63	5.89
Critical limit		0.02	1.30	10.00	5.00

Source: [13]

permissible critical concentration (Table-7). Accumulation of Cd was comparatively much lower than the other metal ions.

It was also reported that concentration of Pb and Cr in different parts of summer vegetables irrigated with untreated city effluent was several times higher than the vegetables grown under canal irrigation [10]. The concentration of Cr in spinach roots was much higher than in the leaves, indicating its poor translocation to upper plant parts [21].

In another study, Cu concentration in vegetables irrigated with effluent was found above the permissible critical level (Table-8). Eggplant accumulated highest concentration of Cu, followed by Spinach and Okra.

Table-8: Copper concentration in vegetables (mg kg^{-1}) irrigated with city effluent.

Vegetable	Plant Part		Mean
	Leaf	Fruit	
Spinach	28.43	-	28.43
Vegetable Marrow	15.25	22.62	18.94
Egg Plant	30.10	30.22	30.16
Okra	26.40	26.95	26.68

Permissible concentration in eaTable-portions ~ 10 mg L^{-1}
Source: [12]

As is clear from data in Table-9, Fe concentration was the highest in wheat followed by cauliflower. However, mustard and cabbage contained comparatively lower concentrations of Fe. The concentration of Mn was highest in cabbage followed by mustard and wheat. Copper concentration was the lowest in cauliflower, followed by cabbage and mustard. However, wheat contained the highest amount of Cu. Zinc concentration was found to be highest in cabbage closely followed by cauliflower and mustard, while wheat contained its lowest concentration. Cd concentration in all the crops was almost similar with slightly more concentration in wheat. The accumulation of certain heavy metals in wheat and cauliflower could become beyond human consumption levels if discharge of sewage sludge effluent is continued. The average/normal concentration of Cd is 0.05 ug g^{-1} dry matter, and that of Ni is 260 ug g^{-1} dry matter, respectively [22]. Wheat out of four plant species can to some extent tolerate the excess limits of heavy metals from contaminated soil and, can be treated as accumulator plant [23]. Certain aquatic plants, which absorb and accumulate high contents of heavy metals, possess photo-remediating abilities. Many free-floating emergent and submerged species have been identified as potential accumulators [24-27]. Such plants can be utilized for improving water quality and reducing the pollution load in water bodies. The submerged macrophytes are particularly useful in abatement and monitoring of heavy metals. They do not migrate and attain equilibrium with their surroundings with in short period as these are used to bio-absorb the metals from wastewater [28].

Pathogen in Wastewaters

Wastewaters are generally contaminated with all types of pathogen. The possible level of Pathogens in wastewater are given in Table-10.

Wastewater thus may contain all types of microorganism such as viruses, bacteria, protozoa

Table-9: Average concentration of heavy metals in different plant species irrigated with wastewater.

Name of crop	Average concentration of metals (mg kg^{-1})							
	Fe	Mn	Cu	Zn	Ni	Co	Cr	Cd
Wheat	529	105	22.0	48.3	8.12	7.34	3.55	1.83
Mustard	374	125	19.7	71.5	5.17	8.80	6.14	1.50
Cabbage	370	130	17.3	75.9	7.65	3.45	5.81	1.65
Cauliflower	3.84	65	12.3	75.3	7.18	4.87	7.47	1.61

Source: [23]

Table-10: Possible levels of pathogen in municipal wastewater.

Type of pathogen		Possible concentration L^{-1}
Viruses	*Enteroviruses*	5000
Bacteria	*E. Coli*	?
	Salmonella spp	7000
	Shigella spp	7000
	Vibrio cholerae	1000
Protozoa	*Entamoeba histolytica*	4500
Helminths	*Ascaris Lumbricoides*	600
	Hookworms	32
	Schistosoma mansoni	1
	Taenia saginata	10
	Trichuris trichiura	120

Figures in brackets show the usual survival time.
Source: [29]

Table-11: E. coli count and Helminthes eggs in canal water and wastewater used for irrigation in Haroonabad, Pakistan.

Pathogen	Unit	Canal water	Wastewater
E. Coli	Count/100	$1.6\ 10^3$	$6.3\ 10^7$
Helminthes eggs	Number L^{-1}	n.d.	100

Source: [30]

and helminthes [29]. *E. coli* count and Helminthes eggs in canal water and wastewater used for irrigation in Haroonabad, Pakistan (Table-11) were much higher than international health guidelines for *E. coli* (<1000/100 mL) and helminthes eggs (<1 L^{-1}) making the wastewater unusable for agriculture of any kind. Even the canal water with much lower faecal contamination was also unfit for irrigation according to same guidelines.

As is evident from the data in Table-12, faecal coli form in wastewater of Haroonabad and at Narwala and channel 4 sites in Faisalabad were much higher than WHO guidelines. Helminthes eggs count in wastewater of two sites were also much higher than, the said guidelines

Survival of Pathogen

Under favourable conditions enteric pathogen can survive for longer periods of time on crops, in water and in soil [31]. The survival of pathogens in soil varies from hours to several months. A summary of pathogen survival rate is given in Table-13.

In most cases it appears that 2-3 months is sufficient for the reduction of pathogenic bacteria to negligible number once they have been applied to the soil. It is important to know the persistence and movement of pathogen in soil, overland run off, groundwater, crops and aerosols. The factors that effect the survival of enteric bacteria and viruses are given in Table-14 above.

The studies show that the bacteria can penetrate in broken, bruised and damaged portion of vegetables. These are not removed with ordinary washing. Crook reported in 1978 that heavy rainfall did not wash away coliforms from crops irrigated with wastewater. Bacteria survive longer in dense gross. It survives longer in leafy vegetables than in smooth vegetables. The crops eaten raw, therefore, pose greater (potential) risk (Table-15).

Table-12: Pathogens in wastewater used for irrigation in Haroonabad and at Narawal and channel 4 sites in Faisalabad, Pakistan.

Pathogen	Unit	FAO & WHO Guidelines	Haroonabad	Faisalabad	
				Narawal road	Channel 4
Faecal Coliform	Count/ 100^{-1}ml	1000	6.3×10^7	$>10^8$	$>10^8$
Heliminth eggs	No L^{-1}	<1	100	763	-

Table-13: Survival of excreted pathogens (at 20-30 °C).

Type of pathogen	Survival time in days.*			
	Faeces, night soil & sludge	Fresh water & sewage	In the soil	On crops
Viruses				
Enteroviruses	<100(<20)	<120(<50)	<100(<20)	<60(<15)
Bacteria				
E. Coli	<90(<50)	<60(<30)	<70(<20)	<30(<15)
Samonella spp	<60(<30)	<60(<30)	<70(<20)	<30(<15)
Shigella spp	<30(<10)	<30(<10)	<10(<5)	
Vibrio cholerae	<30(<5)	<30(<10)	<20(<10)	<5(<2)
Protozoa				
Entamoeba	<30(<15)	<30(<15)	<20(<10)	<10(<2)
Heliminthes				
Ascaris eggs	Many Months	Many Months	Many Months	Many Months

Source: [29]
* Figures in brackets show the usual survival time.

Table-14: Factors effecting survival of enteric bacteria and viruses.

Factor	Effect
pH	Shorter survival of bacteria in acidic soils (pH = 3 to 5)
Antagonism from soil	Increased survival time of bacteria in sterile soil.
Moisture content	Longer survival time of bacteria and viruses in moist soil
Temperature	Longer survival of bacteria and viruses at low temperature.
Sunlight	Shorter survival of bacteria and versus at the soil surface
Organic matter	Longer survival of bacteria and viruses when sufficient organic matter is available.

Source: [32]

on human health are rated as a silent epidemic. The effects of different metal ions on human health are variable. In general, they increase birth defects, absorption and certain forms of cancer, and decrease the average weight of children at birth. Some of the ions such as Cd, Cr and Pb, which have high mammalian toxicity are more toxic to human being than to plants (have medium phytotoxicity). Lead itself is not poisonous to human being [35]. Some people have lived for years with lead containing bullets in their bodies. Irrigation waster with low level of lead (around 30 ug L^{-1}) has a minimum

Table-15: Contamination of vegetables grown near the sampling sites with pathogenic bacteria and giardia cyst.

Type	No of Sampling Sites	No of sampling	Fecalfound *coliform*		*E.coli* found		Giardia cyst found	
			No	%	No	%	No	%
Cabbage	4	12	12	100	12	100	6	50
Lettuce	4	12	11	97	6	50	6	50
Green Vegetables	4	12	12	100	11	97	3	25
Tomatoes	3	9	6	67	9	100	0	-
Cucumbers	3	9	9	100	6	67	0	-

Source: [33]

Human Health Hazards Related to the Use of Wastewater

Effect of Heavy Metal Ions

The use of industrial wastewater in agriculture and livestock presents potential risk for health, due to toxic nature of chemical compounds present in wastewater. Much of the urban population in big cities of Pakistan regularly consumes the effluent-irrigated vegetables with high concentration of heavy metal ions, continuous use of which will result in toxic level of accumulation of heavy metal in the human body. Information in Table-16 indicates as to how heavy metal accumulation increases in human body over period of time.

Also several studies have demonstrated adsorption of heavy metals by plants, such as wheat and rice that can affect consumers [34]. An epidemiological evidence was the case of Toyama, Japan, where the population was affected by the ingestion of Cd contained in rice, the origin of this element was a nearby mine that contaminated the irrigation water.

Metal ions once taken up by human body are released and excreted very slowly. Because of their slow and silent action on human health, their effects

Table-16: Metal ion intake in human body on the basis of 1.0 kg/wt vegetables consumption.

Metal ions	Human intake of metal ion (mg)		
	Week	Month	Year
Cd	0.08	0.3	4
Cr	5.20	22.4	270
Cu	13.77	59.2	716
Fe	195.50	840.6	10166
Pb	3.11	13.4	162
Mn	9.27	39.9	482
Ni	10.59	45.6	551
Zn	8.55	36.8	445

Source: [12]

influence in the toxicological quantity of vegetables whose edible part grows beneath. Specific disorders regarding the effect of toxic level of different metal ions on human being are given in Table-17.

Effect of Pathogen

The use of sewage-contaminated wastewater has significant health implication for the farmers and the consumer [37]. The wastewater is laden with faecal bacteria and at the most could expose the farmer to the risk of dysentery or even cholera. Total population of surface micro flora and endomicroflora was much higher near to source that furthest from the sewage source. Population of total surface micro flora and E. coli at the vegetable ridge was much lower than in the basin. The farmers stand in the furrows in the flowing wastewater rather the risk of

Table-17: Effects of excessive intake of metal ions on human health.

Metal ion	Expected human health hazards
Cd	Sever nausea, salivation vomiting, diarrhea, lipid deposition in the arteries of heart, abdominal pain.
Cr	Lung cancer, gastro intestinal upset, ulcer, edema, dermatitis
Cu	Nausea, epigastric burning, diarrhea, gastrointestinal bleeding
Fe	Gastrointestinal hemorrhage, metabolic acidosis
Pb	Anemia, headache, dizziness, loss of memory
Mn	Lethargy, increase in muscle tone tremor, mental disturbance
Ni	Abdominal discomfort, vomiting, nausea, diarrhea, headache, cough
Zn	Dehydration, electrolyte imbalance, abdominal pain, nausea, lethargy, dizziness, muscular incardination

Source: [36]

Table-18: Relative health risks from the use of untreated excreta and wastewater in agriculture and aquaculture, Engel berg 1995.

S. No	Class of pathogen	Relative amount of excess frequency of infection or diseases
1	Intestinal nematodes: Ascaris, Trichuris, Ancylostoma, Necator	High
2	Bacterial infections: Bacterial diarrhoeas (e.g. cholera) Typhoid	Lower
3	Viral infection: Viral diarrhoeas hepatitis A	Least
4	Trematode and cestode infection: Schistasomiasis, clonorchiasis, taeniasis	From high to nil depending upon the particular excreta, use practice and local circumstances

Table-19: Effectiveness of enteric pathogens to cause infections through wastewater irrigation related to their epidemiological characters.

Enteric Pathogen	Persistence in environment	Minimum Infective Dose	Immunity	Concurrent Routes of infections	Latency soil development stage
Viruses	Medium	Low	Long	Mainly home contact and food or water	No
Bacteria	Short/ medium	Medium/high	Short/ medium	Do	No
Protozoa	Short	Low/medium	None/little	Do	No
Helminthes	Longs	Low	None/little	Mainly soil contact outside home and food	Yes

damaging the ridges during vegetable transplanting and weeding operations, thus increasing their contact with and exposure to untreated wastewater [38].

Information regarding relative health risk from the use of untreated excreta and wastewater in agriculture and aquaculture is given in Table-18. Frequency of infection or disease due to intestinal nematodes has been found to be high. Bacterial and viral infection has been found to lower and the least. Trematode and cestode infection has been found to vary from high to nil depending upon the particular excreta, use practice and local circumstances.

The prevalence of helminthes infection was found to be significantly higher among children in region using wastewater for agriculture purposes compared to control [39]. Intestinal helminthes infections were caused by five parasites (Ascaris lumbriclodes, trichuris trichiura, enteriobius vermicularis, himenolepis nana and Taenia Siginata). Prevalence of ascariasis was five fold higher in children living in areas where wastewater irrigation was used compared to the control group. In a similar study carried out in India, it was found that 47 % of sewage farm workers were positive for ascariasis; as compared to 13 % for control group [40].

The effectiveness of enteric pathogens to cause infection through water irrigation related to their epidemiological characteristics such as persistence in environmental, minimum infective dose, immunity and concurrent routes of infection is given in Table-19.

Conclusions

Urban settlements in developing countries are growing at an unparalleled rate and are requiring increasing water supplies and sanitation coverage that will continue to release high amount of wastewater. Since there is general shortage of good quality irrigation water for use in agriculture, especially in arid and semi arid countries hence wastewater is valuable natural resource and considered as an alternative option for periurban agriculture. City wastewaters are no doubt chief source of soil nutrients and organic matter but contain high

concentration of salts and are also heavily contaminated with heavy metal ions and pathogen. Use of wastewater for growing vegetables not only increases the concentration of heavy metals in vegetables but this also results in increasing their concentration in soil. Use of such wastewater for growing vegetables for longer time periods will result in the toxic accumulation of the heavy metal ions in human body leading to severe health problems. Also the wastewater contains pathogens, which cause human diseases by direct contact or eating the raw vegetables contaminated with these pathogens. In view of this, serious consideration should be given to treatment of all types of wastewaters before their use for agricultural purposes.

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