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Short communication

The comparison of parasite eggs and protozoan cysts of urban raw wastewater and efficiency of various wastewater treatment systems to remove them

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ABSTRACT

One of the most important quality characteristics associated with wastewater reuse in agriculture is the microbial quality. This study aimed to determine the efficiencies of Ghasreshirin (constructed wetland), Islamabadgharb and Gilangharb wastewater treatment plants (stabilization ponds), Sarpolezahab and Paveh (extended aeration activated sludge) and Kermanshah (conventional activated sludge) in the removal of protozoan cysts and parasitic eggs.

This study was carried out during six months and samples were collected at weekly intervals from influent and effluent of the wastewater plants. In order to determine the concentration of ova, 288 samples were analyzed by Mc Master Slide according to Bailenger method.

No parasite eggs or protozoan cysts were detected in the effluents of the constructed wetland or stabilization ponds systems. The extended aeration activated sludge system of Sarpolezahab removed 99–100% of parasite eggs and ≥99% of protozoan cysts. The respective values for extended aeration activated sludge system of Paveh were 97.5–100% and ≥99%. However, the conventional activated sludge of Kermanshah removed 97–99% and 99–100% of parasite eggs and protozoan cysts, respectively.

According to the results, removal efficiency for cysts and parasite eggs in natural systems (constructed wetland and stabilization ponds) is better than mechanical systems (extended aeration activated sludge and conventional activated sludge). The effluent quality of all systems in terms of nematode eggs is consisted to Engelberg index (nematode eggs count: 1 ≥ counts per liter).

1. Introduction

In relation to the reclaimed wastewater application, suitability of effluent quality particularly in terms of microbial parameters and compliance with national and global standards is very important (Carr, 2005; Bitton, 2005; Kalavrouziotis and Apostolopoulos, 2007; Papaiacovou, 2001; Weizhen and Andrew, 2003).

In reusing, if do not pay attention to microbial quality and sanitary aspects of effluent, human health and environment may be encountered to serious risks. It would be more important when the effluent is applied to irrigation of public lawns and parks and raw crops such as vegetables (Palese, 2009; Lubello, 2004; Gupta et al., 2009). The wastewater must be treated in order to remove pollutants such as organic matters and pathogens. There are various biological treatment processes including activated sludge, trickling filter, aerated lagoon, stabilization pond, and constructed wetland (Ansola et al., 2003; García et al., 2008; Song et al., 2006; Tchobanoglus and Burton, 2003). Mechanisms of parasite eggs removal via wastewater treatment processes are varied from the removal mechanism of the other pollutants. The eggs are removed mainly through precipitation, sedimentation, filtration, adsorption by plant roots, trapping in suspended biosolids, and deactivation due to unfavorable environmental conditions (Donald and Rowe, 1995; Miranzadeh and Mahmoudi, 2002; Patricia et al., 2008).

Based on recent researches, efficiencies up to 99% for trickling filter, 99.9% for aerated lagoon, 99% for activated sludge, and nearly 100% for stabilization ponds and subsurface constructed wetlands (due to high retention times) are achieved in parasitic eggs removal. In any process, removal efficiency is a function of wastewater characteristics and treatment plant design criteria and experiences high variations (Patricia et al., 2008; Matteus, 2000). In Iran, a few studies have been conducted on efficiency of removal by wastewater treatment plants in protozoan cysts and parasite eggs removal and there is no similar research on natural and mechanical wastewater

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Table 1
The mean parasitic contamination level of raw and treated wastewater in Kermanshah province (count per liter of wastewater).

Plant	Sampling location	*Ascaris lumbricoides*	*Hymenolepis nana*	*Trichuris trichiura*	Giardia cyst	Amoeba cyst	Total parasite eggs	Nematode egg	Total protozoan cysts
Kermanshah	Influent	45.75	4.52	0	10.77	19.33	50.27	45.75	30.1
	Effluent	0.97	0	0	0.35	0.22	0.97	0.97	0.57
Islamabadgharb	Influent	29.98	9.96	0	7.6	10.5	39.94	29.98	18.1
	Effluent	0	0	0	0	0	0	0	0
Sarpolezahab	Influent	45.85	5.07	2.49	14.44	7.49	53.41	48.34	21.93
	Effluent	0.45	0	0	0.24	0	0.45	0.45	0.24
Ghasreshirin	Influent	30.43	5.42	0	6.85	13.1	35.85	30.43	19.95
	Effluent	0.08	0	0	0	0	0.08	0.08	0
Paveh	Influent	38.88	6.84	0	15.55	9.87	45.72	38.88	25.42
	Effluent	0.56	0.11	0	0.2	0	0.67	0.56	0.2
Gilangharb	Influent	37.99	6.81	2.53	9.11	6.5	44.8	39.99	15.61
	Effluent	0	0	0	0	0	0	0	0

treatment systems in full scale and in the similar climates. Furthermore, since a new wastewater treatment plant has recently been developed in Kermanshah, this study aimed to compare treatment plants performances in Ghasreshirin (constructed wetland), Gilangharb and Islamabadgharb (stabilization ponds), Sarpolezahab and Paveh (extended aeration activated sludge), and Kermanshah (conventional activated sludge) in removal of protozoan cysts and parasite eggs. Appropriation of produced effluent for application in agriculture and irrigation of crops have also been evaluated.

2. Materials and methods

This cross-sectional study was performed within 6 months during spring and summer seasons. Samples were collected weekly from raw wastewater (screening unit) with 1 l volume, and final treated effluents (after chlorination unit) with 10 l volume. In total, 288 samples were collected and analyzed (i.e. 48 samples from each plant). Sampling days during the week were randomly selected and the samples were delivered to a microbiological laboratory in faculty of health, Kermanshah University of medical sciences in order to parasitological experiments.

Parasitological analysis was conducted based on modified Bailenger method with McMaster counting slides (with volume held under the grid equal to 0.3 ml) (Rachei and Mara, 1996).

Finally, all statistical tests were carried out using SPSS-Version.16 with a level of significance of 0.05.

3. Results

Results show that constructed wetland and stabilization ponds removed ≥99% of parasite eggs and protozoan cysts. The efficiencies for extended aeration activated sludge in Paveh were 97.5–100% and ≥99%, respectively. The conventional activated sludge system in Kermanshah removed 97–99% and 99% of parasite eggs and protozoan cysts, respectively.

The mean parasitic contamination levels of raw and treated wastewater samples are presented in Table 1. Minimum and maximum counts of parasite eggs and protozoan cysts found in raw and treated wastewater samples are shown in Table 2. The statistic results from Kruskal–Wallis and Mann–Whitney and one-Sample kolmogorov Smirnov tests are summarized in Tables 1 and 2. The mean of parasite egg and protozoan cyst counts in raw wastewater

Table 2
Minimum and maximum counts of parasite eggs and protozoan cysts in raw and treated wastewater samples (count per liter of wastewater).

Plant	Sampling location	Count	*Ascaris lumbricoides*	*Hymenolepis nana*	*Trichuris trichiura*	Giardia cyst	Amoeba cyst	Total parasite eggs	Nematode egg	Total protozoan cysts
Kermanshah	Influent	Min	0	0	0	0	0	0	0	0
		Max	175	50	0	40	93.3	225	175	105.7
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	4	0	0	2	3.2	4	4	3.2
Islamabadgharb	Influent	Min	0	0	0	0	0	0	0	0
		Max	80	41.7	0	50	75	106.7	80	73.7
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	0
Sarpolezahab	Influent	Min	0	0	0	0	0	0	0	0
		Max	120	33.25	18.3	46.7	90	120	120	120
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	2.7	0	0	1	0	2.7	2.7	2.3
Ghasreshirin	Influent	Min	0	0	0	0	0	0	0	0
		Max	100	67.7	0	30.7	50	167.8	100	75
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	0.8	0.67	0	0	0	0.8	0.8	0
Paveh	Influent	Min	6.7	6.7	0	0	0	0	6.7	0
		Max	80	33.3	0	82	65	83.3	80	82
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	3	2	0	2	0	3	3	2
Gilangharb	Influent	Min	7.3	0	0	0	0	7.3	7.3	0
		Max	88	44.4	25.7	106.7	20.7	158	113.7	106.7
	Effluent	Min	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	0