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Elimination of Nematode Cysts and Ova from Hospital Sewage by Activated Sludge Process

[1]*Zabihollah Yousefi* and [2]*Hajar Ziaei hezarjaribi*

[1]School of public health, Mazandaran University of Medical Sciences, Sari, Iran
[2]School of Medicine, Mazandaran University of Medical Sciences, Sari, Iran

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Abstract: Although medical wastewaters are considered as hazardous, little attention is paid to their proper management and disposal. This study conducted on two typical educational hospitals with 300 and 220 beds capacity for parasite cysts and Ova reduction by the hospital wastewater treatment plants. Samples were collected from influents and effluents of the treatment systems by grab and composite methods. Three samples were taken per week in three months by Bailenger method with concentration-flotation on 33 percent zinc sulphate was applied. Slide was prepared and observed under a microscope. Cyst count was done by Mac Master Slide. The average parasites in influent and effluent samples of Imam Hospital was 8.53 and 13.83 per liter, respectively. The Nematode larva with the highest number of 4.78 per liter from the influent and *Oocyst* with 7.81 per liter of the effluent of the system were determined. Similarly, in Boali Hospital the Nematode larva in influent and *Oocyst* in effluent were 9.06 and 10.97 per liter, respectively. Nematode larva with 5.97 and of *Entamoeba histolytica* with 4.12 ranked the highest number. Presence of Nematode in the wastewater influent in both hospitals under study did not match the Engelberg Guideline (less than one per liter).

Key words: Activated sludge · Hospital wastewater · Nematode Ova · *Oocyst* · Removal efficiency

INTRODUCTION

Hospital wastewater is a special category of liquid wastes, which is highly hazardous due to its infectious and/or toxic characteristics. Hospital wastewater is considered as a complex mixture populated with pathogenic microorganisms. Although medical wastewaters are considered as hazardous, little attention is paid to their proper management and disposal. One of the main problems of the environment is discharging of hospital wastewater. Reuse of treated wastewater for agriculture and irrigation of green area is the main objective of wastewater treatment [1-3]. Hospitals use a large amount of water daily bases roughly estimated 400-1200 L/d/bed [3, 4]. Hospitals generate an average 750 L of wastewater by bed in a day [5]. Hospital wastewater is contaminated with pathogenic microorganisms, radioactive elements, heavy metals and other toxic chemical substances. Hospital sewages are harmful to ecology and public health [3-6, 23].

Hospital wastewater is the source of infection and under the act of medical wastes [7]. Helminth eggs are the infective agents for the types of worm diseases known globally as helminthiases. Although helminths are pluricellular animals their eggs are microscopic (around 20 to 80 ìm for those that are important in the sanitary field) and are contained in variable amounts in wastewater, sludge and excreta. Hospital wastewater is one of the distribution ways of the helminth eggs in the environment. Helminth eggs infect humans through: 1. the ingestion of food crops polluted with wastewater, sludge or excreta, 2. direct contact with polluted sludge or faecal material and 3. the ingestion of polluted meat or fish. Wastewater has to be treated to remove the microbial as well as chemical contaminants. There are different methods of removing contaminants; the common treatment processes are activated sludge, stabilization pond, aerated lagoon, trickling filter and etc. In order to remove helminth eggs from wastewater, processes, which remove particles, such as sedimentation, filtration or

Corresponding Author: Hajar Ziaei hezarjaribi, School of Medicine,
Mazandaran University of Medical Sciences, Sari, Iran. E-mail: ziaei2000@yahoo.com

coagulation-flocculation are employed [8-10]. Extended aeration is one of the modified processes of active sludge; aeration time and microbial retention time are high and no need of the primary sedimentation tank. Mechanism of removing Ova during processing is different. Ova's sedimentation is due to high molecular weight and trap of parasite biologic mass, the active sludge and inactivation due to improper condition of environment [11]. The wastewater pool has high efficiency of evening up to 100% in removing the parasite Ova due to more staying of wastewater [11, 12].

Wiandts has reported elimination rate of 99.5 to 99.8% *Giardia* cyst by activated sludge [12]. Also, Miranzadeh has reported that activated sludge process by aeration method has 100% efficiency for the removal of Nematode Ova [11]. Other study indicated 99% efficiency of activated sludge method in removing parasite Ova [13]. An independent researcher has found that activated sludge process had ability of maximum 99% of the Ova removal [14].

Caccio *et al*. have showed that rate of eliminating cysts is 94.5% when the secondary treatment includes active oxidation plus sedimentation and the effect is more than the method of activated sludge and sedimentation, which was 73.1 to 88% [15].

Not all treatment processes are efficient enough to inactivate the amount of eggs contained in wastewater sludge in developing countries, in terms of reliably or affordably [16-21].

World health organization (WHO) has published guidelines with regards to the level of treatment required. They have suggested that a value = 1 egg/L in wastewater intended for the irrigation of crops to be eaten uncooked is safe [22].

Since, efficiency of Boali and Imam Hospitals' wastewater treatment plants for the removal of the parasites Ova has not been investigated yet; the aim of this study is to determine the elimination rate of these treatment plants in removing parasites within duration of three months.

MATERIAL AND METHODS

Imam hospital has 287 active beds with 150 m^3 wastewaters and Boali hospital with 220 beds and 84 m^3 wastewaters per day. The treatment method in these hospitals is activated sludge through expanded aeration. The plants have different parts of bar screen, aeration tank, secondary clarifier, chlorination tank and anaerobic or aerobic digestion tank. The effluent discharged to the absorption wells. The anaerobic digestion tank is drained by a sludge collector truck for transfer to a treatment plant once a year. Figure 1 shows the HWWTP studied in this research. Some detail of hospital data and wastewater treatment plants are given in the Table 1.

This study was conducted based on 100 samples taken within 3-month period. One liter of influent and 4 liters of effluent were sampled 2-3 times a week. At the time of sampling, pH, temperature, level of residual chlorine and turbidity were recorded. The samples were transferred to the university laboratory for Ova investigation by Bailenger method and some detail analysis.

For Helminthes eggs determination, the samples were kept in Imhaf cone and settled for two hours, the suspended materials got settled, then 90% of the supernatant water removed by a vacuum pump, sediment added to the centrifuge tube and centrifuged for 15 minutes at 1000 rpm, then the supernatant water removed and the sediments mixed not to allow any sediment left. From this sediment, a suspension of buffer with acetoacetic pH=4.5 prepared. Two folds volume ether added, then the suspension mixed thoroughly with a stirrer. The sample centrifuged at 1000 rpm for 15 minutes

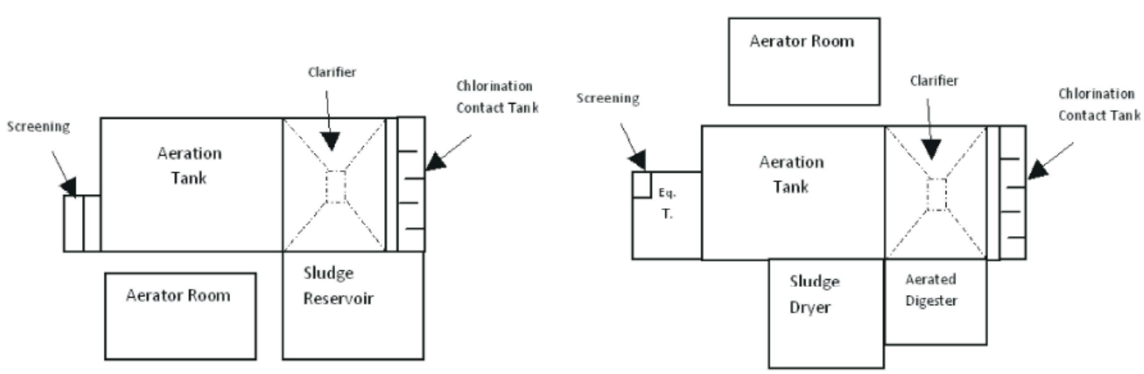

Fig. 1: Configuration of Imam and Boali HWWTP

Table 1: The characteristic of the Two Hospitals Wastewater Treatment Plants

Parameter	Unit	Imam HWWTP	Boali HWWTP
Average influent to the wastewater tank	m^3/day	150	84
Garbage remover	-	manually	manually
Open space of bar screen	centimeter	1	1
bar screen Angle	degree	45	45
Type of biologically treatment plant	Extended Aeration Active sludge		
Volume of aeration tank	m^3	176	96.9
Average of hydraulic detention time	hours	28	27.7
Solid retention time (SRT)	day	15 to 30	15 to 30
Type of aeration system	-	diffuser	diffuser
Number of air compressors (blowers)	Instrument	2	1
Power of each blowers	kilowatt	5.5	7.5
Size of aeration tank	meter	11×4×4	7.5×3.8×3.4
Size of the secondary sedimentation tank	meter	7.5×3.5×4	3.7×2.2×2.7
Volume of the secondary clarifier	m^3	84	22
Detention time of secondary clarifier	h	13.4	6.3
Average of the surface overflow load (SOR)	meter/day	5	10.3

and supernatant removed. Again with the sediment a suspension prepared with 5 fold volume of 33% zinc sulfate, the suspension mixed well with a stirrer then the remained sediment also transferred by Pasteur pipette to Mac Master slide of 0.3 ml content for study of Ova. Number of Ova counted in each volume by the formula of N=A6/py, while N= number of the Ova, A= number of counted Ova, y= volume of the sediment and p= volume of Mac Master Slide.

RESULTS AND DISCUSSION

Influent of Boali hospital were 9.6 Ova/liter, most number with larva of nematode, mean of 5.97/liter and from effluent 10.97/liter most with cyst of *Histolytica* and mean of 4.12/liter (Fig. 2). In Imam Hospital, finding shows that the total number of the Ova in the influent is 8.53/liter, most with nematode larva with a mean number of 4.78/liter. The mean number of Ova in effluent was 13.83/liter, most of the Oocytes with mean of 7.81/liter (Fig. 3).

It is worth mentioning that at the time of this study gasoline leaked to the plant pool of Boali hospital and as a result reduced the counting rate.

As is shown in Fig 2, the larva of nematode were obtained the highest level of density and crowding in Boali influent and effluent. Also the figure showed that, presence of Helminthes Ova in effluent is mostly more common than influent. This event reveals that the operation and maintenance can affect the efficiency of HWWTP.

It was found that Boali Sina hospital wastewater treatment plant had 100% efficiency for the removal of Ova of *Fasiola* hook worm, *Hymenolepsis nana* and the lowest rate of removing the *histolytica* cyst with negative resultant. In Imam Hospital 100% efficiency at eliminating Ova of *Dicrosolium* and *Tricocephal* but reduction of *Oocyst*, indicating the negative resultant of the plant. Presence of nematode Ova and the other parasitic agents in the effluent of Boali and Imam Hospitals treatment plants demonstrate that not only the systems cannot remove parasites completely, but also has a negative resultant in reducing all parasites.

It reveals that wastewater treatment plants of both hospitals can't remove properly the cysts and Ova due to under standard level of chlorination of the influent. Wiandt *et al*. reported elimination rate of 99.5 to 99.8% of *Giardia* cyst using activated sludge [10], while in our study, in Imam and Boali hospitals the rate of reductions were 78 and 50.97%, respectively.

Miranzadeh and Mahmoudi have reported that the reduction rate of 100% for nematode Ova using activated sludge expanded aeration method [9]. While in Boali and Imam Hospitals elimination rates were 93 and 80% respectively. Fischen *et al*. have reported the activated sludge process can remove Ova of parasites maximum 99.8%. In a similar study results showed that activated sludge method has removed 99% of the Ova. Another research demonstrated that activated sludge process has eliminated up to 99% of the parasites Ova. Caccio *et al*. have found that when the secondary treatment includes active oxidation plus O_2 and sedimentation, the rate of elimination (94.5%) is more than when the treatment is with activated sludge and sedimentation (72.1 to 88%) [15].

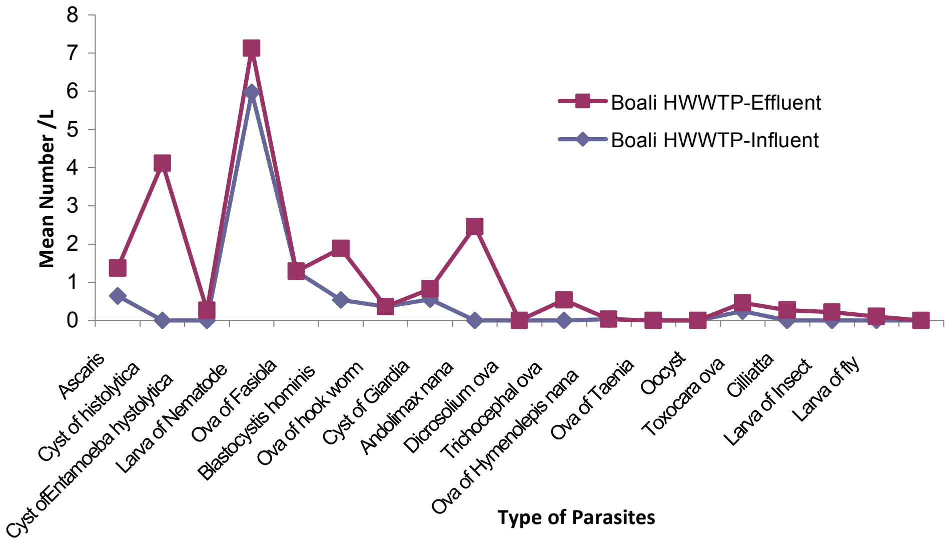

Fig. 2: Parasites of the Boali Hospital Wastewater Treatment Plant

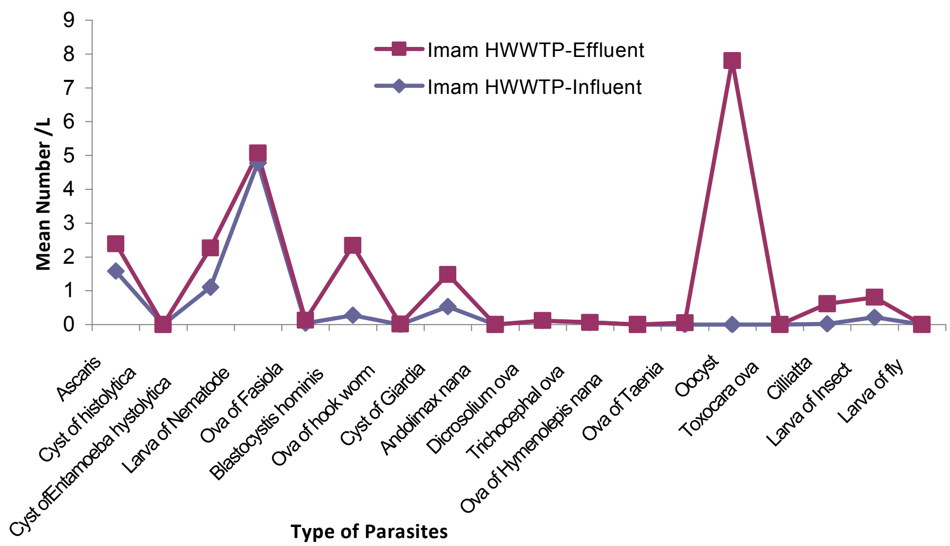

Fig. 3: Parasites of the Imam Hospital Wastewater Treatment Plant

Considering the above findings activated sludge process is the best type of treatment at removing Ova of nematode, cyst of *Giardia* and the other parasites. Though in both hospitals under study the wastewater treatment is done by activated sludge along with expanded aeration, but do not have the sufficient efficiency to remove all the parasites due to improper chlorination and supervision of the plant and improper residence time for sludge, lack of chlorination in the setting and for lack of recording the data to solve the treatment complication.

Considering Engleberg index, that indicates the number of nematode Ova =1 in one liter. Totally the number of the cysts and Helminthes Ova was obtained higher than standard in wastewater effluent and dried sludge. Therefore, it is essential to control operation of wastewater treatment plant more carefully, especially if its effluent is used for irrigation purposes.

CONCLUSION

Effluents of these two hospitals wastewater treatment plants cannot be used for agriculture and watering green areas. Hospital sewage toxicity ?owing into the municipal sewerage system is an issue of critical signi?cance that requires further examination and research from experts.

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Persian Abstract

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چکیده

اگر چه فاضلابهای مراکز پزشکی به عنوان فاضلاب های خطرناک مورد ملاحظه قرار می گیرند، به مدیریت و دفع مناسب آنها توجه کمتری می شود. این مطالعه در دو بیمارستان شاخص آموزشی با ظرفیت های ۳۰۰ و ۲۲۰ تخت بیمارستانی برای کاهش کیست و تخم انگل توسط تصفیه خانه فاضلاب بیمارستان انجام شد. نمونه ها از فاضلاب ورودی و پسآب سیستم های تصفیه به روش لحظه ای و مرکب جمع آوری شد. طی مدت سه ماه ، سه نمونه بصورت هفتگی اخذ و روش بلینجر همراه با تغلیظ-شناورسازی توسط سولفات روی ۳۳ درصد بکار گرفته شد. اسلاید آماده سازی و زیر میکروسکوپ مورد ملاحظه قرار گرفت. کیست ها و تخم انگل ها توسط لام مک مستر مورد شمارش قرار گرفت . در بیمارستان امام خمینی (ره) میانگین تعداد تخم انگلها در ورودی و خروجی به ترتیب ۸/۵۳ و ۸۳/ ۱۳ عدد در لیتر است . بیشترین تعداد انگل در ورودی و پسآب خروجی بیمارستان امام خمینی، بترتیب لارو نماتود به میزان ۷۸/ ۴ و اووسیست به تعداد ۸۱/ ۷ و در بیمارستان بوعلی به ترتیب مشابه ۰۶/ ۹ و ۹۷/ ۱۰ عدد در لیتر است. لارو نماتود با میزان ۹۷/ ۵ و کیست هیستولیتیکا با میزان ۱۲/ ۴ عدد در لیتر بیشترین تعدا بیمارستان بوعلی بودند. وجود لارو نماتود در پساب خروجی هر دو بیمارستان نشان دهنده عدم مطابقت کیفیت پساب خروجی با شاخص انگلبرگ (تعداد تخم نماتود ≤ ۱ عدد در لیتر) است.