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Environmental hazards associated with treated sewage used for irrigation in Sudan

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ABSTRACT

All samples collected from Aeration, Setting, Prefilter and Irrigation parts of the Sewage treatment Station showed positive isolation of *Citrobacter spp*. as (18.5%), *Klebsiella spp*. as (17.0%), *E.coli* as (14.5%) and *Enteriobacter spp*. as (13.3%). Highly pathogenic and opportunistic bacteria were also isolated as *Salmonella paratyphi* B (2.2%), *Salmonela typhi* (1.5%), *Shigella spp*. (1.5%), *Salmonella paratyphi* A (0.7%), *Pseudomonas spp*. (22.2%) and *Proteus spp*. (8.9%). Results were discussed and illustrated according to the negative impact of the presence of these bacteria in the environment and their presence in water used for irrigation.

Key words: Environmental hazards, Sewage, Pathogenic bacteria.

Introduction

Sewage contains mixture of substances that are normally offensive in character and behavior and are dangerous to the general health for both human and animals (Duggal , 2004). The same author added that beside solids and liquids, sewage also contains gases which obtained from atmosphere and due to the action of the bacteria on sewage compounds, these gases are mainly dihydrogen sulphide (h_2S), carbon dioxide (CO_2) and methane (CH_4). Also wastewater contains significant amounts of ammonium, of which only a small proportion is oxidized by conventional treatment plants (Strom, *et al* 1976). Ammonium oxidation and the decomposition of organic matter within receiving waters can have a significant draw-down effect on dissolved oxygen with potentially detrimental consequences for aerobic biota (Courchaine, 1968). Much of the research on nitrification and nitrifying bacteria associated with wastewater effluent has concentrated on the microbiota within the water column rather than in sediments (Cébron, *et al* 2004). However, it is in sediments that the highest concentrations of organic matter and microbial biomass are likely to be found (Sandler and Kalff, 1993). Furthermore, oxygen gradients and concentration interfaces, such as those between sediments and the overlying water, are important sites for coupling between microbial mediated biogeochemical processes, such as nitrification and denitrification (Seitzinger, *et al* 2006) and the methylotrophic cycling of C_1 compounds (Kalyuzhnaya, *et al* 2004).

Although assessments of river health are widely based on the use of macroinvertebrates as indicators (Carter, *et al* 2006; Wright, *et al* 1995), bacteria and other microorganisms may also be informative of the condition of aquatic ecosystems. Important attributes include not only their sessile habits in sediments and biofilms and continued exposure to the water column but also their ubiquitous presence and high abundance in aquatic systems (Lawrence, *et al* 2005). Most importantly, bacteria are responsible for biogeochemical transformations, such as nitrification and denitrification, and thus, the impacts of stress and disturbance upon microbial communities can have implications for ecosystem functions and processes as well as biodiversity and aquatic community structure. However, much research on microbial bioindicators in aquatic systems has been limited to heterotrophic bacteria in relation to the decomposition of dissolved organic matter (Ward, 2006) and as a measure of sewage pollution (Geldreich, 1976; Miescier and Cabelli. 1982).

Hospitals generate wastes that are of hazardous nature. These wastes are discarded along with the other wastes in a common dumping site (Kapoor, 2001).This indiscriminate disposal of such wastes become potential source of risk for public health. It is essential to regulate these wastes and evolve a system for proper treatment and disposal of these wastes. The solid wastes generated in hospitals can be categorized into general wastes and biochemical wastes, the biochemical wastes are further classified as chemical wastes, pathological wastes, highly infectious wastes, sharp objects, pharmaceutical wastes, pressurized containers and laboratory wastes (Kapoor, (2001).

Pathogenic organisms that commonly found in waste water include parasites (*Ascaris, Entamoeba, Leptospira, Shistosoma and Taenia*), Bacteria (*Salmonella, Brucella, Bacillus, Shigella, Mycobacterium* and *Vibrio*) Viruses (*Poliomyelitis* and *Hepatitis)* were reported by WHO (Wright, *et al* 1995).

The WEDC (2002) reported that the environmental impacts of a proposed waste water treatment facility are as important, if not more so, as cost consideration. Authors also added that the protocol of evaluation of

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environmental impacts is set in the National Environmental Policy Act (NEPA) and environmental evaluation should focus on social, technical, ecological, economic, political, legal and institutional criteria (STEEPLI).

Materials and Methods

Area of the study:

This study was carried out in Military Hospital, Omduman city, this hospital consider as medical city. The sewage and waste water are carried out to the station in pipe system. The final product from treated sewage is use in the hospital garden irrigation.

Collection of samples:

Samples were collected aseptically from Aeration tank, Setting tank, Prefilter tank and irrigation tank. Samples were stored in ice box and the microbiological examination was done within two hours of collection in the Microbiology laboratory, Faculty of Science and Technology, El Neelain University.

Microbiological examination:

MPN techniques (technique of untreated water for Aeration and Setting parts and Treated water technique for prefilter, Aspiration and Irrigation parts) were used to evaluate the presence of feacal pollutant organisms on all sections of the station, using MacConkey broth and BGLB, EMB and nutrient agar medium. MacConkey agar, XLD, EMB,SS agar, Selinite F broth, Nutrient agar and Muller and Hinton agar media and all the other biochemical tests used for the isolation, identification and counting of organisms were done according to Cheesbrough (Cheesbrough, M. (1984).

Results:

MPN technique results:

All samples that collected from Aeration and Setting parts of the station showed positive reaction on the three rows of the test which indicates presence of more than 1800 cfu/100 ml coliform cells , these also confirmed by the total bacterial count which revealed uncountable number of bacterial(Table 1).

Prefilter, Irrigation and Aspiration parts of the station showed positive reaction of in the 50ml bottles and all 5 tubes of the 10 ml which indicated presence of more than 18 cfu/ ml coliform cells (Table 1). The total bacterial count was uncountable at the all these parts.

Identification of the isolates:

The isolated bacteria were identified according to the morphological appearance, cultural characteristic and biochemical reactions as *E.coli, Citrobacter spp, Enteriobacter spp., Klebsiella spp.*, *Proteus spp., Pseudomonas spp., Samonella typhi, Salmonella paratyphi A, Samonella paratyphi B and Shigella Spp.*.

Number and percentage of isolated bacteria from all parts of the station:

As shown in table (2) 135 isolates were recovered from collected samples, these were identified as *Pseudomonas spp* 30 (22.2%), *Citrobacter spp* 25 (18.5%), *Klebsiella spp* as 23(17.0%), *E. coli* as 19 (14.5%), *Enterobacter spp* as 18 (13.3%), *proteus spp* as 12 (8.9%), *S. paratyphi B* as (2.2%), *Shigella spp* as 2 (1.5%), *S. typhi* as 2 (1.5%) and *S. paratyphi A* as 1 (0.7%).

Discussion:

Water with high levels of feacal coliform increases the chance of developing illness (fever, nausea or stomach crump's) from pathogens entering the body through the mouth, nose, ears or wounds.

Our results indicated that the biological control of sewage at the station showed impaired and the presence of these organisms in the environment might contribute to develop of serious problems. The presence of fecal contamination is an indicator for that potential health risk exists for the individuals exposed to this water.

In this study it was clear that some pathogenic and opportunistic pathogenic bacteria resist treatment procedures and these might contributed to cause water borne outbreak due to the presence of the station beside

the river the main source of drinking water supply for Khartoum state. Otherwise these organisms might enter the distribution system through leakage.

We supported the finding of (Duggal , 2004) and (Strom, *et al* 1976). who reported that there is a significant correlation between contamination of beaches, soils and contamination of adjacent seawaters, accordingly we expected that wind can act as a vehicle to carry the isolated organisms from the irrigation area and the surroundings to the adjacent river. Otherwise the treated water might also contain harmful chemicals and toxins that escape through filtration and their presence have negative impact in the environment due to their bioaccumulative effect.

Planning for the development of new water projects for upgrading of existing ones offers ample and timely opportunities to incorporate human health considerations. A health impact assessment (HIA) provides the methods and procedures to ensure such incorporation in a systematic, comprehensive and focused manner. The HIA approach considers changes in environmental and social determinants of health resulting from development. The awareness raising and enhancing the capacity for informed personal choice are increasingly seen as important factors in ensuring the safe use of treated sewage. The general public has to rely on information about safety, hazards to health.

Our results supported the finding of (Pruss, 1998); (Aulicino *et al*, 1985); (Black, 1999); (Bonadonna, 2002); (Casey, 1997) and WHO, 1997).

Assessments of hazard and risk inform the development of policies for controlling and managing risks to health draw upon experience and the application of common sense, as well as the interpretation of data.

Because hazards may give rise to health effect after short-term exposures, it is important that standards, monitoring and implementation enable preventive and remedial actions within real time frame.

Table 1: Counting and MPN results of the station

Part of the station	MPN result	Counting
Aeration	≥1800	Uncountable
Setting	≥1800	Uncountable
Prefilter	≥18	Uncountable
Irrigation	≥18	Uncountable
Aspiration	≥18	Uncountable

Table 2: Number and percentage of isolated bacteria.

Bacteria	No. of Isolates	Percentage
Pseudomonas spp	30	22.2%
Citrobacter spp	25	18.5%
Klebsiella spp	23	17.0%
E.coli	19	14.5%
Enterobacter spp	18	13.3%
Proteus spp	12	8.9%
S. paratyphi B	3	2.2%
Shigella spp	2	1.5%
S. typhi	2	1.5%
S. paratyphi A	1	0.7%
Total	135	

Conclusion and Recommendation:

This study concluded that in spite of the effort done to control and eliminate the hazard of the sewage and waste water in the hospital, isolation of very infectious bacteria (*Shigella spp* and *Samonella spp*) or opportunistic pathogenic bacteria (*E. coli, Citrobacter spp, Enterobacter spp, Klebsiella spp and Pseudomonas Spp*) were shown which raised a question on their negative impact towards public health and the environment.

We recommended that hospital staff, workers and co-patient should be aware to not used irrigated water as drinking water or for other purposes. The efficiency of the station should be raised by replacing new parts or by maintenance and the effect of the bacteria that survival to the end of treatment stages toward the plants, animals and human need further investigation.

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