

Salmonella contamination of recycled effluent of treated sewage and urban waste water

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Abstract

This study was conducted to determine the effectiveness of the removal of enteric pathogens such as *Salmonella* in recycled sewage effluent and urban waste water after the treatment process at the Harare Firle Sewage Works. A total of 633 samples were collected from raw sewage, tank effluent, filter effluent, humus, sludge, maturation pond, final effluent, river upstream and river downstream at the point of effluent discharge. These samples were processed and colonised on nitrocellulose filters to form dot-blots. The colonised filters were prepared for DNA-DNA hybridisation, using a *Salmonella*-specific DNA probe. When the results were analysed, an overall *Salmonella* contamination frequency of 23.7% was obtained. Further analysis at each stage in the sewage treatment process showed that in raw sewage 65% of the samples were positive for *Salmonella* while 52% of tank effluent and 4% of maturation pond-sample were positive respectively. In filter effluent 7.3% of the samples were positive, while the humus effluent and the sludge samples were 2% and 3.12% positive respectively. In the final effluent discharge 1.8% of the samples were positive for *Salmonella*. Thirty four percent (34%) of samples from the river upstream of effluent discharge and 36% of samples from the river downstream of effluent discharge were positive for *Salmonella*. The bacterial concentrations in the positive samples varied from greater than 1×10^3 cells (+++++) per tested sample volume in raw sewage which is higher than the clinically infective dose of 1×10^5 cells, to less than 1×10^2 (+) cells per tested sample volume in the final effluent. This indicated that the sewage treatment process at Firle Sewage Works does not effect total removal of *Salmonella*. Other pathogens, which were not tested, could be higher. The final effluent, which is recycled from the Harare Firle Sewage Works for potable water supply and also used directly in agriculture for irrigation, probably supplies *Salmonella* and other pathogens at a contamination rate of 1.8%. The methods employed in this study provide a rapid, sensitive, specific and cost-effective routine detection procedure for the monitoring of *Salmonella* in environmental samples and waste-water treatment works.

Introduction

In recent years, world-wide changes have led to consideration being given to conservation and recycling of many materials (Carrington, 1980; Hillman, 1988). Not least among these considerations is the possibility of greater reuse of sewage and urban waste water in agriculture, industry, recreation and for potable water supply (Pescod, 1985; Diamant, 1985; Cowen and Johnson, 1985). The strategy of planned reuse of waste water in many tropical developing countries is essential in order to recover water as a valuable and limited resource, but the recycling of sewage and urban waste water has been aggravated by droughts which resulted in a shortage of urban potable water supply. The important question to be raised on the reuse (indirect or direct) of sewage and urban waste water is: how efficient are the treatment processes in removing bacterial pathogens? Domestic sewage is known to carry a full spectrum of mainly enteric pathogenic micro-organisms that cause infections such as enteritis, salmonellosis, shigellosis, cholera and yersiniosis (Cowen and Johnson, 1985). Most of these water- and excreta-related diseases are prevalent in developing countries because of poor sanitation and poor treatment of urban waste water (Lewis-Jones and Winkler, 1991).

In a number of studies done on the status of *Salmonella* in conventional sewage and urban waste-water treatment plants, the incidence of *Salmonella* was found to be reduced by 90% or

greater using various treatment methods (Feachem et al., 1983). Treatment by pre-screening had no effect on the pathogen content of sewage influent. Primary sedimentation reduced *Salmonella* by 50 to 90% in 3 to 6 h (Feachem et al., 1983). Trickling filter methods of sewage treatment showed reductions of *Salmonella* in the effluent to be in the range of 71 to 99%, if secondary sedimentation was included. The activated sludge method had between 60 and 99% removal capacity at normal aeration times of 6 to 12 h, but this could be as high as 99.9% following extended aeration for more than 24h (Feachem et al., 1983). Notwithstanding the above, several studies have shown that sewage effluent treated by various methods may still contain 2% of the pathogenic bacteria originally in the incoming sewage (Lewis-Jones and Winkler, 1991). In developed countries, this percentage of pathogens can be eliminated by tertiary treatment. However, tertiary treatment in conventional sewage treatment is normally absent in most developing countries.

Wate and Finch (1986) found that viable salmonellae were reduced by 99.9% in 1 h at 55°C and by 99.9999% in 11 min at 60°C. Thus, even thermophilic sludge digestion produces sludge that may still retain a considerable population of *Salmonella*. Temperature and retention time of sludge in digesters are the main factors that determine survival of *Salmonella*. It is important to note that 100% elimination of *Salmonella* is unachievable by sludge treatment methods (Lewis-Jones and Winkler, 1991).

In Zimbabwe, and in other developing tropical countries, the reuse of treated sewage and waste water has been recognised as a strategy to boost the productivity of available water supplies (Marks and Lock, 1988). Modern sewage works operating throughout Zimbabwe are based on the modified activated sludge (MAS) sewage treatment process. The cities and towns are able to recycle most of their sewage and urban waste water. Greater

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