Studies on Bioindicators for Water Pollution In The River Nile

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INTRODUCTION

Over the past decades, the natural quality of water sources has been altered by the impact of various human activities and water uses.

Disposal of waste-water by dilution in large bodies of water such as lakes, rivers, ... etc., was the most common method used for hazard elemination in developing countries. Among the microorganisms that are found in waste-water, are that of pathogenic nature which greatly affect the public health, especially when the receiving water is used for domestic, recreational or agricultural purposes.

Therefore, the aquatic environment plays a crucial role in the transmission of human diseases. As reported by Leclerc and Mossel (1989), about 50% of the enterobacterial species in surface water are antibiotic resistant and this could pose a risk for the consumers when these waters are used as public water supply. In fact, suffering and deaths of most infants in developing countries are due to water-associate diseases. In this respect inadequate water supply, insanitary excreta disposal and vector-infested water courses are held responsible for more than half of the six million infant diarrheal mortalities recorded each year in the third world (WHO 1988). Therefore, microbiological aspects and hygienic acceptability of water are by far the most important requirements related to human consumptions and other domestic uses.

Analysis of water for all the known pathogens would be a very time-consuming and expensive proposition, so, a set of indicator microorganisms has been identified and is now commonly applied to determine the hygienic suitability of water for various uses. As a definition, an indicator microorganism, which should fulfill specific criteria, is one whose presence presumes that contamination has occurred and suggests the nature and the extent of the contaminants (Gray, 1989). In fact, most of the waterborne pathogens are introduced through fecal contamination of water, therefore coliform group and in particular their fecal types which flourish inside the intestinal tract of human and animals are universally recognised in assessing microbiological quality of water, where elevated levels of such group indicate to a fecal sources of contamination or inadequate treatment. In addition, the examination of water for both fecal coliforms and fecal streptococci has been suggested in several reports as a method for tracing wheather fecal pollution is from human or animal sources (Geldreich 1976; Sherry et al, 1979; Martins et al, 1984; Menon, 1985; Khalaf et al, 1989 and Pourcher et al, 1991).

Furthermore, attempts have been paid to correlate specified hazardous microorganisms with other known indicators. In this respect, Staphylococcus aureus was found more resistant to disinfection process than classical indicators of fecal pollution (Keirn and Putnam, 1968 and El-Hawaary and Khalafalla, 1987) and proposed as an effective indicator of hygienic quality of swimming water (Alico and Dragonjac, 1985). Besides, the presence of the yeast Candida albicans have been considered as a direct result of fecal contamination in water since it is widespread in developed countries where 80% of the adult population having low levels of infections with decteble levels of the yeast in their faces. In addition to inability of such yeast to exist or grow independently in water (Gray, 1989).

On the other hand, Aeromonas hydrophila which is not considered to be a normal inhabitant of the intestinal tract of man or animals, it was found in polluted water in a significant numbers. Its significant role was proved as a waterborne pathogen for fish and man (Shotts et al, 1972; Davis et al, 1978 and Pathak et al, 1988).

The River Nile which is considered as the main water source in Egypt is still a recipient of most of the wastewater discharged by several drains and industries (El-Sherbini and El-Moatassem, 1990). Therefore, the improvement and protection of the River Nile water quality has been identified as one of the national goals.

To achieve this goal, monitoring of the River Nile water quality is considered as the first step. Thus the present investigation is devoted to evaluate the microbiological quality of the River Nile water through monitoring of seven specified microbial parameters include both of classical and complementary indicators (total coliform, fecal coliform, fecal streptococci, Staphylococcus aureus, total yeasts, Candida albicans and Aeromonas hydrophila) at 30 sites as well as of outlets of 67 drains distributed along the River Nile from Aswan to Cairo (945 km) through two trips, carried out in May and December.

More attention has been paid for the river water of Cairo segment as the most important part of the River Nile through monthly monitoring over one year of the same microbial parameter at five sites beginning from Cairo inlet at El-Ekhssas to Cairo outlet at El-Kanater (about 50 km).

REVIEW OF LITERATURE

Water is considered as the most important natural resources in the world since without it life cannot exist and industry cannot operate. In fact there are two sources of water namely, surface water and ground water. Surface water can be utilized in various purposes including domestic and industrial water uses, commercial fishering, recreation, transportation and for disposal of waste water. In spite of these vital roles played by water resources in the development of communities, unfortunately, a variety of wastes from such communities have a considerable potential effect on environmental pollution and in particular water environment. If rivers, as the most important source of surface water, are polluted, their utility can be reduced and restricted. Pollution of river water may be arising from various wastes, sanitary drainage (sewage) and industrial discharge wastes as well as soil run-off. In fact, sewage discharging to river water has a great potential for transmitting a wide variety of microorganisms causing diseases. To evaluate water quality from microbiological point of view, analysis of water for all the known pathogens would be expensive and a very time-consuming. Therefore, the use of bacterial indicators was considered as a good tool for evaluation of water quality. As reported by Gray (1989) the criteria specified for selection any of bacterial indicator are; it is must they are present wherever pathogen are present and in much greater number; it should be consistently and execlusively associated with the source of pathogen, it must be as resistant or even more resistant to disinfectants during treatment systems and in the aquous environment than pathogenic organisms, and it should be suitable for routine isolation by growing readily on selective media and be easily identified and enumerated with reasonable accuracy and precision. According to these criteria bacterialogical examination of water, in assess its sanitary conditions, is based mainly on the presence of bacterial indices of pollution.

For many years, coliform group including their fecal types has its way to be the classical and convential group as an indictor of faecal pollution. However, according to the deficiency of coliform group which has been recorded by several investigators (El-Hawaary et al., 1981 and Farrah et al., 1981) the attention was directed towards investigation of other fecal indicators in conjunction with fecal types of coliform group. In spite of that Escherichia coli is known as the most important bacterial indicator used for testing the presence of fecal pollution. In fact E coli is generally accepted to be specifically of fecal origin but its use is limited because certain pathogens persist longer in the environment or may be more resistant than E Coli to disinfection processes. Therefore, Dutka (1973) recommended a test for the more persistent fecal streptococci as a useful addition to or even as an alternative for E coli. However, Evison and James (1973) compared between data collected from Britain and East Africa for the distribution of intestinal bacteria. The author found that in tropical countries, the indicator which most commonly advocated was the fecal coliform group which have the ability to ferment lactose at 44.5 °C.

The use of fecal streptococci as an indicator of fecal pollution has received wide spread acceptance in conjunction with, but not alternative to, fecal coliforms. In this respect the fecal streptpcocci have been used with fecal coliforms to differentiate human fecal contamination from that of other warm-blooded animals. A ratio greater than 4 was considered indicative of human fecal contamination, whereas a ratio of less than 0.7 was suggestive of contamination by nonhuman sources (Geldreich 1976).

With the increased use of natural waters for recreational purposes, a need has developed to protect water recreationists from enteric, respiratory tract and skin infections which may result from contact with water as well as sand or dust-born infections agents. In this respect the usefulness of coliform or other enteric indicators to determine the safety of recreational waters has been debated (Gray, 1989) as the contamination in such water is via the mouth, nose, throat and skin of bathers, rather than urine and faeces. Therefore, staphlococci and in particular Staphylococcus aureus have been considered as better indicators for evaluating the hyginic quality of swimming water.

In fact the use of S. aureus for this purpose refered to several reasons, i.e., they are consistently shed from the skin, mouth, nose and throats of bathers, they are five to twenty times more resistant to chlorine than coliform and also are more resistant to other halogen disinfectants than coliforms and entrococci (Keirn and Putnam 1968). The resistance of S. aureus for halogen compounds results in a longer survival time in water than coliform.

The most exciting new potential indicator in recent years is the yeast Candida albicans. It is known as a component of the body flora of humans (Beneke and Rogers, 1970), of animals (Van Uden, 1960) and of birds (Cragg and Clayton 1971). Because of its intestinal habitate, C. albicans commonly found in urine and feces and has been isolated from fresh, marine and esturine waters and its occurrence has usually been attributed to fecal contamination. Since C. albicans is the causal agent of a variety of mycotic infections in man (Emmons et al., 1977), its occurrence in water may result in a health hazard to water recreationists.

Attention had been paid for Aeromonas sp. which are known as important members of normal aquatic microflora as an indicator bacteria. A. hydrophila has been recognized as a fish pathogen (Shotts et al., 1972) and more recently considered as a potential pathogen of man (Davis et al., 1978). Moreover it had been reported by Joseph et al., 1979 that wound infection casued by such bacteria were related to contact with water containing them.

The survival of bacteria in natural environment is of practical importance in public health, therefore the behaviour, survival and viability of bacteria in both sediment and aquatic environment, have been studied by many authors.

Survival of Eschericha coli in the bottom sediment of lake Onalaska, Mississippi river was investigated by Laliberte and Grimes (1982). The data indicated that E. oli had the ability to survive for about five days in aquatic sediment due to the presence of fine soil particles which contain high organic nutrient. It was concluded that the survival ability of E. coli suggests that the presence of fecal coliform in water may not always indicate recent fecal contamination of that water but rather resuspension of viable sediment-bound bacteria. Thus the aquatic sediment can serve as a reservoir for indicators bacteria.

Sinclair and Alexander, 1984 studied the behaviour of Streptococcus faecalis, Staphylococcus aureus, Bacillus subtilis and two types of Rhizobium in lake water and sewage. The results showed that the first three organisms readily lost viability and rapidly disappeared in the absence of organic nutrients which are in low concentratrion in lake water, and as a result of intense competion in sewage. The study showed that in case of Rhizobium the two types were resistent to starvation.

Using a developed technique, Hendricks (1970) isolated salmonellae from both surface water and bottom sediment of the north Oconee river. The rate of salmonellae recovery from bottom sediment were higher than those from surface water. The high recovery could be attributed to the sedimentation and adsorption of the organisms to the sand and clays which concentrate bacteria on the bottom stream where suitable nutrients are present.

Pettibene et al. 1987 studied the survival of antibiotic resistant and sensitive strains of E. coli, Ent. faecalis, Ent. faecium, St. equinus and two environmental isolates in estuarine water. The results indicated that for all indicators species except Ent. faecium and Ent. faecalis, the number of colonies declined to less than 1% of the initial bacterial numbers after 4 days. The results supported the