Conclusions
5.1. CONCLUSIONS

Application of sewage in pisciculture in order to augment fish production has been an ancient practice in India and other countries like i.e. China, Egypt and Europe. Possible health hazard from these sewage-fed aquaculture systems or bheries has become a subject of serious debate probably since the inception of such fish culture system.

Urgency thus impels to assess the bacterial levels in water and fish tissues, as fish may act as suitable bio indicators, indicating the toxicant level and extent of pollution of the system.

It is evident from the investigation that the system offers considerable potential for biological sewage treatment, with respect to reduction of ammonia nitrogen, BOD and COD. The TVC and enteric bacterial counts were detected in higher numbers and some of the members recovered in this study like *Vibrio* are established fish and human pathogens. High rate recovery of *E.coli* from the water of the sewage works also imposes threats because of their pathogenic potentiality or toxin producing ability.

Counts of faecal coliforms in the sewage-fed ponds exceeded WHO (WHO, 1989) guideline value of \( \leq 10^3 \) faecal coliforms per 100 ml for water to be used in aquaculture. The detection of the high numbers of bacteria in the ponds used for fish farming in this study should therefore give some concerns.

Disease-causing microbes (pathogens) in these wastewaters can cause diarrhoea, cramps, nausea, headaches or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems (USEPA, 2004). The results of this study should invite the implementation of management guidelines for pathogenic bacteria that can affect human health. This particular assessment station of wastewater treatment has to take in account enterobacterial pathogens as potential pathogens that should be correctly controlled.
Good correlation between bacterial population and the water quality variables like DO, BOD and ammonia nitrogen opens an avenue for research in this line to establish a water quality and microbial quality model useful in assessing the quality and safety status.

Fish grown in wastewater ponds also found to be contaminated with bacteria. Some human pathogens such as *Escherichia*, *Salmonella*, *Shigella* and *Vibrio* have been found to survive and multiply in the gut and muscles of fish and thus render fish a potential vector for human disease. If fish are eaten raw or undercooked, transmission of bacterial infections may occur.

Considerable fluctuations of TVC, TC, FC, *E.coli* and FS in pond water and in raw sewage might have affected quality of fish flesh and contents of bacteria in their muscles and digestive tract contents.

Fluctuations of the number of indicatory bacteria in sewage might have resulted from disturbances in sewage treatment process. Strong correlation between bacterial microflora of fish gut and the concentration of bacteria in water was reported.

Bacterial composition of the water varies with season. Since organisms form an intimate relationship with the surrounding aqua environment; seasonal variations of bacterial accumulation in water and fish tissue deserve special emphasis.

Bacterial counts in fish were significantly higher in monsoon and pre monsoon than post monsoon. This scenario was highly correlated with the seasonal variation of bacterial concentrations of pond water. Low values of bacteria in fish during post monsoon season associated to reduce rate of sewage inflow, indicates that an interruption in the inflow of bacteria can result in the self-cleaning of the fish.

It has been claimed that the risk to public health from antimicrobials in aquaculture probably is very low (Alderman et al., 1998). This is likely true in North American and European aquaculture where the use of antimicrobials is generally decreasing. In contrast, legislation and enforcement of antimicrobial use in developing countries may be less strict. Furthermore, environmental bacteria from warmer climates may be acclimatized to temperatures near human body temperature and may upon ingestion survive and transfer antimicrobial resistance genes to human gut bacteria (Alderman et al. 1998).
Uncontrolled use of antibiotics and common practice of self medication typical of the Indian setting would pose a selection pressure in wastewater and fishes reside there in favour of antibiotic resistant organisms. Observations by other investigators indicate that resistance to antimicrobials may persist for a considerable number of years after antibiotic usage has been discontinued (Hinton et al. 1986). Mach and Grimes (1982) demonstrated the high transfer frequencies of enteric bacteria in a wastewater.

In this study, thermotolerent faecal coliforms were used as bacterial indicators of antimicrobial resistance. Most of the isolates were predominantly ampicillin-resistant indicates human influence in the environment. High resistance to chloramphenicol is of special interest because it is one of those 19 antibiotics which are banned in India.

Significantly higher numbers of multi antibiotic resistant bacteria were present in water and fish of sewage fed ponds. Proliferation of MAR bacteria may be achieved through horizontal gene transfer, by which resistant genes are transferred to nonresistant bacteria.

Conjugation probably plays a major role in transfer of resistance factors. Several studies indicate that the environmental conditions in wastewater may enhance the likelihood of gene transfer (Pote et al., 2003). High transfer frequencies were reported by faecal bacteria of present experiment. Additionally resistant bacteria may pose a risk of therapeutic problems to public health and fish population.

To minimize the risk associated with bacteria, an experiment was carried out where bacteria contaminated fish were kept in clean uncontaminated water for 25 days. When bacterial intake ceases, their removal pattern can be suitably studied from the amount of bacteria decreased from the tissues during the period of exposure.

Fish got rid of the majority of allochthonous faecal coliforms, *E.coli* and faecal streptococci from the muscles and digestive tract contents. Pathogenic, natural constituents *Vibrio* spp. were frequently found in cleaned fish.
5.2. REFERENCES


