SUMMARY

Water is polluted by substances like traditional organic wastes, wastes generated from industrial processes, chemical agents for fertilizers, pesticides for crop protection and silt from degraded catchments. The present investigation comprises the analyses of effluent quality, aerobic and anaerobic treatment, acute bioassay studies, energetics, haematological, microbiological as well as histological, histopathological, and histochemical changes.

Sugar mill effluent is a complex of several chemicals. The effluent showed the range of pH (7.0 - 8.5), BOD (244 - 878 mg/l), COD (438 - 1474 mg/l), total suspended solids (53 - 875 mg/l), and total organic carbon (31 - 71%). The effluents from three treatment plants were studied by the colony-forming-curve analysis. The colony counts in P₂ and P₃ showed an increase even after six days of incubation, whereas the colony in P₁ showed a decline and reached a constant level within five days of incubation. The bacterial strains identified were Bacillus sp., Micrococcus sp., Pseudomonas sp., Vibrio sp., and Enterobacteriacea the dominant microflora.
Aerobic bioreactor (Continuous Stirred Batch Reactor) for treating the moderate strength (less than 1 g of BOD) of sugar mill effluent was examined with three different bacterial strains. Among the three aerobic bacterial strains tested, *Vibrio anguillarum* (0.5 g MLVSS) bioreactor consistently removed 77% of BOD and 74% COD at 33°C with the loading rate of $1.74 \times 10^3$ kg /COD after 96 hrs retention time. The aerobic CSBR process could be an effective method for treatment of sugar mill wastewaters. The COD and other organic matter removal efficiency visibly declined with reduction of low retention time.

At a COD loading rate of $9.04 \times 10^3$ kg / COD / day (1644 mg/l) the UASB treated effluent contained only 75.6 mg / l BOD and 114 mg / l COD and therefore could be suggested for profitable use of agriculture and pisciculture requirements. The retention time required in UASB to obtain the above BOD and COD level was 24 hrs. The biogas yield using sugar mill wastewater was 2946 ml / l from the COD loading rate of $9.04 \times 10^3$ kg COD / day. The biogas production increased with COD loading rate. The reduction of organic matters was statistically significant. The biokinetics worked out for UASB treatment were as follows: Yield coefficient ($Y$) 0.14 mg VSS / mg COD; decay coefficient ($K_d$) 0.8 d$^{-1}$; half velocity constant ($K_s$) 47.18 mg/l; rate of substrate utilization ($k$) 18.87 d$^{-1}$ and maximum specific growth rate ($\mu_{max}$) 2.64 d$^{-1}$.

Acute toxicity of the sugar mill effluent on the fresh water air-breathing fish *Channa striatus* was tested. Bioassays were made on *Channa striatus* for effluents collected at different treatment plants. The LC$_{50}$ for 96 hrs exposure was found to be 91.5% in UASB treated OSTE effluent. Two different sublethal (1/3 and 2/3 the LC$_{50}$ 96 hrs) concentrations of UASB treated effluent were chosen for the study on growth and biochemical analyses of *C. striatus*.

Fish reared in 30.5% effluent showed an increase in specific growth rate, food conversion rate, gross conversion efficiency, protein efficiency ratio and the best food conversion ratio values. It is probable that the sugar mill effluent contains some unidentified growth promoters and 30.5% effluent concentrations appeared to achieve optimum growth. Thus 30.5% UASB treated effluent may be regarded ideal for better growth of *C. striatus*.
Exposure of fish to the effluent produced an elevation in the total number of erythrocytes, leucocytes, haemoglobin content and haematocrit values. Both the effluent concentrations harboured certain aberrant forms of erythrocytes in the blood; the nucleus size of erythrocytes showed a decrease after 60 days of exposure. The size of the basophil nucleus increased in the fish exposed to 30.5% effluent. Variations in blood cell number, size of entire cell and size of nucleus in the treated fish were significant.

Microbiological studies of the digestive tract in the control and treated fish revealed a change in pattern in the gut microfloral population. Microbiological studies comprised total viable count of heterotrophic gut microflora, their generic composition and physiological groups (amylolytic, caseinolytic, gelatinolytic and lipolytic bacteria) in control, and treated fish. *Bacillus* spp; *Micrococcus* spp., *Pseudomonas* spp., *Achromobacter* spp., and *Flavobacterium* spp. were encountered.

Histopathological and histochemical changes were discernible in liver, gill, stomach, intestine, testis and ovary. The study revealed remarkable pathological effects produced by the effluent on the organs examined. Hypertrophy of the blood vessels of the gills leading to aneurysm, haemorrhage, erosion of the gill epithelium, increase in the number and size of the mucocytes were a few of the significant changes. In the liver the histopathological changes were well pronounced. Hypertrophy of hepatocytes, including the nucleoli, loss of basiphils due to loss of the ergastoplasm, accumulation of pigments in the cytoplasm, vacuolation of the cells, decrease in RNA synthesis and ultimate degeneration by necrosis and lysis of the hepatocytes were noticed.

Increase in blood supply to the stomach as seen in size of the blood vessels of the submucosa as well as the increase in the number of erythrocytes in them were common in the treated fish at 61% concentration. The mucosal epithelium, lining the stomach showed hypertrophy and there was a copious secretion of mucus by them. The intestine in the control fish is a very simple tube and is circular in cross section without any villi in the lumen. The number of columnar epithelial cells increased enormously to provide tissue for the villi.
Histochemical studies in the gill and intestine revealed that in the control, the mucus secreted was neutral mucopolysaccharides. However, it changed to acid mucopolysaccharides and ultimately to sulphated mucopolysaccharides in the treated fish.

The sugar mill effluent failed to cause damaging responses from the testis of treated fish. There was a slight lowering of spermatogenetic activity in the treated fish. On the other hand, the ovary reflected the toxicity by striking changes in oogenesis. Vitellogenesis and formation of the ovum were greatly affected by the effluent. RNA synthesis was drastically affected resulting in decreased protein synthesis. Cytopathological changes in the nuclei, nucleoli, and yolk nuclei were remarkably high.

The sugar mill effluent at high concentration is a toxic liquid with complex of harmful ingredients. These ingredients can potentially affect all the organ systems and produce perceptible decrease in their functioning efficiency. However, lower concentration of treated effluent evidently enhanced the growth of *C. striatus* and did not affect the organs. The current study has established that cost effective treatment and appropriate dilution of the effluent can render it suitable for prosperous culture of *C. striatus*. 