



TOXIC EFFECTS OF DETERGENT ON THE FISH, *OREOCHROMIS MOSSAMBICUS*

R. Kalaichelvi , A. A. Sivakumar* and K. Vijayaraman*

Advanced Environmental Laboratory, Tamil Nadu Pollution Control Board

Gandhi Park, Coimbatore 641001.

* Department of Environmental Studies, K. S. G. College of Arts & Science

Singanallur, Coimbatore 641 015

Received: 20.11.12

Accepted: 05.05.13

Toxic effects of the detergent "Nirma" on this fish, *Oreochromis mossambicus* were studied. LC_{50} value was found to be 90 ppm and 70 ppm, for the exposure periods 12 hr and 24 hr, respectively. Rate of oxygen consumption was found to be increasing with the increase in the detergent concentration and increasing with the increase of exposure period. Haemoglobin content was found to be decreasing with the increase of detergent concentration and decreasing with increase of exposure period. Glucose level in the blood was found to be increasing with the increase of detergent concentration and decreasing with the increase of exposure period. Glycogen content in the liver and muscle was found to be decreasing with the increase of detergent concentration and decreasing with increase of exposure period.

Quality of water is of major importance in the aquacultural practices. Synthetic detergents and industrial effluents are known to alter the physicochemical properties of water and make fish life more difficult¹⁻³. As fishes are important source of proteins in a nation's diet, the need for understanding toxicity of the detergents to the fish is of greater importance.

The use of synthetic detergent is increasing rapidly by propagation of electric washing machine. The main ingredient (alkyl benzene sulfonate) runs into the natural waters and cause severe damage by its direct action and also by accumulation. The synthetic detergents are cleaning materials which are based on a non-soap surface active agent. These agents may be anionic, cationic or non-ionic in nature. Out of these agents, the cationic ones are the most harmful. The synthetic detergents are slowly biodegradable and leading to the increased concentrations in the environment. Detergents had replaced soap products for cleaning purposes. It is estimated that 40 % of the pollutants entering the freshwater environment are coming from the waste water from detergent washing operations.

The interrelationship between blood glucose and hepatic glycogen has been studied earlier⁴. Long-term effects of bleached craft effluents on carbohydrate metabolism and hepatic xenobiotic biotransformation enzymes in fishes have been studied in detail⁵. The hardness of water due to an anionic detergent was proved earlier⁶. Though investigations

were made on the toxicity of detergents on marine organisms⁷ no report is available on the fresh water organisms.

MATERIAL AND METHODS

The LC_{50} value of the detergent "Nirma" for the fish, *Oreochromis mossambicus* was determined at 12 and 24 hours. Fishes were exposed to sublethal concentrations of the detergent for 1, 2, 3 and 4 hours to study the effects on the rate of oxygen consumption and 12 and 24 hours for blood glucose level and glycogen content in the muscle and liver. Glucose in the blood was estimated by following O-Toluidine method⁸; Haemoglobin by Cyanide method⁸; and glycogen by Anthrone method⁹.

RESULTS AND DISCUSSION

Living organisms usually respond to any change which alters the normal conditions existing in the environment. They face stress and respond to overcome the stress by adjusting physically and physiologically¹⁰. In the present study, the rate of oxygen consumption was observed as increased with the increase in the concentration of the detergent (Table 1). The detergent polluted water would have retarded the gaseous exchange by absorption of the detergents on the gill surface as observed with the crude oil¹¹.

Haemoglobin content of the fish was observed to be decreased with the increase in the concentration of the

detergent (Table 2). As the detergent is toxic to fish, it would have affected the red blood corpuscles of the blood. This might have resulted in the the increase of the haemoglobin content, thus the fish would have taken in an increased amount of oxygen due to stress condition¹². It was reported that the increase in blood glucose level contribute an active flux of metabolites¹³. Elevated glucose levels in the present observation (Table 3) reflect an increase in the rate of transportations of glucose probably from liver muscle, where high energy demand was met due to brisk and erratic movements observed in the fish.

Glycogen content in liver and muscle of the fish was observed as decreased with the increase of the concentration of the detergent (Tables 4 and 5). The significant reduction of glycogen content in the liver and muscle might due to increased glycogenolysis to meet the excess energy demands imposed as the severe anaerobic stress of detergent intoxication¹⁴. The reduction in the glycogen content of the liver and muscle together with the rise of blood glucose level in the fish might be due to the inhibitory effect of this detergent on the

corticosterone synthesis and the inhibition of the thyroid gland activity. Reduced corticosterone concentration in the adrenal might have affected the activity of glyconeogenesis by which the liver glycogen concentration was reduced¹⁵.

Decrease in glycogen content in the tissues of experimental fish suggests its utilization by the anaerobic glycolysis to meet the energy warranted by the toxic environment¹⁶. Muscle glycogen showed significant decrease since liver glycogen levels were reduced considerably and hence muscle was forced to depend on its own reserves to meet the energy requirement. This marked glycogenolysis in muscle and liver of the fish was probably caused by a stree induced increase in circulating catecholamines¹⁷.

It is thus concluded that the detergent promotes a massive utilization of carbohydrate reserves from liver and muscle in order to meet the increased energy requirements of enhanced metabolic activity which the detergent causes. This indicates that the fish treated with the detergent even at the sublethal concentrations is not able to maintain a normal physiological balance compared to the control.

Table 1. Rate of oxygen consumption in the fish, *Oreochromis mossambicus*, exposed to sublethal concentrations of the detergent.

Concentration of the detergent	Exposure period & Rate of O ₂ Consumption (mg/gm/h)			
	1 hr	2 hr	3 hr	4 hr
Control	0.020	0.050	0.055	0.064
7 ppm	0.050	0.057	0.063	0.071
14 ppm	0.060	0.064	0.071	0.077
21 ppm	0.070	0.081	0.085	0.092
28 ppm	0.091	0.098	0.104	0.114
35 ppm	0.107	0.110	0.113	0.122

Table 2. Haemoglobin content (gm%) in the blood of *Oreochromis mossambicus*, exposed to sublethal concentrations of the detergent.

Exposure period	Concentration of the detergent (ppm)					
	Control	7	14	21	28	35
12 hr-Hb	11.70	10.30	9.72	8.90	8.28	7.20
24 hr-Hb	10.70	9.50	8.80	7.40	6.70	6.00

Table 3. Glucose level (mg%) in the blood of *Oreochromis mossambicus*, exposed to sub-lethal concentrations of the detergent

Exposure Period	Concentration of the detergent (ppm)					
	Control	7	14	21	28	35
12 hr-Glucose	97.5	108.7	114.1	121.2	127.0	135.8
24 hr- Glucose	48.3	60.8	84.1	91.2	96.6	102.0

Table 4. Glycogen content (mg/gm) in the liver of *Oreochromis mossambicus*, exposed to sub-lethal concentrations of the detergent.

Exposure Period	Concentration of the detergent (ppm)					
	Control	7	14	21	28	35
12 hr-Glycogen	0.351	0.326	0.319	0.314	0.308	0.302
24 hr-Glycogen	0.322	0.300	0.289	0.285	0.279	0.273

Table 5. Glycogen content (mg/gm) in the muscle of *Oreochromis mossambicus*, exposed to sub-lethal concentrations of the detergent.

Exposure Period	Concentration of the detergent (ppm)					
	Control	7	14	21	28	35
12 hr-Glycogen	0.159	0.152	0.142	0.132	0.121	0.114
24 hr- Glycogen	0.151	0.144	0.139	0.126	0.118	0.110

REFERENCES

1. Mc Kim, J. M., Annderson , R. L., Benoit, D. A., Sphear, R. L. and Stokes, G. N. (1975). *WPCE*, 1442 .

2. Brungs, W. A., Cornick, J. H., Neitheisel, J. W., Sphear, R. L., Stephen, C. E. and Stockes, G. N. (1977). *WPCE*, 425.

3. Jhingran, V. G. (1982). In: Fish and Fisheries. Hindustan Publishing Corp., New Delhi, India. 954 pp.

4. Bhattacharya, T., Arunkumar, R. and Shelley, B. (1987). *Indian J. Exp. Bio.*, 25 (8): 539.

5. Anderson, T., Bengt-Erik, B., Lars, F. Jan. H. and Ake, L. (1987). *Ecotoxicol. Environ. Saf.*, 13 (1) : 53.

6. Tovell, P.W. Newsome, C. and Howes, D. (1974). *Water Res.*, 8 (5) : 291.

7. Albert, M. C. , Guillemant, D. and Albert, J. (1987). *Rev. Int. Oceanogr. Med.*, 87/88(1) : 171.

8. Cooper, G. R. and MC Daniel, V. (1970). In: Standards Methods of Clinical Chemistry. Ed. R. P. Mac Donald Academic Press, New York and London. 159 pp.

9. Carol, W.V., Longley and Roe, J. H. (1956). *J. Biol. Chem.*, 220 : 583.

10. Prosser, C. L. and Brown, Jr. F. A. (1965). In: Comparative Animal Physiology. W. B. Saunders Company, London. 695 pp.

11. Depledge, M. H. (1984). *Comp. Biochem. Physiol.*, 78 (2) : 461.

12. Muley, D. V. and Mane, U. H. (1987). *Comp. Anim. Physiol.*, 5 (1): 128.

13. Bhakthavathsalam, R. and Srinivasa Reddy, Y. (1982). *J. Biosci.*, 4(1): 19.

14. Skidmore, J. E. and Tovell (1972). *Water Res.*, 6 : 217.

15. Srebocan, V. Gotal, J. P., Adamovic, V., Sokic, B. and Delok, M. (1971). *Poult. Sci.*, 50 (5): 1271.

16. Wasserman, D. , Wasserman, M. and Lozorovict, S. (1970). *Bull. Environ. Contam. Toxicol.*, 5 : 373.

17. Bhakthavathsalam, R. and Srinivasa Reddy, Y. (1987). *Indian J. Environ. Hlth.*, 27 (2): 159 .