*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **3(8),** 1-5, August **(2014)** *Int. Res. J. Environment Sci.*

Effects of different Concentrations of Detergents on Dissolved Oxygen Consumption in fresh water fish *Mystus montanus*

Chandanshive N.E.
Zoology Department, Fergusson College, Pune-411004, Maharashtra, INDIA

Available online at: www.isca.in, www.isca.me
Received 17th January 2013, revised 19th June 2014, accepted 10th July 2014

Abstract

The detergents are household chemical cleaning compound required in wide range of our daily life for diverse purposes. In many of these of application, the surfactants are used in interaction with water. Surfactant is a major constituent of detergents; this is a compound of high biological activity and has a tendency to accumulate in organisms, making adverse effects possible even at very levels of exposure. In some rivers the concentrations of detergents is quite high. The freshwater fish like Mystus montanus is highly sensitive to the household detergents like Surf and Nirma powder. The average mortality in each concentration was taken to determine the LC_{50} by plotting a graph, taking concentration on X-axis and mortality on Y-axis. According to graphical plots the 50% mortality values of Surf excel and Nirma for 96 hours were 20.0 mg/litre and 23.5 mg/litre respectively. The Fishes were exposed to sublethal concentrations (1/3rd and 2/3rd of LC_{50} values of Surf excel and Nirma) as per suggestions for a period of 96hrs[2]. The oxygen consumption has increased with 1/3rd sublethal concentration of both detergents with increase in time. However, the lowest oxygen consumption was observed at 2/3rd of lethal concentration with increase in time.

Keywords: Detergents, dissolved oxygen, fish, *mystus montanus*, chemical cleaning.

Introduction

The chemical nature of the environment has been greatly changing after the Second World War through the addition of thousands of chemicals such as pesticides, detergents, heavy metals, sewage and several other wastes from different industrial units, drainage from cities and mills and changing lifestyle. Many of these chemicals show acute toxicities for a wide range of animals including human beings. While others are not being so toxic to the living organisms but some of these are highly resistant to degradations in the environment and may accumulate within the body of the organisms including human beings causing adverse effects.

Studies on oxygen content of water and its consumption by fishes attracted the attention of some fishery workers as the mortality occurred on a large scale during the transportation of fish and fry. Soap and detergents are made of fatty acids and various chemicals such as Alkyl Benzene Sulphonates, Polyphosphates, Cellulose, Succinic acid and so on. They are widely used in daily activities and these detergents cause excess frothing and growth of floating aquatic weeds (eutrophication) on the water surface, affecting aeration and quality of fresh water. This adversely affects the physiological and biochemical processes of fishes, number of factors such as temperature, pH, salinity, turbidity and so on affecting the oxygen content as well as the oxygen consumption by the fishes. The synthetic detergents can alter pH and salinity of receiving freshwater body, which affect oxygen consumption by aquatic organisms including fishes.

Acute toxicity of two common household detergents, 'Surf and 'Nirma' to *Gara mullya* was investigated by Litchfield and Wilcoxon graphical method. In terms of LC_{50} values, *Gara mullya* was found be more susceptible to Surf than Nirma. *Gara mullya* exposed to these detergents exhibited abnormal behaviour like frequent surfacing, jerky movement, trying to jump out of experimental aquarium and loss of body balance. The LC_{50} values of Surf excel is 28.5 mg/litre and Nirma 41.75mg/litre[1]. The studies on acute toxicity of two detergents to *Mystus montanus* was investigated using static bioassays. The 96h LC50 values was determined by the Litchfield and Wilcoxon graphical method. These were for Det-I 20.0mg/litre and Det-II 23.5 mg/litre[2]. During exposure period, the test fishes exhibited several behavioural changes before death such as restlessness, rapid swimming, and loss of balance, respiratory distress and haemorrhaging of gill filaments amongst others. Opercula ventilation rate as well as visual examination of dead fish indicates lethal effects of the detergent on the fish[2,3.] Effect of different concentrations of detergent on dissolved Oxygen consumption was investigated in *Anabus testudineus*[4].

Material and Methods

During experimentation, the collection, maintenance and experimental methods recommended in the APHA were followed[5]. Detergents like Surf excel and Nirma were weighed accurately as per requirement and dissolved in water before adding the fishes into the aquarium. For each set of experiment ten moderate size fishes were selected for the experiment having length ranging from 12.3 cm to 14.5 cm and weight ranging

from 18.72gm to 23.86gms of acclimatized fish from original stock. The average mortality in each concentration was taken to determine the LC_{50} by plotting a graph, taking concentration on X-axis and mortality on Y-axis[6]. According to graphical plots the 50% mortality values of Surf excel and Nirma for 96 hours were 20.0 mg/litre and 23.5 mg/litre respectively. These fishes were subjected to two different sub-lethal concentrations ($1/3^{rd}$ and $2/3^{rd}$ of LC_{50} values) of detergents i.e. Surf excel and Nirma as per suggestions for different exposure periods (24, 48, 72 and 96 hours)[7]. Similar number of fish was maintained in controls for similar duration of exposure[8]. After each exposure periods such as 24, 48, 72 and 96hours, Experimental weighed fishes were kept in various sublethal concentrations of detergents in an air tight glass jar for one hour. The oxygen consumption was estimated in ---mg/litre/gram of body weight by modified Winkler's method[9].

Results and Discussion

In *Mystus montanus* oxygen consumption has increased with $1/3^{rd}$ sublethal concentration of both detergents with increase in time. At $2/3^{rd}$ sublethal concentration of both detergents, significant decrease in oxygen consumption with an increase in time was noticed from 48 hours of exposure. Similar results have been noticed by many workers.

When experimental fishes were introduced into water containing detergent, at higher concentrations, they started showing discomfort within few minutes and began to move rapidly. *Mystus montanus* exhibited a variety of behavioural responses like opercular movement was 20-25 times more faster than controlled, loss of nervous control, try to jump out of media. Body was slimy due to mucus secretion from epithelium of gills.

The fishes were surfacing frequently. Affected fishes were swimming on lateral side of the body; nervous control and equilibrium were lost. During tests, the test fish exhibited several behavioural changes before death such as restlessness, rapid swimming and respiratory distress. Opercula ventilation rate as well as visual examination of dead fish indicates lethal effects of the detergent on the fish.

In air breathing fish's *Anabus testudineus* dissolved oxygen consumption increased when it was exposed to the water containing detergent. With increase in the concentration of the detergent, increased breathing and signs of distress were exhibited by the fish. Even though *Anabus testudineus* is very sturdy in tiding over stressful environment, presence of detergents proved detrimental. Other less sturdy fauna would easily succumb to increased concentrations of detergents in their environment[4].

The oedema within the lamellar epithelium extends the blood-water diffusion barrier, thus increasing the diffusional distance, or decreasing the diffusional conductance of oxygen[10]. Also, epithelial lifting (delamination) and fusion of the lamellar epithelium would decrease the available surface area for gas exchange and increase the diffusional distance for gases[11]. The hydropic degeneration, spongiosis and delamination of the lamellar epithelium and lamellar fusion, all could have contributed to an interference with respiratory gas exchange resulting in hypoxia. Decreased diffusional efficiency, resulting in hypoxia, may have also impeded carbon dioxide efflux, causing hypercapnia[12].

Respiration was largely affected in presence of surfactants. The respiratory rate was increased in *Lepomis machrochirus* at concentrations above 1.56 ppm when exposed to alkyl ethoxylates[13]. The effects of LAS in the metabolic enzymatic activity in the gills of *Heteropneustes fossils* indicated that this toxin had a high potential to interfere with the aerobic mechanisms[14]. Some studies of the pathological effects caused by chronic exposure to synthetic detergents evidenced the gradual destruction of the gills filaments, kills the fishes due to asphyxia[15]. In *Cirrhina mrigala,* the epithelial cells of gill lamellae showed a distorted appearance indicating severe damage that led to dysfunctions in respiration and osmoregulation[16]. A commercial detergent "Ariel" at 5ppm was found to induce moderate degenerative changes in the respiratory lamellae in *Oreochromis mossambiccus* on 2 days exposure and the chronic exposure led to drastic changes like separation of epithelium layer and atrophy[17]. The studies on fish *Sparus aurata*, found pronounced alteration in the filaments of individuals exposed to concentrations from 3 to $15mgL^{-1}$ of SDS and LAS. In general, when an extensive destruction of the metabolic surface of the gills occurs, there was a decrease of the entrance of oxygen in blood stream of the fishes, causing suffocation[18]. The lamella's epithelial tissue got three times more swollen than normal due to edemas. Also, thickening of cellular walls was observed. In the shrimp *Panaeus japonius* exposed to $0.75mgL^{-1}$ of LAS-C12 for 96 hr, that the secondary filaments of the gills were found to be fused due to necrosis of the cells[19].

The swelling process would inhibit the passage of oxygen from the water to the bloodstream to the fish, causing it to consume less oxygen. For mullets exposed for a period of until 120h to LAS-C-12, a smaller specific consumption of oxygen was observed when compared to the control[20]. Dissolved oxygen and viscosity are factors affect the oxygen consumption and swimming capacity of fish. Such factor could be related to the swelling of the gills that would be hindering the passage of oxygen. The investigation shows that the lowest oxygen consumption in $1.0mgL^{-1}$ was for 24, 48 and 72 hours of exposure.

However, for short periods of exposure to the polluting agent, a maximum of one and a half hour, an increase was observed in the specific consumption of oxygen[21]. In case of toxicity of detergents, the fish would decrease the tolerance to low concentrations of dissolved oxygen[22].

Table-1
Effects of Surf excel on Oxygen consumption in *Mystus montanus* at various sublethal concentrations

Concentraions ---in mg/litre	Exposure Time			
	24hrs	**48hrs**	**72hrs**	**96hrs**
Control	0.10623 ± 0.002646	0.106267 ± 0.002681	0.106246 ± 0.002754	0.106284 ± 0.002746
6.67mg/lit.	0.110964** ± 0.003556	0.11367* ± 0.00454	0.115042 ** ± 0.002894	0.110978** ± 0.002298
13.3mg/lit.	0.11051* ± 0.00277	0.104608* ± 0.003651	0.092026** ± 0.002793	0.087605** ± 0.001781

Values expressed as --mg/litre/gram of body weight, ± = Standard deviation of three observation. * = Insignificant, ** = Significant at 5.5%, ***= Significant at 1 %, ANOVA table was used for calculation.

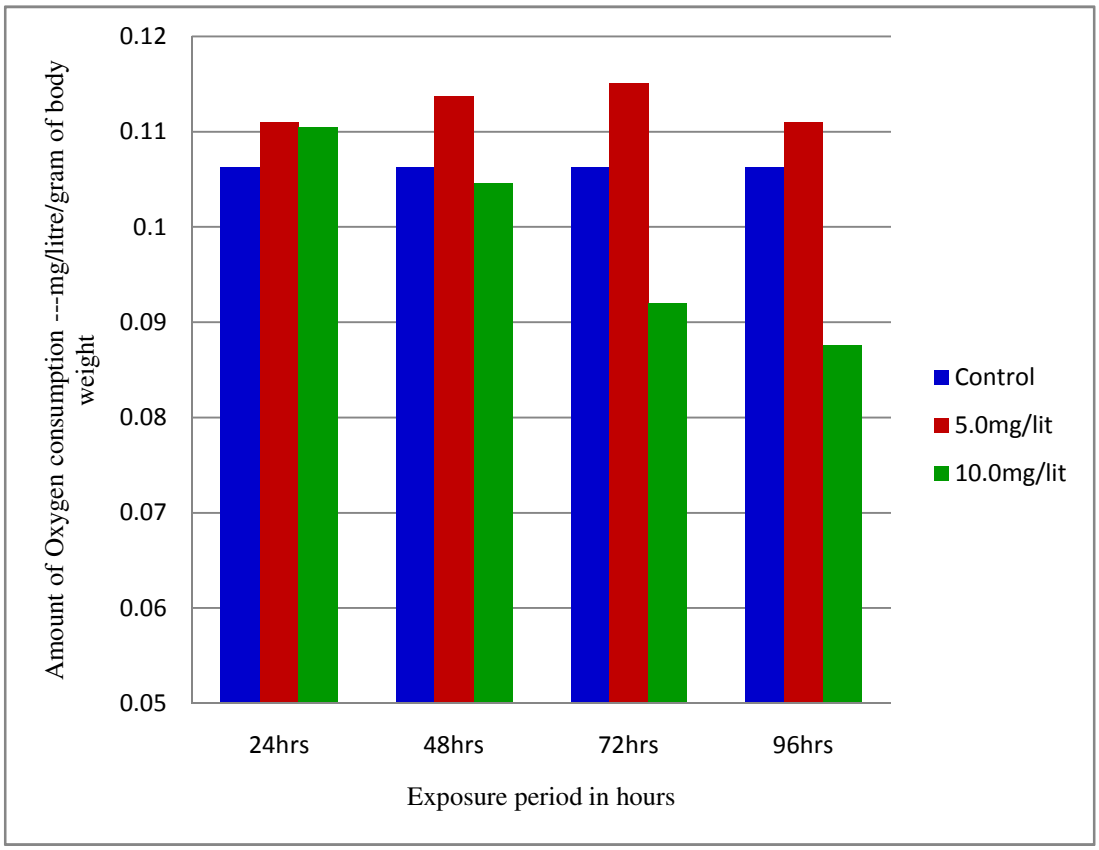

Figure-1
Effects of Surf excel on Oxygen consumption in *Mystus montanus*

Table-2
Effects of Nirma on Oxygen consumption in *Mystus montanus* at various sublethal concentrations

Concentraions ---in mg/litre	Exposure Time			
	24hrs	**48hrs**	**72hrs**	**96hrs**
Control	0.106375 ± 0.003347	0.106327 ± 0.002076	0.106385 ± 0.002432	0.106404 ± 0.002206
7.833mg/lit.	0.107929* ± 0.004474	0.112295** ± 0.001877	0.114204* ± 0.0039	0.110369* ± 0.00167
15.67mg/lit.	0.104013* ± 0.003507	0.097478* ± 0.004983	0.087244** ± 0.004504	0.084049** ±0.001665

Values expressed as --mg/litre/gram of body weight, ± = Standard deviation of three observation. * = Insignificant, ** = Significant at 5.5%, ***= Significant at 1 %, ANOVA table was used for calculation.

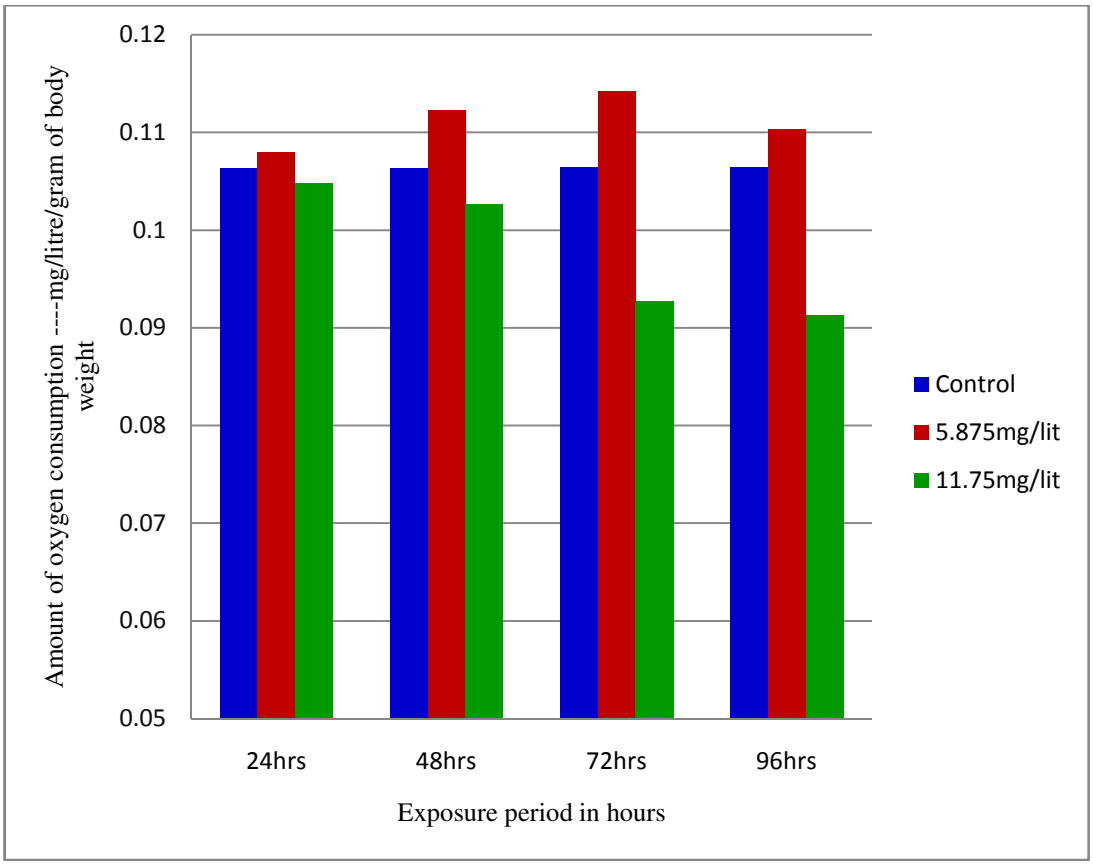

Figure-2
Effects of Nirma powder on Oxygen consumption in Mystus montanus

Conclusion

The detergent molecules can penetrate and solubilize the lipid content of cell membrane and may reduce its permeability. Gills are osmoregulatory organs in fishes and are primary site of uptake for water borne pollutants. Therefore, gills are the first sites where the effect of pollutants would be observed, because of the swelling of gill epithelium it leads to decreased efficiency for gases exchange and oxygen consumption. Toxic elements of detergents also cause excessive secretion of mucus over gill filament and irritation of gill epithelium which can alter and interfere in respiration as well as reduced gill diffusing capacity, resulting in decrease or increase in oxygen consumption. Oxygen consumption decreases with an increase in concentration and time of exposure and may be due to i. penetration of the pollutants at sub-cellular levels, and ii. damage of gill tissues. In *Mystus montanus* oxygen consumption has increased with low sublethal concentration ($1/3^{rd}$) of both detergents with increase in time may be due irritation of gill epithelium, movement of gills was observed faster. Whereas with $2/3^{rd}$ sublethal concentration of both detergents, significant decrease in oxygen consumption with an increase in time was noticed from 48hours of exposure due damage if gill tissue after two days exposure.

Reference

1. Chandanshive N. E. and S.M. Kamble, Acute toxicity of Surf excel and Nirma to freshwater fish *Garra mullya* (*Skyes*), *Journal of Aquatic Biology,* **21(3),** 53-57 **(2006)**

2. Chandanshive N.E., Studies on Toxicity of Detergents to *Mystus montanus* and Change in behaviour of Fish *Research Journal of Animal, Veterinary and Fishery Sciences,* **1(9),** 14-19 (**2013**)

3. Chandanshive N.E., Kamble S.M. and Yadav B.E., Fish Fauna of Pavana river of Pune, Maharashtra, *Zoo's print Journal,* **22(5)**, 2693-2694 (**2007**)

4. Emi Mathew, Subitha P.T. and Philip Litto Thomas, Effect of different concentration of detergent on dissolved Oxygen consumption in *Anabus testudineus, IOSR Journal of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT),* **5(3)**, 01-03 **(2013)**

5. APHA, Standard methods for the examination of water and wastewater 20^{th} edition **(1998)**

6. Finney D.J., In: *Statistical Methods in Biological Assay,* 3rd Edn. Grffin Press, London (**1978**)

7. Konar S.K., Laboratory studies on the organophosphorous insecticides, DDVP, and phosphamidon, as selective toxicants. *Trans Amer. Fish Soc,* **98**, 430-437**,** (**1969**)

8. Burress R.M., Development and evaluation of on-site toxicity test procedure for fishery investigations, U.S. Department, *Fish. Wild. Serv. Wash*., **68,** 1-8 **(1975)**

9. Harish Kumar and Gujaria S.C., Modified Winklers Method for dissolved oxygen content, *Geobios New Rep.,* **14(1)**, 73-75 (**1995**)

10. Ellis A.G., Smith D.G., Edema formation and impaired O2 transfer in knger-perfused gills of the eel, *Anguilla austrdlis*. *J. exp. Zool.,* 227-371-380 (**1983**)

11. Skidmore J.F., Tovell P. M7**.** A., Toxic effects of zinc sulphate on the gills of rainbow trout, *Wat. Res*., **6**, 217-230 (**1972**)

12. Albassam M., Moore J. and Sharma A., Ultrastructural and clinicopathological studies on the toxicity of cationic acrylainide-based flocculant to rainbow trout, *Vet. Pathol*. **24**, 3 4-43 (**1987**)

13. Maki A.W. and W.E. Bishop., Acute toxicity of surfactants to *Daphnia magna and Daphnia pulex, Environ. Contam. Toxicology.* **8**, 599-612, (**1979**)

14. Zaccone G., Fasulo S., Lo Cascio P. and Licata A., Patterns of enzyme activities in the gills of the catfish *Heteropneustes fossils* (Bloch) exposed to the anion-active detergent sodium alkyl benzene sulfonate (LAS), *Histochem. J.,* **82**, 341-343, (**1985**)

15. Misra V., Lal H., Chawla G., Viswanathan P.N., Pathological changes in gills of fish fingerlings (*Cirrhina mrigala)* by linear alkylbenzene sulphonate, *Ecotoxicol. Environ. Saf.,* **10**, 302-308, (**1985**)

16. Misra V., Chawla Geeta Kumar V. Hazarilal and Viswanathan P.N., Effect of Linear alkyl benzene sulphonate in skin of fish fingerlings (*Cirrhina mrigala*); observation with scanning electron microscope, *Ecotoxico. Environ. Safety,* **13(2)**, 164-168 **(1987)**

17. Raju C.S., Anil Kumar D.M.H.S., Praskasa Babu P., Jayantharao K., Effect of detergent (Ariel) on oxidative enzymes and histology of the teleost *Oreochromis mossambicus, J. Ecotoxic. Environ. Monit.,* **4(3),** 227-230 **(1994)**

18. Ribelles A., Carrasco C. and Rosety M., Morphological and histological changes caused by sodium dodecyl-sulfate in *Sparus aurata. L. Euro. J. Histochem.,* **39(2),** 141-148, (**1995**)

19. Supriyono E., Takashima F., Strussmann C.A., Toxicity of Linear alkylbenzene sulphonate (LAS) to juvenile kuruma shrimp, *P. Japonicus:* a histopathological study on acute and sub-chronic levels, *J. Tokyo Univ. Fish,* **85(1),** 1-10, **(1998)**

20. Barbieri E., Phan V.N., Gomes V., Effects of LAS-C12, Linear Alkybenzene Sulphonate, on metabolic rate and swimming capacity of *Cyprinus carpio. Ecotox. Environ. Rest,* **3(2)**, 6-75 **(2000)**

21. Barbieri Edison, use of metabolism and swimming activity to evaluate the sublethal toxicity of surfactant (LAS-C12) on *Mugil platanus, Braz. arch. biol. technol.,* **50(1)** (**2007**)

22. Huang B.Q. and Wang D.Y., Effects of Linear alkylbenzene sulphonate (LAS) on the respiratory functions of tigerperch (*Terpon-jurbua*), *Zoo.Stu.,* **34(1)**, 41-46 (**1994**)