Effect of different concentrations of detergent on dissolved oxygen consumption in fresh water fish Anabas testudineus

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Abstract— Population growth and industrial development are the major causes of contamination of water resources. In developing countries, pollution of water resources has become a serious problem which leads to ecological disorders and causes many physiological as well as biological changes in aquatic animals. Detergents and other cleansing agents have been around for a quite long time. Wide spread use of detergents cause excess frothing and growth of floating aquatic weeds (eutrophication) on the water surface, affecting aeration and quality of fresh water. Anabas testudineus, a common fresh water fish in Kerala was selected in the present study to determine the effect of detergent pollution on the oxygen consumption capacity of the fish in four different concentrations of a popular brand of detergent (sunlight). The amount of dissolved oxygen consumed by fishes was determined using Winkler's method. It is evident from the present study that the samples treated with 50 ppm, 100 ppm, 500 ppm, 1000 ppm of detergent for a time period of 1 hour, the dissolved oxygen content showed a decreasing trend with higher concentration of detergent. Further it demonstrated that dissolved oxygen consumption in Anabas testudineus increases with an increase in the concentration of detergent. All these results clearly indicate a severe impact of detergents on the aquatic ecosystem.

Keywords: Detergents, Dissolved Oxygen, Fish, Pollution, Anabas

I. INTRODUCTION:

Water is one of the prime elements responsible for life on earth. Unfortunately, many of its water bodies are becoming increasingly murky, smelly and chocked with growth of algae. Most of the rivers have become darkened 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 in them. Likewise, indiscriminate use and dumping of domestic sewage into fresh water resources has taken its toll on the various life forms of the aquatic habitat (Simon, 2017). Consequently, a number of fish species that were abundant years ago have failed to cope up with the stress caused by increased concentrations of various chemicals that are poured into the water bodies (Sheela *et al*., 2011).

For agricultural purposes man uses chemical fertilizers, pesticides, insecticides which create great problem to the ecology and environment. These pollutants are directly or indirectly discharged into water bodies. Promiscuous use of pesticides and fertilizers has made these water bodies unsuitable for human use. Besides, many studies have reported the ill effects of fertilizers and pesticides on the fauna and flora of aquatic systems (Aktar *et al*., 2009). However, apart from fertilizers and pesticides, another harmful chemical agent that often goes unnoticed is detergents including a huge amount of various brands of detergent powders, flakes, various shampoos and toilet soaps. Detergents are very widely used in both industrial and domestic premises and these detergents cause excess frothing and growth of floating aquatic weeds (eutrophication) on the water surface, affecting aeration and quality of fresh water. All fish require oxygen for long-term survival; however, the physical properties of water make oxygen uptake a challenge even at high DO. Oxygen consumption is a measure of the metabolic state of the animal. If more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken, or die. Hence it is considered as vital parameters and indicates the physiological and metabolic alteration as the animal.

Anabas testudineus is a common food fish abundant in tanks, ponds, streams and lakes of India. They inhabit both brackish and fresh water. Anabas has the habit of migrating from pond to pond. In the wild, *Anabas* species grow up to 30 cm long. They are perch- like fishes placed under the genus of climbing gouramis native to southern and eastern Asia. When in water, the fish frequently comes to the surface to breath air. They possess a labyrinth like accessory breathing organ on either side of the head which allows it to breathe atmospheric oxygen, so it can be out of water for an extended period of time (Hughes and Morgan, 1973) and also helps to survive in water with low Oxygen levels. The air swallowed by Anabas is taken into two chamber situated one on each side above the gills, forming outgrowths from the ordinary brachial chambers, richly supplied with fine blood vessels and covered with thin epithelium (Norman, 1975).

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. Vast majority of fishes cannot live out of water for any length of time. As a general rule, fishes with wide external gill openings die more rapidly than those in which the apertures are reduced. Those fishes which also survive out of water have a gill structure which enables then to keep sufficient moisture trapped between the filaments to prevent both collapse of the folds and the drying-out of the gill surface (Fry, 1957). All fish require oxygen for long-term survival; however, the physical properties of water make oxygen uptake a challenge even at high DO. The effect of detergents on tissue of different fishes has been studied by Abel (1994). Gills a primary site of osmoregulation, as well as respiration, may be highly vulnerable to lesions because they are in immediate contact with aquatic toxicants. Therefore, the most prominent manifestation of the acute toxicological effect of detergents is on the gill tissue of the fish (Misra *et al*., 1985). It has been reported that the detergent causes damage to the buccal lining and gill epithelium that may result in poor utilisation of food and interfere in oxygen uptake (Chandanshive, 2014). It has been suggested that destruction of the gill epithelium is regarded as a consequence of the reduction of surface tension by the presence of surfactants (Lal *et al*, 1984). Detergent causes impairment of chemoreceptor organs (Brown, 1968) and damage to epidermis and pharyngeal wall (Bromage and Fuchs, 1976). Eleven species of fish exposed to a mixture of hard alkyl benzene sulphonate based detergent under varying environmental conditions and during different stages of development have shown wide differences in response (Bardach *et al*., 1965). Behavioural changes have been used successfully as rapid and sensitive indicators of toxic stress in fish (Thatcher, 1966). It has affected the level of glycogen, protein and fat in fish. The detergent has also affected the behaviour of fish, oxygen consumption and biochemical content in tissue (Chandanshive, 2014). Keeping in this view, the present study aims to understand the effect of various concentrations of detergent on Oxygen consumption of *Anabas testudineus.*

II. Materials and Methods

Fish samples for the study (*Anabas testudineus*) were collected from Thiruvananthapuram district and the weight of the fish was recorded. Anabas was selected for this study due to its sturdy nature with which it can withstand the stress much better than other fishes. Water samples for the experiment were collected from a relatively unpolluted pond. Four different concentrations (50ppm, 100ppm, 500ppm and 1000ppm) of the popular detergent, 'Surf Excel' were prepared in the sample water. Transferred a fish each into four jars with the said concentrations of the detergent and kept for one hour. Similarly four control jars with 50ppm, 100ppm, 500ppm and 1000ppm detergent were kept as controls. After one hour, water samples were collected from the eight jars using siphon and estimated their DO content employing Winkler's method. Difference between the amounts of DO in the sample with only detergent and that with both detergent and fish gave the amount of DO consumed by the fish for that particular concentration of detergent. Similarly, DO consumed by fishes in other water samples was calculated. All experiments were repeated 5 times.

Estimation of Dissolved Oxygen (DO): Winkler's method

Water sample for estimation after the experiment was taken in 250 mL bottles taking care to reduce the contact of this water to air and not to induce any air bubble in the sample bottle. The bottle was closed with a stopper. 1 mL of manganous sulphate and 1 mL of alkaline iodide were poured into the bottle using separate pipettes. Shook well and allowed to settle down. Shook the bottle again and 2 mL of concentrated Sulphuric acid was added to this mixture and shook vigorously to digest the precipitate. 50 mL of this solution was pipetted out into a conical flask. It was then titrated against Sodium Thiosulphate solution taken in the burette until the brown colour of iodine almost disappeared. To this, added 5 drops of starch solution. The end point was marked by the first complete disappearance of blue colour.

Fig.1. *Anabas testudineus*

III. Result

Dissolved oxygen (DO) in the water sample collected was estimated before adding the detergent or introducing the fishes of nearly 12 g and the values averaged at 10.4 mg/L. This reading was taken as the control. DO concentration greater than 10 mg/L indicated that the water sample collected for the experiment contained sufficient amount of dissolved Oxygen for the survival of fishes. As the sample was treated with 50 ppm, 100 ppm, 500 ppm, 1000 ppm of detergent for a time period of 1 hour, the dissolved oxygen content showed a decreasing trend ranging from 10 mg/L, 9.2 mg/L, 8.5 mg/L, 8.1 mg/L (Table 1). Sample water treated with 50 ppm of detergent for 1 hour showed a mean decrease in dissolved

Table 1: Oxygen Consumption of *Anabas testudineus* exposed to various concentrations of detergent (Surf Excel)

Concentration of Detergent (Surf excel) (ppm)	Dissolved Oxygen (mg/L) (Detergent alone)	Dissolved Oxygen (mg/L) (Detergent & Fish)	Dissolved Oxygen consumed by fish (mg/L)	Oxygen Consumption (mg/L/hr/g body weight of fish)
0 ppm	10.4	7.31	3.09	0.26
50 ppm	10	6.4	3.6	0.3
100 ppm	9.2	5.3	3.9	0.32
500 ppm	8.5	4	4.5	0.38
1000ppm	8.1	2.4	5.7	0.48

(All treatments were of 1 hour duration and the values are Arithmetic Mean of 5 independent experiments)

Oxygen of 0.4mg/L from the control. Sample water treated with 100 ppm of detergent for 1 hour showed a mean decrease in DO of 1.2 mg/L from the control. With increased concentration of detergent at 500 ppm for 1 hour, DO further decrease by 1.9mg/L from the control. Similarly, this trend continued also with the sample water treated with a detergent concentration of 1000 ppm for 1 hour where a mean decrease in DO of 2.3mg/L from the control was noted. Estimation of DO consumed by the fishes showed an increasing trend with the increase in concentration of the detergent. Fishes used in control experiment (with no detergent added) showed a DO consumption of 3.09mg/L/hr. Fishes kept at 50 ppm of detergent concentration showed a mean DO consumption of 3.6mg/L/hr. Further, with the detergent concentrations at 100, 500 ppm and 1000 ppm, the mean DO consumption reached 3.9 mg/L/hr, 4.5 mg/L/hr and 5.7 mg/L/hr respectively. All the experimental fishes weighed between 10.7 and 12g. Mean DO consumption per gram body weight of the fishes used in the experiments were calculated and is shown in the last column of Table 1.

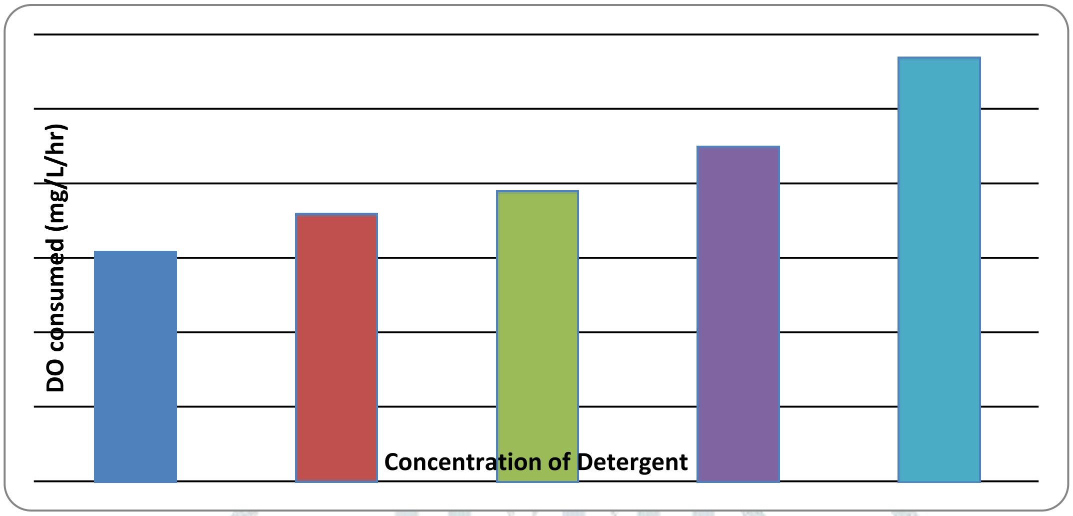

Figure: 2. Effect of various concentrations of detergent on Dissolved Oxygen Consumption in *Anabas testudineus*

IV . Discussion

Pollution of the water bodies will create physiological stress on the aquatic fauna. Among various forms of pollution in water bodies, detergent pollution has an immediate and detrimental effect (Simon, 2017). There are numerous types of detergents available nowadays. They are effective in cleaning purposes but they are highly toxic to lower organisms. Detergents are composed of complex phosphates which eventually breakdown into phosphates usable by aquatic plants. The use of detergents has been responsible for the increase in the phosphorous in sewage effluents. It is evident from the present study that the samples treated with 50 ppm, 100 ppm, 500 ppm, 1000 ppm of detergent for a time period of 1 hour, the dissolved oxygen content showed a decreasing trend ranging from 10 mg/L, 9.2 mg/L, 8.5 mg/L, 8.1 mg/L. The result also supports the view that phosphate pollution of rivers and lakes causes extensive growth of algae which depletes the dissolved oxygen content of water and disrupts the natural food chains (Simon, 2017).

The detergent has also affected the oxygen consumption, and biochemical content in fish tissues (Simon, 2017). This is evident from our study that oxygen consumption rate in the control bottle was 3.09 mg/L. At a concentration of 50 ppm, the oxygen consumption rate was 3.6 mg/L. The rate was shown in an increasing trend of 3.9, 4.5 and 5.7 respectively for further concentrations of 100,500 and 1000 ppm. Above that concentration fish exhibited a decline in the rate of survival. Oxygen consumption with respect to the gram body weight indicates an increased consumption of DO by the fishes under increased concentrations of the detergent.

On treating the fishes with different concentrations of detergents, they exhibited a state of inactive nature with an in increase in the rate of breathing with the secretion of mucous (Chandanshive, 2014). Similarly, it was reported that detergents also affected the behaviour of fish (Simon, 2017). During the present study, it was observed that when experimental fishes were introduced into water containing 50 ppm of detergent, they showed signs of distress and random movement after about 30 minutes and at 100 ppm detergent concentration, they started showing discomfort within 10 minutes and began to move around rapidly. With increased concentrations of the detergent at 500 ppm and 1000 ppm, the time lag for rapid movements reduced to around 5 minutes and 2 minutes respectively. Further it showed a varied frequency of air gulping from the atmosphere. However, in all the experiments, the fishes appeared inactive later and rested at the bottom of the vessel. But, they continued to breathe rapidly and the mucous on the body surface started to come off. This phenomenon was more manifest in the water with 1000 ppm detergent. Behavioral abnormalities in various fish species on exposure to pollutants have been reported by several researchers. Sprague (l97l) reported that fish fed pollutant contaminated phytoplankton and zooplankton comes up with damaged peripheral organs and reduction in swimming activities. Ghatak and Konar, (1990) observed frequent surfacing with irregular opercular movement and loss of equilibrium in *Tilapia mossambicus* when exposed to different concentrations of cadmium. These behavioural features provide useful measures of sub lethal toxicity because they represent the integrated results of any biochemical and physiological processes (Simon, 2017).

In air breathing fish *Anabas testudineus,* dissolved oxygen consumption increased when it was exposed to the water containing detergent. With an increase in the concentration of the detergent, the breathing rate increased and signs of distress were exhibited by the fish. From this experiment it is observed that the detergent had a severe impact on the experimental fish. Though Anabas has large respiratory capacity than other fresh water fishes due to the presence of accessory respiratory organs and it is very sturdy in tiding over stressful environment, presence of detergents proved detrimental (Mathew *et al*., 2013). Therefore, it is clear that other less sturdy aquatic fauna would easily succumb to increased concentrations of detergents in their environment. All these results clearly indicate a severe impact of detergents on the aquatic ecosystem.

V. Conclusion

The study on effect of different concentrations of detergent on dissolved oxygen consumption in *Anabas testudineus* shows that the presence of detergents are deleterious to natural population of fish. It was clearly evident from the present study that at higher concentration of detergents in water will lead to the decrease in dissolved oxygen. This study is very influential now a day because almost all households use detergents for washing purposes and in most cases, the sewage water is discharged into the water bodies. People need to be made aware of the adverse causalities of detergents on various forms of aquatic life. Sewage water generated from households should not be allowed to be discharged directly into the water bodies. Of course, Governments should enforce the more, on the industries, the proper treatment and disposal of effluents, lest our waters become wastes banks and eventually lose their aesthetic values while the natural fish population becomes impaired.

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