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Effect of monocrotophos on the oxygen consumption of the freshwater fish channa striata

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Abstract
The freshwater fish, *Channa striata* fingerlings were exposed to 10% and 30% sublethal concentrations of (LC_{50} for 96h ppm – 0.38 ppm) monocrotophos for a period of 10, 20 and 30 days to study the effect of monocrotophos on the rate of oxygen consumption. The rate of oxygen consumption in control *Channa striata* were 0.579, 0.584 and 0.582 ml/O_2/g/hr at 10,20 and 30 days, respectively. The fish exposed to sub lethal concentrations of monocrotophos shown the oxygen consumption at the rate of 0.518, 0.439, 0.367, 0.448, 0.382 and 0.274 ml/O_2/g/hr at 10 and 30% sub lethal concentrations of 10, 20 and 30 days respectively. In this study, the oxygen consumption was gradually decreasing with increasing exposure periods. Maximum decline (-52.92%) over control in the rate of respiration was noticed in 30% sub lethal concentration on 30 days of exposure.

Keywords: monocrotophos, oxygen consumption and *Channa striata*

Introduction
Any change in the aquatic medium affects respiratory potentials of the fishes. The respiratory potentials of an animal are the important physiological parameters to assess the toxicity stress because it is a variable indicator of energy expenditure in particular. The early symptoms of acute poisoning by pesticides are the alteration or failure of respiratory metabolism (Holden, 1973). A number of investigations on oxygen consumption of fishes have been reported (Sigh and Singh, 1979; Sarkar, 1989, Sultana and Umadevi, 1995; Mathew *et al*., 1997 and Vitukuru, 2005). The overall decrease in the amount of oxygen consumption in *Channa striatus* is due to injury caused to the red blood corpuscles by the pesticides and reduction in the RBC count, following exposure to Metasystox (Natarajan, 1981). When *Channa punctatus* was exposed to different concentrations of Sevin, it showed tremendous drop in its opercular movement. This reduced opercular movement was affected by the contact of pesticide through the gill chamber of the fish (Anbu and Ramasamy, 1991). A reduction in haemoglobin content and erythrocyte count resulting in hypochromic microcytic anaemia have also been suggested as reasons for drop in O_2 uptake in the fish *Sarotherodon mossambicus* exposed to lethal concentration of sumithion and sevin (Ranganatha Koundinya and Ramamurthi, 1979). Natarajan (1981) and Huner *et al.* (1967) have also got similar results in the fish *C. striatus*, and blue gill, *Lepomis macrochirus* respectively due to the exposure of the pesticides, metasystox and endrin, respectively. The O_2 consumption of the fish *Tilapia mossambica* has disturbed when exposed to sublethal concentration of organochlorine pesticide DDT (Ravindran and Swami, 1987). Exposure of gold fish to methyl parathion tends to depress the rate of oxygen consumption (Holden, 1972). Ramakrishnan and Sivakumar (1993) reported that the rate of oxygen consumption is decreased with increasing concentrations of Quinolphos. Subramanian and Manickavasakam (1993) studied the effect of alcohol distillery industry effluent on the oxygen consumption of the freshwater edible fishes *Cyprinus carpio* and *Oreochromis mossambicus* and reported a decrease in O_2 consumption. Lomte and Jedhav (1982) studied the effects of toxic compounds on oxygen consumption in the freshwater bivalve, *Corbicula regularis* and observed a decrease in the rate of oxygen consumption. The decreased oxygen consumption in the fish *Oreochromis mossambicus* has been observed by Mathivanan (2004) when exposed to Quinolphos. Therefore in the present investigation, the same concept has been employed to assess the impact of pesticide, monocrotophos on oxygen consumption of *Labeo rohita*.

Materials and Methods
The fish, *Channa striata* fingerlings (Weight: 15g; Length 9 cm) were collected from the Aqua Farm near Pattukkottai, Tamil Nadu.
They were acclimatized for 15 days in large cement tanks (Temperature – 28 ± 2°C**;** total hardness – 518 ± 23 mg/l; DO - 5.6 ± 0.2 mg/l; salinity - 1.2 ± 0.13 ppt and pH - 7.8 ± 0.04) previously washed with 1% potassium permanganate. The water as renewed every 24 h. The LC_{50} of monocrotophos for 96h was found out by using Probit method (Finney, 1971). For biochemical studies *Channa striata* were reared in sublethal concentration (10% of 96 hours LC_{50} - 0.38 ppm) for a period of 10, 20 and 30 days. At the end of 10, 20 and 30 days, oxygen consumption was measured in both control and treated fish.

Estimation of Oxygen Consumption
A series of rectangular glass jars, each with one litre capacity were used as aquarium. They were filled with water. Care was taken to avoid trapping of air bubbles. Only one fish was introduced into each aquarium and a thick layer of coconut oil was spread on the surface of the medium to prevent the contact of the medium to the atmosphere and to prevent the fish from reaching the atmospheric air.
Before starting the experiment, the initial oxygen content of water used for the preparation of animal chambers was estimated by collecting a sample into a narrow mouth, glass

stoppered sample bottle of known volume following the Winkler's method (Annon, 1984). A healthy fish was allowed to respire for one hour in animal chambers. After one hour, samples from respiratory chamber were taken into the sample bottle of known volume through siphon system and the dissolved oxygen was estimated.

Determination of oxygen content of the sample

The initial oxygen content of water was determined by collecting the sample in a narrow mouthed glass stoppered sample bottle of known volume. To this 1 ml of manganous sulphate solution was added followed by addition of 1 ml of alkaline iodide solution. The bottle was stoppered and shaken vigorously and kept in a dark place to prevent any photochemical reaction for about 15 minutes. A few drops of conc. sulphuric acid were added into the sample bottle in order to dissolve the precipitate. The precipitate was completely dissolved by shaking vigorously. Twenty ml of the sample was taken in a clean conical flask and the liberated iodine was titrated against sodium thiosulphate using four to five drops of starch as indicator. The disappearance of blue colour was taken as end point. The burette values were tabulated. The final oxygen content of the respiratory chamber was also determined in the same manner. Oxygen consumed by the fish was calculated by finding out the difference between the initial and final oxygen content in the animal chambers. Also the rate of oxygen consumption per gram weight of the fish per hour was calculated and the values were expressed as ml O_2/gm/hour.

The dissolved oxygen content in the water was calculated using the following formula:

$$O_2 \text{ content ml/litre} = \frac{K \times 200 \times \text{volume of } Na_2S_2O_3 \text{ consumed} \times 0.698}{\text{Volume of the sample titrated}}$$

$$\text{Where } K = \frac{\text{Volume of sample bottle}}{\text{Vol. of sample bottle - Vol. of reagents added}}$$

(0.698 is the conversion factor to convert parts per million to ml/litre) (200 is the constant which is obtained by multiplying the equivalent weight of oxygen and normality of $Na_2S_2O_3$ and 100 ml).

Results and Discussion

Oxygen consumption of fish, *Channa striata* exposed to sublethal concentrations of pesticide monocrotophos is presented in Table 1 and Fig.1. Decrease in O_2 consumption rate was observed in *Channa striata* exposed to 10 and 30% sub lethal concentrations of monocrotophos for a period of 10, 20 and 30 days.

The rate of oxygen consumption in control *Channa striata* were 0.579, 0.584 and 0.582 ml/O_2/g/hr at 10,20 and 30 days, respectively (Table 1). The fish exposed to sub lethal concentrations of monocrotophos shown the oxygen consumption at the rate of 0.518, 0.439, 0.367, 0.448, 0.382 and 0.274 ml/O_2/g/hr at 10 and 30% sub lethal concentrations of 10, 20 and 30 days respectively. In this study, the oxygen consumption was gradually decreasing with increasing exposure periods. Maximum decline (-52.92%) over control in the rate of respiration was noticed in 30% sub lethal concentration on 30 days of exposure (Table 1).

The rate of oxygen consumption is a true index of the metabolic state, particularly in aquatic animals whose body is continuously bathed by the surrounding water and is a valuable indication of sub lethal stress. When the pesticides enter the living system, they primarily affect the metabolism, which is concerned with oxygen consumption. Respiration is one of the most important processes as oxygen taken up during this process is essential to provide energy for life activities in the living organisms. The O_2 consumption is a very sensitive physiological process and the change in respiratory activity has been used as an indicator of stress in animals exposed to toxicants (Sarkar, 1999). In this study, the rates of O_2 uptake of whole organism were altered by pesticide, monocrotophos. The decreased oxygen uptake could be suggested as a equal to gill damage or due to hypochronic microcytic anaemia under pesticide stress (Koundinya and Ramamurthi, 1980), Toxic substances present in the pesticide interfered with respiration by damage of gill and inhibition of enzyme system at mitochondrial levels resulting in reduced oxygen uptake. The drop in oxygen uptake of pesticide treated *Channa striata* indicates the onset of severe hypoxia under pesticides stress, which has triggered the metabolic pathways of fish. Similar observations have been reported in *Channa striata* after chlordane, metasystox and severe intoxication (Bansal *et al*., 1979). Decrease in oxygen uptake with increasing concentrations of pesticide in *Channa striata* supports the earlier findings of Gopalakrishna Reddy and Gomathi (1977) in *Mystus vittatus* due to thiodon intoxication and Pandey *et al.* (1976) in *C. punctatus* after exposure to Malathion. A similar decrease in oxygen uptake has been reported in *M. vittatus* (Reddy and Gomathy, 1977) exposed to thiodon, in *Sarotherodon mossambicus* (Vasanthi and Ramasamy, 1987) exposed to thiodon and in *Cyprinus carpio* (Nagarathinama and Ramamurthi, 1982) due to methyl parathion exposure. Lutherdas *et al*. (1999) observed decline in the rate of oxygen consumption when *Channa punctata* has been exposed to synthetic pyrethroid, cypermethrin. Sublethal concentrations of deltamethrin, a pyrethroid, have decreased oxygen consumption in *Oreochromis mossambicus* (Nazeemual Khane *et al*., 1992). Similar result is observed when the same species of fish has been exposed to metasystox as reported by Natarajan (1981) and this has been explained as due to the injury caused to the red blood corpuscles and reduction in the RBC count. A reduction in haemoglobin content and erythrocyte population resulting in hypochromic microcytic anaemia have also been suggested as reasons for drop in oxygen uptake in *S. mossambius* exposed to lethal concentration of Sumithion and Sevin (Ranganatha Koundinya and Ramamurthi, 1979). When *Oreochromis mossambicus* is exposed to quinophos, decreased consumption of oxygen has been noted (Mathivanan, 2004). The increasing concentrations of the textile dye effluent decreased the oxygen consumption in *Oreochromis massambicus* (Baskaran *et al*., 1989). Similar result has been obtained by Hingorani *et al*. (1979) in the fish *Labeo rohita* when exposed to different concentrations of textile dye effluent. The decrease in the rate of oxygen consumption has also been noted in fresh water fish, *Oreochromis mossambicus* exposed to sublethal concentration of fertilizer urea (Palanivelu *et al.*, 2005).

The oxygen consumption is a very sensitive physiological

process and the change in respiratory activity has been used as an indicator of stress in animal exposed to toxicants. Many workers (Pandey *et al*., 1976; Rajamannar and Manohar, 1998; Gurusamy and Ramadas, 2000 and Mathivanan, 2004) have observed the decreasing trend in oxygen consumption when fish are exposed to pollutants. They have suggested reasons for the reduction of oxygen consumption as (i) the coagulation of mucus in the gills, which interfere with respiratory metabolism, (ii) due to abnormality in gill and other tissues and (iii) due to injury caused to the RBC, reduction in RBC count and haemoglobin content. The results of this study confirm the earlier report (Saradhamani *et al*., 2009) on oxygen consumption by fish in pesticide mixed water.

Table 1: Changes in the oxygen uptake of *Channa striata* at different sublethal concentrations of monocrotophos (O_2 ml/g/hr)

Experimental group	Exposure periods (days)		
	10	20	30
Control	0.579±0.070	0.584 ± 0.065	0.582 ± 0.068
10% SLC %Variation	0.492±0.045 -15.03	0.419 ± 0.048-28.25	0.321 ± 0.065-44.85
30% SLC %Variation	0.421±0.036 -27.29	0.362 ± 0.055-38.01	0.233 ± 0.75 -59.97

Values are mean ± SD of six observations. – or + indicate percent decrease or increase over control

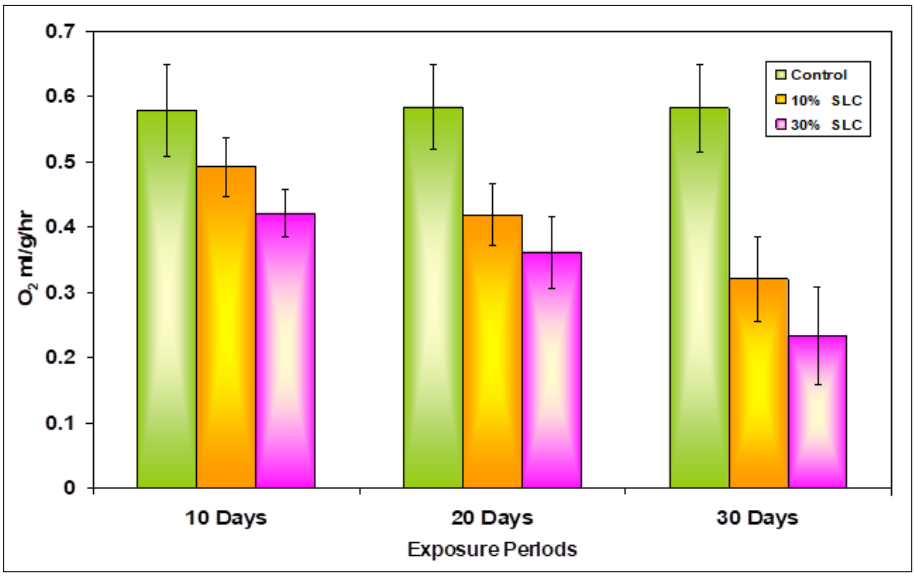

Fig 1: Changes in the oxygen uptake of *Channa striata* at different sublethal concentrations of monocrotophos (O_2 ml/g/hr)

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