Journal of Environmental Biology
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November 2009, 30(6) 1031-1033 (2009)
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Acute toxicity of Nuvan®, an organophosphate to freshwater fish *Ctenopharyngodon idella* and its effect on oxygen consumption

K.S. Tilak* and R. Swarna Kumari

Department of Zoology, Acharya Nagarjuna University, Nagarjunanagar, Guntur - 522 510, India

(Received: October 31, 2007; Revised received: April 20, 2008; Accepted: July 28, 2008)

Abstract: *The acute toxicity of Nuvan to the grass carp Ctenopharyngodon idella was determined using static and continuous flow through system for 24, 48, 72 and 96 hr. The median lethal concentration (LC_{50}) values were 13.1, 10.9, 9.8 and 6.5 mg l^{-1} respectively in static system and 10.7, 9.5, 8.0 and 7.5 mg l^{-1} respectively in continuous flow through system. A reduction in oxygen consumption is observed when the fish is exposed to the toxicant and the mortality is due to effect of metabolism of energy synthesis.*

Key words: *Acute toxicity, Ctenopharyngodon idella, Nuvan®, Organophosphate, LC_{50} values, Oxygen consumption*
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Introduction

Aquatic environment is the ultimate sink for all pollutants where they are going to affect the zoans more than their counterparts in the two environs of land and water. The agri and aquaventures necessiates the use of chemicals and these chemicals as contaminants where ever studed (Rand and Petrocelli, 1985) damage the living inhabitance. To contemplate a clean environment in a policy and planning unless possible affect on aquatic inhabitants are assessed it can be a dream only. Fish bioassay experiments, the trophic level connection in aquasystems are indices to determine the acute toxicity and possible effect on oxygen consumption due to the toxicant stress (Laws, 1981; Murty 1986; Subrahmanyam, 2004).

Hence in the present study, Nuvan® an organophosphate pesticides used in the local area to combat pests is selected to study the acute toxicity to the fresh water grass carp *Ctenopharyngodon idella* (Valenciennes) and to observe changes in oxygen consumption during stress.

Materials and Methods

The freshwater fish, grass carp *Ctenopharyngodon idella* (Valenciennes) of size 5 to 6 cm in length and weight 3-4 g were brought from local fish farms. The pesticide Nuvan® is locally purchased (Hikal Limited 629/630 GIDC Industrial Estate, Panoli Bharuch, Gujarat).

The fish were acclimated to laboratory conditions in well aerated unchlorinated tap water at 28±2°C. During the period of acclimatization and experiments the fish were not fed. If the number of deaths exceeded 5% in any batch of fish during the above process the entire batch was discarded. The toxicity studies were conducted using Nuvan 76% EC dissolved in acetone and diluted appropriately employing static and continuous flow through systems as recommended American Public Health Association (APHA, 1998). All the precautions laid down the above recommendations are followed to conduct the acute fish bioassay experiments for 24, 48, 72 and 96 hr. For the flow through systems the test solutions of desired concentrations were prepared once in every five hours in glass reservoirs and let into the test containers through thin walled polyethylene tubes. The flow rate was adjusted with regulators such that 4 l of water passed through containers in one hour. The conditions of the test medium were: Temperature 28±2°C, oxygen 6-8 ppm hardness 80 mg l^{-1} alkalinity 425 mg l^{-1} and pH 8.3.

Pilot experiments were conducted to determine the concentrations causing 10 to 90% mortality of the test fish and the experiments were repeated thrice. Probit analysis (Finney, 1971) as recommended by Roberts and Boyce (1972) was followed to calculate the LC_{50} values and 95% confidential limits of were also derived considering a normal variate of 1.96.

The lethal (LC_{50} 24 hr *i.e.* 13.1 mg l^{-1}) and sublethal concentrations ($^1/_{10}$ of LC_{50} 24 hr *i.e.* 1.31 mg l^{-1}) for *Ctenopharyngodon idella* (Valenciennes) was taken to study the oxygen consumption for 24 hr in static system through respiratory apparatus developed by Job (1955). The amount of dissolved oxygen in water was estimated by modified Winkler method (Golterman and Clymo, 1969). The difference in the dissolved oxygen content between initial and final water samples represents the amount of oxygen consumed by the fish.

* **Corresponding author:** proftilak@yahoo.com

Table - 1: The LC_{50} values, 95% confidence limits and Regression equations of Nuvan 76% EC to fish *Ctenopharyngodon idella* for 24, 48, 72, 96 hr in static and continuous flow through systems

Duration	Type of test	LC_{50} value	Confidence limits (95%)	Regression equation
24 hr	Static	13.1	3.20	Y = 24.3962 – 2.4691X
	Continuous flow through	10.7	3.09	Y = 52.1201 – 5.7143X
48 hr	Static	10.9	3.12	Y = 0.5090 – 0.0435X
	Continuous flow through	9.5	3.07	Y = 41.2052 – 4.6512X
72 hr	Static	9.8	3.13	Y = 10.6307 – 1.1848X
	Continuous flow through	8.0	2.99	Y = 2.9036 - 3.7175X
96 hr	Static	6.5	3.04	Y = 2.8148 – 0.7047X
	Continuous flow through	7.5	2.93	Y = 23.4529 – 2.8409X

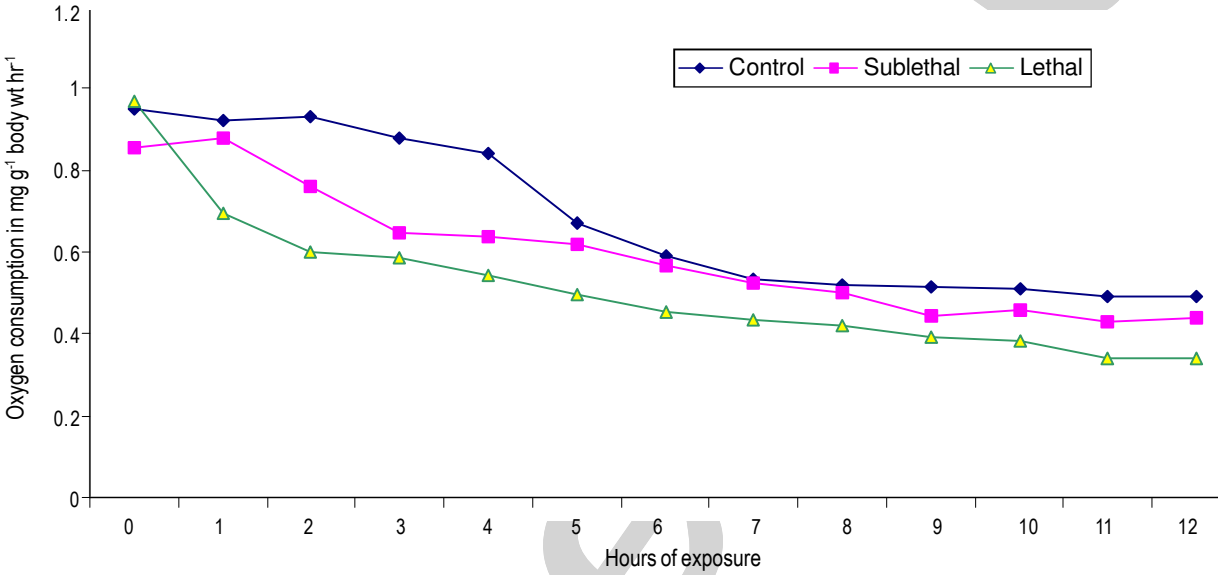

Fig. 1: The amount of oxygen consumed in mg g^{-1} body weight hr^{-1} of the fresh water fish *Ctenopharyngodon idella* exposed to sublethal and lethal concentrations of nuvan 76% EC

Results and Discussion

The lethal concentrations *i.e.* LC_{50} values 95% confidential limits and regression equations for 24, 48, 72 and 96 hr are given in Table 1. A survey study made by Sekizewa and Eto (1988) reveals that nuvan® is toxic to fish and other aquatic organisms. According to EPA report (1985) Dichlorovos, the other name for nuvan is listed as the category I (first group) being considered highly toxic. In the present study static values are higher to continuous flow through system (CFS) which is due to constant maintenance of concentration in flowthrough system and fluctuations resulting bioaccumilation of pesticide absorption. The 76% emulsifiable concentrate contains some ingredients which can also contribute the cumulative affect.

Ghosh and Chatterjee (1989) to *Channa punctata* and Padmaja *et al*. (1985) to snail *Bellamya dissimilis* reported high toxic values for Nuvan. Since it is an organophosphate compound when other similar class of chemicals like chlorpyrifos, the possible toxic action can be visualised as inhibiting the enzyme acetyl cholinesterase. The observed values of static are high to CFS, as low as are comparable to earlier reports of Borthwick *et al*. (1985), Mayer (1987), Tilak *et al*. (2004).

Yamin *et al*. (1994) found that where carps are exposed to a concentration of 25 mg l^{-1} of Dichlorovos for 45 minutes, the cholinesterase activity of many tissues was inhibited or totally lost. Based on a 60 day study (Verma *et al*., 1981), the estimated maximum acceptable toxicant concentration (MATC) at which no effect was seen for *Cyprinus carpio* was 0.016 -0.020 mg l^{-1}.

The decrease of the oxygen consumption to the fish exposed to Nuvan is clearly evident as per graphical presentation (Fig. 1). Stress resulted a marked response to organophosphate insecticide activity. The depletion of the oxygen consumption is due to the disorganization of the respiratory action caused by rupture in the respiratory epithelium of the gill tissue. As per the data, oxygen consumption is decreased when the time of exposure to toxicant is increased. The respiratory potential and the oxygen consumption of an animal are the important physiological parameters to assess the toxic stress because it is a valuable indicator of energy expenditure during metabolism (Proser and Brown, 1973).

Bradbury *et al*. (1986) stated that the greater decrease in the rate of oxygen consumption in the fish *Cirrhinus mrigala* may be due to internal action of the pesticide, as toxicant altering the metabolic cycle at subcellular level. Similar observations were also reported by Mushgeri and David (2003) and Jadhav and Sontakka (1977). The decrease in oxygen consumption at sublethal concentration of the toxicant appears to be lowering of energy requirements. In such a case, because of highly toxic action maintenance of energy requirement is considered and the decrease is oxygen consumption is going to cause pronounced haematological changes (Tilak and Satyavardhan, 2002).

Reduction in oxygen consumption was reported in *Channa striatus* exposed to organophosphate pesticide by Natarajan (1981). The pesticide induced changes in oxygen consumption of the whole animal and also of its tissues dichlorovos when exposed to which reduced the oxygen consumption of the excised tissues of gill in *Tilapia mossambica* (Rath and Mishra, 1979a,b).

Sublethal concentration of dicholorvos 0.5 to 1 mg l^{-1} have been found to decrease the respiratory rates of *Tilapia mossambica* in 3 different age groups exposed for 3 weeks and later fish were transferred to fresh water, the rate of decrease did not completely not related to its pre-exposure value (Rath and Misra, 1979a,b).

In studies of Verma *et al.* (1984) *Heteroneustes* (Saccobranchus) *fossilis* exposed to dichlorovos for 30 days at a concentration of 0.44 mg l^{-1} respiration, haematological parameters and activities of two enzymes were determined and the respiration rate also decreased.

A conclusion may be drawn from the above study that formulations are more toxic and cause of the death of the fish is due to reduction in oxygen consumption.

Acknowledgment

The author R. Swarna Kumari acknowledge the UGC, Rajiv Ganghi fellowship in which the present work is reported.

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