Article

Impact of organophosphate pesticides on oxygen consumption in the freshwater bivalve *Lamellidens consobrinus*

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Abstract

Organophosphate pesticides like profenofos and quinalphos are commonly used against agricultural crop pests. These pesticides are found harmful to the freshwater bivalve like *Lamellidens consobrinus*. Pesticides enter in the body mainly through gills and affect the respiratory physiology. The present study was carried out to assess the impact of profenofos and quinalphos on the rate of oxygen consumption in the freshwater bivalve, *Lamellidens consobrinus*. Healthy specimens were exposed to sub lethal concentration ($1/10^{th}$ LC_{50} value of 96 hrs.) of the pesticides, profenofos (0.59 ppm) and quinalphos (0.412 ppm) for 10, 20 and 30 days. The oxygen consumption was estimated by Winkler's method in relation to control group. The rate of oxygen consumption in freshwater bivalve *Lamellidens consobrinus* after chronic exposure to the pesticides showed significant decrease after every 10 days as compared to controlled bivalves. The rate of oxygen consumption on 10^{th} day of exposure was decreased by 13.00% in profenofos and 20.01% in quinalphos, on 20^{th} day of exposure it was decreased by 17.54% in profenofos and 27.84% in quinalphos, on 30^{th} day of exposure it was decreased by 23.96% in Profenofos and 34.37% in quinalphos. The rate of oxygen consumption was found to be decreased with increase in exposure period. It was also found that decrease in the rate of oxygen consumption was more in the bivalves exposed to quinalphos as compared to the bivalves exposed to profenofos.

Keywords oxygen consumption; organophosphates; profenofos; quinalphos; bivalve; *Lamellidens consobrinus.*

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1 Introduction

Indiscriminate use of pesticides to control the agricultural pests has increased over the years, especially in agro-based developing countries (Santhakumar et al., 2000; Zhang, 2018). It is estimated that only about 0.1% of the total pesticide applied reaches the specific target (Rand et al., 1998; Aguiar, 2002). The rest amount of pesticides which are used for crop protection in agriculture and horticulture may enter in ditches, ponds, lakes and rivers in various ways such as direct overspray, spray drift, leaching to surface and ground water, run off

from land, and accidental spills (Capri et al., 1998). Organophosphate pesticides have become the most widely used class of insecticides which are highly toxic to aquatic organisms (Chebbi, 2010; Zhang, 2018; Zhang et al., 2011). From the organophosphate pesticides profenofos and quinalphos are widely used in the agricultural field. Quinalphos is a synthetic organophosphate pesticide, acting as a cholinesterase inhibitor with contact, stomach and respiratory action (Chebbi, 2010). Quinalphos decreases oxygen consumption in freshwater fish *Cyprinus carpio* (Muttappa et al., 2014). Sublethal concentration of profenofos showed significant decrease in oxygen consumption in the Indian major carp *Catla catla* (Maharajan, 2013). Respiration is one of the most important characteristics of life because it provides energy in the form of ATPs to perform various activities like metabolic reactions, growth and development, reproduction, muscular contraction, movements and locomotion. A constant supply of oxygen is essential to oxidize food materials to release energy. The activity of animal can be measured in terms of oxygen consumption. Aquatic animals have to pass large quantities of water through their gills so have high risk of exposure to the toxic substance (Shelke et al., 2005). The pesticide like cypermethrin was found highly toxic to iridescent shark, *Pangasius hypophthalmus* affecting oxygen uptake and ammonia excretion (Dhamagaye et al., 2015). Fipronil affects oxygen consumption rate of Mahseer fry (Dhamagaye et al., 2020). Monocrotophos reduces oxygen consumption in freshwater fish *Channa striata* (Rajasekar et al., 2021). Effect of dimethoate pesticide on oxygen consumption and gill histology of the fish, *Channa puntatus* was also recorded (Jothinarendiran, 2012). Freshwater bivalve molluscs from families like Unionidae and Corbiculidae, are important components of aquatic ecosystems (Thorp et al., 2011). *Lamellidens consobrinus* is one of the important freshwater bivalves belonging to the family Unionidae with high economic value like other species of *Lamellidens* (Sarma et al., 2022; Shiny et al., 2024; Babar et al., 2017). Earlier the toxicity of profenofos and quinolphos in terms of histopathological effects on gills and hepatopancreas was studied in *L. consobrinus* (Khapre et al., 2025; Khapre et al., 2026). In this work for acute toxicity testing the bivalves were divided into two groups i.e. control and experimental group. The experimental group was exposed to 15 to 20 different concentrations of profenofos pesticide. LC_{50} values obtained for 24, 48, 72 and 96 hours were 50.36, 24.51, 9.71, 5.90 ppm respectively for profenofos. Similarly, in case of quinalphos LC_{50} values obtained for 24, 48, 72 and 96 hours were found 23. 21, 10.56, 6.66 and 4.12 ppm. In the present work in accordance with these results the sublethal concentrations of both the pesticides were used as one tenth of the LC_{50} at the 96 hours i.e. 0.59 ppm for profenofos and 0.412 ppm for quinalphos.

2 Study Area and Methodology

2.1 Study site

Freshwater bivalve *Lamellidens consobrinus* were collected from the site nearby village Chehedi. It is located on the bank of Darana river, passing through Nashik district (MS), India (Lat 19.931192º Long 73.854105º).

2.2 Methodology

The specimens were brought to the laboratory and they were cleaned with water to remove mud and other biomass like algae and fungi from their shells. The bivalves were allowed to acclimatize for the period of 4 to 5 days under laboratory conditions. Healthy and mostly equal sized specimens were selected for experiments. They were divided into three groups i.e. control group, experimental group I and experimental group II. Control group was reared without treatment of profenofos and quinalphos while experimental group I was exposed to sub lethal concentration of pesticide Profenofos (0.59 ppm) while experimental group II was exposed to sublethal concentration of quinalphos (0.412 ppm) for 10, 20 and 30 days. After exposure period, 10 specimens from each group were maintained in one liter air tight containers separately for one hour. The dissolved oxygen content of this water before and after one hour was estimated by Winkler's method of all the

three groups. The process was repeated for all the test intervals i.e. 10, 20 and 30 days exposure. The oxygen consumed by each specimen was calculated and expressed as mg/lit/hr/gm weight of the bivalve. Statistical analysis using Anova test of all values of results was carried out for confirmation of results obtained. Percentage differences in experimental groups as compared to control group were also calculated.

3 Results and Discussion

The measurement of rate of oxygen consumption in freshwater bivalve *Lamellidens consobrinus* after chronic exposure to sublethal concentrations of profenofos (0.59 ppm) and quinalphos (0.412 ppm) showed significant decrease in the rate of oxygen consumption after every 10 days as compared to control (Table 1, Fig. 1). The rate of oxygen consumption on 10th day in control group was 0.04292±0.00429 mg/lit/hr/gm body weight of bivalve, while in experimental group I i.e. exposed to profenofos it was 0.03734±0.002483 mg/lit/hr/gm. These results revealed 13% reduction. In experimental group II i.e. exposed to quinalphos, it was found 0.03433±0.004295 mg/lit/hr/gm i.e. it is further decreased to 20.01%. On 20th day the rate of oxygen consumption in control group was 0.04163±0.002477 mg/lit/hr/gm. In experimental group I it was found 0.03433±0.002477 mg/lit/hr/gm i.e. decreased up to 17.54%. In experimental group II it was estimated 0.03004±0.00429 mg/lit/hr/gm. It reveals further decreased up to 27.84%. On 30th day the rate of oxygen consumption in control group was 0.0412±0.002483 mg/lit/hr/gm. In experimental group I it was further decreased to 23.96% where the oxygen consumption was found 0.03133±0.002484 mg/lit/hr/gm. In experimental group II it was significantly decreased to 34.37% where the oxygen consumption was found 0.02704±0.002485 mg/lit/hr/gm.

Table 1 Rate of oxygen consumption in mg/lit/hr/ gm body weight of freshwater bivalve, *Lamellidens consobrinus* after chronic exposure to the pesticides, profenofos (50% EC) and quinalphos (25% EC).

Treatment	10 Days	20 Days	30 Days
Control	0.04292*±0.00429	0.04163*±0.002477	0.0412**±0.002483
Profenofos (0.59 ppm)	0.03734*±0.002483	0.03433*±0.002477	0.03133**±0.002484
Percentage change over control	13.00%	17.54%	23.96%
Quinalphos (0.412 ppm)	0.03433*±0.004295	0.03004*±0.00429	0.02704**±0.002485
Percentage change over control	20.01%	27.84%	34.37%

Values are significant at *P<0.01, **P<0.001.

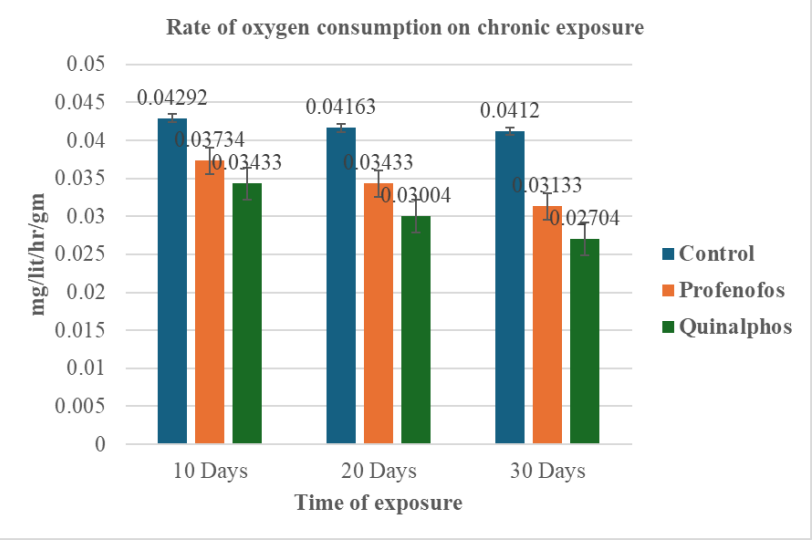

Fig. 2 Rate of oxygen consumption in freshwater bivalve, *Lamellidens consobrinus* on chronic exposure to the pesticides,

profenofos and quinalphos.

The present study revealed toxic effect of profenofos and quinalphos on respiratory physiology of freshwater bivalve, *Lamellidens consobrinus*. Most of the pesticides cause reduction in the oxygen consumption in the bivalve species. Similar kind of results were found in case of the freshwater bivalve *Lamellidens corrianus* during acute exposure to the organochlorine pesticide thiodon (endosulfan, 35% EC) in monsoon, winter and summer seasons (Kamble, 2012). Reduction in oxygen consumption in *Lamellidens corrianus* was also noted after both acute and chronic exposure to the heavy metal, mercury chloride (Mestry, 2017). The rate of oxygen consumption was also found to be decreased with increase in exposure period of organophosphate pesticide, triazophos (40% EC) to the freshwater bivalve, *Lamellidens marginalis* during acute as well as chronic exposure conditions (Rane, 2013). Fluctuations in the rate of oxygen consumption were also noted in the snails, *Lymnaea accuminata* during exposure to the insecticide phytofos (Lonkar, 2012). Variations in oxygen consumption was also observed in estuarine clam, *Katelysia opima* exposed to both lethal and sub-lethal concentrations of cypermethrin (Mukadam, 2014). There are some reports stating the similar effect of pesticides occurs in fresh and marine water fishes. Decrease in the rate of oxygen consumption with increased exposure to pesticides were noted in the fishes such as *Channa striata* exposed to monocrotophos (Rajasekar, 2021), cypermethrin was found highly toxic to iridescent shark, *Pangasius hypophthalmus* (Dhamagaye et al., 2015), *Catla catla* exposed to profenofos (Maharajan, 2013). The results of the present research work are similar to that of earlier work (Kamble, 2012; Mestry, 2017 and Rane, 2013) conducted in case of other species of Mollusca. However, the species and sublethal concentrations used in present work are different than that of the previous reports.

4 Conclusions

The organophosphate pesticides, profenofos and quinalphos were found toxic to the freshwater bivalve, *Lamellidens consobrinus*. In the present research, freshwater bivalve, *Lamellidens consobrinus* showed remarkable decrease in the rate of oxygen consumption during chronic exposure to profenofos and quinalphos as compared to control. Excess secretion of mucus was also observed during exposure period which might be due to decreased level of oxygen. The rate of oxygen consumption was found to be decreased with increase in exposure period. It was also found that decrease in the rate of oxygen consumption was more in the bivalves exposed to quinalphos as compared to that exposed to profenofos. Therefore, quinalphos pesticide was found more toxic than profenofos. The decrease in oxygen consumption might be the result of metabolic stress created due to the pesticides. Chronic exposure is responsible for severe impact on economically important animals like bivalves. The present study suggests that the organophosphate pesticides such as profenofos and quinalphos may also affect the other aquatic animals like fishes. Therefore, it is essential to reduce use of chemical pesticides and increase the use of biological control methods.

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