The Bioscan 8(2): 469-472, 2013
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF THIAMETHOXAM ON OXYGEN CONSUMPTION OF THE FRESHWATER BIVALVE, *LAMELLIDENS MARGINALIS* (LAMARCK)

RANE MINAKSHI* AND A. Y. MAHAJAN
Department of Zoology, D. N. College, Faizpur, Jalgaon - 425 503 (M.S.), INDIA
e-mail: minakshirane1@gmail.com

KEYWORDS
Thiamethoxam
Oxygen consumption
Acute
Chronic
Lamellidens marginalis.

Received on :
09.11.2012

Accepted on :
19.02.2013

***Corresponding author**

ABSTRACT
The impact of acute and chronic dose of Thiamethoxam on the rate of oxygen consumption of the freshwater bivalve, *Lamellidens marginalis* was studied. After 24, 48, 72 and 96h of exposure to acute concentration, the average oxygen consumption was 0.4935, 0.4826, 0.4763 and 0.4501 (mL/gm/L/h) and after 7, 14 and 21 days of chronic exposure, it was 0.2943, 0.2925, 0.2724 (mL/gm/L/h). It was observed that the rate of oxygen consumption was decreased with increase in the exposure period. The decrease was maximum in chronic exposure as compared to acute exposure to Thiamethoxam.

INTRODUCTION

The pollution of rivers and streams with chemical contaminants has become one of the most critical environmental problems of the century. Environmental pollution is one of the undesirable side effect of industrialization and an important aspect of environmental degradation (Jothinarendiran, 2012). Pesticides are spreading over agricultural crops, throughout the year with different concentrations, different formulations and with different modes affect aquatic inhabitants. The assessment of these effects of insecticides to non-target aquatic organisms is very difficult. As a result of the release of pollutants from industrial areas, and agricultural runoff into the environment pollute water bodies (Tyagi, 2000) and their chemical persistence, many fresh water ecosystems are facing the spatial or temporal alarming high levels of xenobiotic chemicals (Brack *et al.,* 2002; Diez *et al.,* 2002). Some of these chemicals are non-biodegradable and remain dangerous for a long time. The direct discharge of industrial effluents and runoff comprising versatile chemicals exert their toxic effect on the aquatic organisms (Mathivanan, 2004) by depleting the dissolved oxygen, altering the pH, changing the CO_2 content which affects the life cycle of the animals (Dehadri, 1990).

Pesticides are indicated to cause respiratory distress or even failure by affecting respiratory centers of the brain or the tissue involved in breathing. The effect of toxicants on the respiration of fishes and invertebrates have received wide spread attention and were reviewed by Hughes (1976) and Wright (1978). Aquatic organisms like prawns, fish, bivalve, crab respire through gill. Such respiratory surfaces frequently encounter harmful pollutant present in water in different forms. These pollutants may lead to the alteration in the normal respiratory area which causes reduction in oxygen consumption and physiological imbalance in the organism (Mukke and Chinte, 2012).

Holden (1973) observed that one of the earliest symptoms of acute pesticide poisoning is respiratory distress. This serves as a tool in evaluating the susceptibility or resistance potentiality of the animal. Respiration is a vital process though the organisms obtain oxygen from external environment and utilizes it for the energy generation during oxidative metabolism (Prosser and Brown, 1973). The activity of animal can be measured in terms of oxygen uptake. Aquatic animals have to pass large quantities of water over their respiratory surface and are subjected to relatively greater risk of exposure to the toxic substances (Shelke and Wani, 2005). Depletion in oxygen content occurs in the medium when pesticides, chemicals, sewage and other effluents containing organic matter are discharged into water bodies. Pesticides in sub lethal concentrations present in the aquatic environment are too low to cause rapid death directly but may affect the functioning of the organisms, disrupt normal behavior and reduce the fitness of natural population. In the aquatic environment one of the most important manifestation of the toxic action of chemical is the over stimulation or depression of respiratory activity.

The review of literature shows that, there is no adequate

information about the effect of pesticide on respiratory metabolism of freshwater bivalve, *Lamellidens marginalis*. Hence the present study was carried out to study the alteration in the rate of oxygen consumption in freshwater bivalve, *Lamellidens marginalis* after exposure to acute and chronic doses of Thiamethoxam.

MATERIALS AND METHODS

The fresh water bivalves, *Lamellidens marginalis* were collected from Hatnur dam near Hatnur. The animals were immediately brought to laboratory and acclimatized for 4-5 days at laboratory conditions. Medium sized healthy and active bivalves were used for experiments. They were divided into three groups, first group was considered as control, animals of second group were exposed to acute concentration (12.895ppm, $LC_{50/2}$ values of 96h of thiamethoxam up to 96h and of third group to chronic concentration (2.579ppm, $LC_{50/10}$ values of 96h) of thiamethoxam up to 21 days. The rate of oxygen consumption of control animals and animals exposed to acute concentrations was estimated after every 24h up to 96h and that of animal exposed to chronic dose was estimated after every 7 days with control up to 21 days. Oxygen consumption was estimated by standard Winkler's method (Welsh and Smith, 1960). The animals were dissected and the fresh weight of soft body was measured. Oxygen consumption was expressed as mL of oxygen consumed per gram of soft body wet weight per h per liter (mL of oxygen consumed/gm. of soft body wet weight/h./L at NTP). The 't' test was carried out and percent change in oxygen consumption in exposed animals was noted.

RESULTS

The measurement of rate of oxygen consumption in *Lamellidens marginalis* after acute and chronic exposure to Thiamethoxam showed significant decrease in the rate of oxygen consumption as observed in Table 1 and 2. The rate of oxygen uptake of *L. marginalis* after acute exposure was significantly decreased after every 24h up to 96h as compared to those of control group of bivalves. Table 1 indicates that *L. marginalis* showed gradual decrease in the rate of oxygen consumption on acute treatment to thiamethoxam.

The treatment of $LC_{50/10}$ concentrations of thiamethoxam showed a profound decrease in the rate of oxygen consumption after every 7 days in experimental bivalves as compared to the control group. The decrease depicted after 21 days was more than that of the bivalves exposed to acute dose.

DISCUSSION

The present study revealed that there is significant decrease in the rate of oxygen consumption in the bivalves exposed to both acute and chronic doses of thiamethoxam as compared to control. The effect of pesticide on the respiratory metabolism of different organisms varies with the dose of pesticide and duration of exposure of pesticide. Mukke and Chinte (2012) observed decrease in oxygen level with increase in concentration. The pesticide causes a physiological stress to fresh water organisms (Pardeshi, 1992). Pesticides alter the metabolic rate and affects oxygen consumption in different animals due to deposition or accumulation of pesticides in the body of animals (Jadhav, 1993).

The decrease in oxygen consumption after pesticidal stress was observed in *Corbicula regularis* (Lomte and Jadhav, 1982). The decline in oxygen consumption was greater in higher concentration which might be the result of reduced state of metabolism owing to toxicant stress (Lomte and Massarat, 1996; Marigoudar *et al.,* 2009). Number of workers have reported that pesticidal stress affect the respiratory physiology and decrease the rate of oxygen consumption in molluscs, *Thiara lineata* (Chaudhari *et al.,* 1992), *Corbicula striatella* (Jadhav, 1993), *Parreysia cylindrica* (Lomte and Waykar, 1998) and stated that oxygen uptake was dependent on the concentration of the pollutant and time of exposure. The decrease might be due to the penetration of the pollutant molecules and their action on the alteration of metabolic cycles at the sub cellular levels (Mahajan and Zambare, 2003). It was suggested that decrease in oxygen consumption is brought about by the severing of links between oxidative and phosphorylative processes. The continuous decrease in oxygen consumption after short time exposure to pesticide could also be due to inhibited oxidative phosphorylation. Tilak and Swarnakumari (2009) observed reduction in oxygen consumption when the fish was exposed to toxicant and

Table 1: Rate of oxygen consumption of *L. marginalis* on acute exposure to thiamethoxam

Sr.No.	Treatment	Average Oxygen consumption (mL/gm./L/h.)			
		24 h	48 h	72 h	96 h
1	Control	0.4966 ± 0.03	0.4912 ± 0.032	0.4905 ± 0.031	0.4901 ± 0.034
2	Thiamethoxam (12.895 ppm)	0.4935 ± 0.021^{NS}(-0.62)	0.4826 ± 0.028^{NS}(-1.75)	0.4763 ± 0.030*(-2.90)	0.4501 ± 0.033**(-8.16)

Each value represents a mean of three observations ± standard deviation; Values in ( ) indicates percent variation over the respective control; Values are significant at* = $p < 0.05$; ** = $p < 0.01$ and NS = Non-significant

Table 2: Rate of oxygen consumption of *L. marginalis* on chronic exposure to thiamethoxam

Sr.No.	Treatment	Average Oxygen consumption (mL/gm./L/h.)		
		7 days	14 days	21 days
1	Control	0.3161 ± 0.03	0.3137 ± 0.038	0.3081 ± 0.045
2	Thiamethoxam (2.579 ppm)	0.2943 ± 0.041^{NS}(-6.90)	0.2925 ± 0.040*(-6.76)	0.2724 ± 0.049*(-11.59)

Each value represents a mean of three observations ± standard deviation; Values in ( ) indicates percent variation over the respective control; Values are significant at * = $p < 0.05$; ** = $p < 0.01$ and NS = Non-significant.

concluded that death of animal was due to reduction in oxygen consumption.

Gills in aquatic animals have a key role in the exchange of gases for the metabolic activities. Stressful conditions, lead towards the change not only in metabolic activities but also in the behavior (Nandurkar and Zambare, 2010). Gills are major respiratory organs and all metabolic pathways depend upon the efficiency of the gills for their energy supply and damage to these vital organs causes a chain of destructive events, which ultimately lead to respiratory distress (Magare and patil, 2000) and impairment in oxidative metabolism (Patil and David, 2008). Mahajan and Zambare (2007) studied the effect of Nickel chloride on oxygen consumption of the freshwater bivalve *Corbicula striatella* and stated that the decrease in the rate of oxygen consumption may be due to disruption of the normal histological built up of gills. Decrease in oxygen consumption in bivalves exposed to insecticides (Muley and Mane, 1987; Kamble and Shinde, 2012) and Metal (Andhale and Zambare, 2012) is also on record. Shelke and Wani (2005) observed decrease in the rate of oxygen consumption of freshwater fish, *Amblypharyngodon mola* due to heavy metal and concluded that the decrease in the respiratory metabolism was due to the gill damage, formation of mucous film over the gill and reduction in efficiency of oxygen uptake of the animal. In present investigation, the rate of oxygen consumption changes after treatment of pesticide. The decrease in oxygen consumption in the bivalve after exposure to thiamethoxam might be due to reduced gill respiration. Mane *et al*. (2012) recorded decrease in the rate of oxygen consumption in freshwater bivalve, *Lamellidens corrianus* after exposure to thiodan. Kumar *et al*. (2012) observed decrease in oxygen consumption of freshwater mussel, *Lamellidens marginalis* after exposure to dimethoate.

The effect of thiamethoxam showed copious secretion of mucous. The high mucous secretion deposited on the respiratory surface may interfere the rate of oxygen diffusion and therefore oxygen consumption can be decreased. The bivalves usually tries to avoid toxicants and in doing so, they can minimize their metabolic activity. The metabolic stress of the drug may decrease the rate of oxygen consumption. Alam and Lomte (1984) suggested that respiratory inefficiency and ultimately total respiration breakdown can also be due to the formation of mucous on the respiratory organs in case of pollutant exposure to *Bellamya bengalensis*. Khan *et al*. (2000) studied the effect of heavy metal on histological structure of gills of crustaceans and stated that the decline in the rate of oxygen consumption may be the result of formation of coagulated mucous over the gills and body surface of the crab. Sontakke (1992) suggested that the pollutant treated molluscs secrete mucous in large amount to reduce exposure to environmental stress or pollutant. In present investigation the decrease in the rate of oxygen consumption in the bivalve treated with thiamethoxam may be due to mucous secretion on body surface, pesticide induced respiratory stress and impaired oxidative metabolism.

REFERENCES

Alam, S. M. and Lomte, V. S. 1984. Effect of $ZnSO_4$ on the oxygen consumption of the freshwater gastropod, *Bellamya* (*Viviparous*) *bengalensis*. *Mar. Univ. J. Scien.* **23(16):** 35-38.

Brack, W., Schirmer, K., Kind, T., Schrader, S. and Schuurmann, G. 2002. Effect directed fractionation and identification of cytochrome P450A-inducing halogenated aromatic hydrocarbons in contaminated sediment. *Environ. Toxicol. Chem.* **21:** 2654-2662.

Chaudhari, T. R., Patil, P. N., Rao, K. R., Subhash, M. and Shejule, K. B. 1992. Toxicity of fencal and sevin to the fresh water gastropod, *Thiara lineata* and its impact on respiration. *Indian J. Envt. and Toxicol.* **2(1):** 45-48.

Diez, S., Abalos, M. and Bayona, J. M. 2002. Organotin contamination in sediments from the western Mediterranean enclosures following ten years of TBT regulation *Water Res*. **36:** 905- 918.

Holden, A. V. 1973. Chapter 6 in Environmental pollution by pesticides. *(Ed.) C. A. Edwards, Plenum Press,* p. 542.

Hughes, G. M. 1976. Effect of pollutants on aquatic organisms. Cambridge university press, Polluted fish respiratory physiology in Lockwood. APM (ed.), Cambridge, pp. 163-183.

Jadhav, S. M. 1993. Impact of pollutants on some physiological aspects of the freshwater bivalve, *Corbicula striatella*. *Ph. D. Thesis, Marathwada University,* Aurangabad (M.S.).

Khan, A., Patel, R. T. and Sheikh, F. I. 2000. Effect of mercuric chloride on the gills of the freshwater crab, *Barytelphusa guerini,* International conference on probing in biological system. Mumbai: p. 134.

Lomte, V. S. and Jadhav, M. L. 1982. Effect of toxic compounds on oxygen consumption in the freshwater bivalve *Corbicula regularis*. *Comp. Physiol. Ecol*. **7(1):** 31-33.

Lomte, V. S. and Massarat, S.1996. Effect of heavy metals ($CuSO_4$, $HgCl_2$and $ZnSO_4$) on oxygen uptake of freshwater bivalve *Lamellidens marginalis*. *Dr. B. A. M. Univ. J.* **27:** 51-55.

Lomte, V. S. and Waykar, B. B. 1998. Effect of Carbaryl and Cypermethrin on the oxygen consumption of the freshwater bivalve, *Parreysia cylindrica*. *Him. J. Env. Zool*. **12(2):** 157-162.

Mahajan, P. R. and Zambare, S. P. 2003. Effect of Caffeine (1, 3, 7-Trimethylxanthene) on mercury, arsenic and lead induced alterations in the oxygen consumption of fresh water gastropod snails, *Bellamya bengalensis* (Lamarck). *Trends in Life Sci.* **18(1):** 11-18.

Nandurkar, H. P. and Zambare, S. P. 2010. Effect of broad spectrum antibiotics on oxygen consumption rate of freshwater bivalve, *Parreysia cylindrica* (Annandale and Prashad). *J. Env. Bio. Sci*. **24(2):** 183-187.

Pardeshi, B. K. 1992. Impact of pesticides on some physiological aspects of *Lymnaea acuminata*. Ph. D Thesis Marathwada University, Aurangabad (M.S.) India.

Prosser, C. L. and Brown, F. A. 1973. Comparative Animal Physiology, 3rd Edition, W. B. Saunder Company, Philadelphia.

Shelke, A. D. and Wani, G. P. 2005. Respiratory response of a freshwater teleost fish, *Amblypharyngodon mola*. *J. Aqua. Biol*. **20(2):** 193-196.

Sontakke, Y. B. 1992. Some Physiological variations associated with pollutant treatment in the snail, *Thiara tuberculata*. Ph. D. Thesis, Marathwada University, Aurangabad. (M.S.) India.

Tilak, K. S. and Swarnakumari, R. 2009. Acute toxicity of Nuvan, an Organophosphate to freshwater fish *Ctenopharyngodon idella* and its effect on oxygen consumption. *J. Env. Biol.* **30(6):** 1031-1033.

Welsh, J. and Smith, R. I. 1960. Laboratory Exercise in invertebrate physiology. Burges, Minneapolles. pp. 1-150.

Wright, D. A. 1978. Heavy metal accumulation by aquatic invertebrates. *Applied Biology.* **3:** 331-394.

Mukke, V. K. and Chinte, D. N. 2012. Effect of sub lethal concentration of mercury and copper on oxygen consumption of freshwater crab, Barytelphusa guerini. *Rec. Res.Sci.Technol.* **4(5):** 15-17.

Mathivanan, R. 2004. Effect of sublethal concentration of quinolphos n selected respiratory and biochemical parameters in the freshwater fish, *Oreochromis mossambicus*. *J. Ecotoxicol. Environ. Monit*. **14(1):** 57-64.

Tyagi, P., Dharam, B., Choudhary, R. and Sawhney, B. L. 2000. Physico chemical quqlity of Ground water in industrial areas of India. *A review. Poll. Res.* **19(3):** 443-445.

Jothinarendiran, N. 2012. Effect of dimethoate pesticide on oxygen consumption and gill histology of the fish, *Channa punctatus*. *Current Biotica* **5(4):** 500-507.

Dehadri, P. V. 1990. Pollution and Aquaculture. *Env. Poll. and Res. of Land and Water*. pp. 1-14.

Marigoudar, S. R., Ahmed, R. N. and David, M. 2009. Cypermethrin induced respiratory and behavioural responses of the freshwater teleost, *Labeo rohita* (Hamilton). *Vet. arhiv*. **79(6):** 583-590.

Magare, S. R. and Patil, H. T. 2000. Effect of pesticides on oxygen consumption, red blood cell count and metabolites of a fish, *Punctius ticto*. *Environ. Ecology*. **18:** 891-894.

Muley, D. V. and Mane, U. H. 1987. Malathion induced changes in oxygen consumption in two species of freshwater lamellibranch molluscs from Godavari river,Maharashtra state. India. *J. Environ. Biol.* **8:** 267-275.

Mahajan, A. Y. and Zambare, S. P. 2007. Effect of Nickel chloride on oxygen consumption of the freshwater bivalve *Corbicula striatella*. *Research Link*. **34(9):** 7-8.

Kamble, V. S. and Shinde, R. A. 2012. Impact of Organochlorine pesticide on oxygen consumption in the freshwater bivalve mollusc, *Lamellidens corrianus*. *Res. J. Pharm. Biol. Chem. Sci.* **3(2):** 607-613.

Mane, B. U., Kamble, V. S. and Rao, K. R. 2012. Effect of acute toxicity of organochlorine pesticide on respiration in lamellibranch mollusc, *Lamellidens corrianus* during winter season. *Am-Euras. J. Toxicol. Sci.* **4(3):** 151-153.

Kumar, S., Pandey, R. K., Das, S. and Das, V. K. 2012. Dimethoate alters respiratory rate and gill histopsthology in freshwater mussel, *Lamellidens marginalis* (Lamarck). *J. Appl. Biosci.* **38(2):** 154-158.

Andhale, A. V. and Zambare, S. P. 2012. Effect of nickel induced respiratory alterations in freshwater bivalve*, Lamellidens marginalis*. *Int. Multidisc. Res. J.* **2(3):** 01-03.

Patil, V. K. and David, M. 2008. Behaviour and respiratory dysfunction as an index of malathion toxicity in the freshwater fish, *Labeo rohita* (Hamilton). *Turkish J. Fisheries and Aquatic Sciences*. **8:** 233-237.