Recent Research in Science and Technology 2010, 2(5): 08-11
ISSN: 2076-5061
www.recent-science.com

TOXICOLOGICAL SCIENCES

STUDY OF ACUTE TOXICITY OF ORGANOTIN TRIBUTYLTIN CHLORIDE ON THE FRESHWATER BIVALVE MOLLUSC, *LAMELLIDENS MARGINALIS* FROM GODAVARI RIVER AT MAHARASHTRA STATE, INDIA

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Abstract

TBT is released from the antifouling paint into water due to the low water solubility, the TBT-compounds are rapidly adsorbed to suspended matter and deposit in the water bodies. The active substance TBT is highly toxic and also damaging to a multitude of non target species. The bivalves have been used for many years to determine the pollution status of water. Static bioassays were performed on bivalve, *Lamellidens marginalis* to evaluate the median lethal concentrations of TBTCl (tributyltin chloride) for 24, 48, 72 and 96 hrs. The LC_{50} values were 4.65, 3.39, 2.65 and 1.72 after 24, 48, 72 and 96 hrs. respectively. The results show that the LC_{50} values decreased with increase in exposure period.

Keywords: *Lamellidens marginalis,* tributyltin chloride (TBTCl), LC50

Introduction

Study of toxic substances present in water and their adverse effects including mortality in aquatic organisms, increase with the growing awareness of the hazards of discriminate water pollution. The toxicological studies of pollutants are gaining more significance in recent time and worldwide attempts have been made to identify a "hazard" from toxic chemical present or released in aquatic environment. The toxicity study is essential to find out toxicants limit and safe concentration, so that there will be minimum harm to aquatic fauna in the near future.

Among the several aspects of toxicity studies the bioassay constitutes one of the most commonly used methods in aquatic environmental studies with suitable organisms. The necessity of determining the toxicity of substances to commercially aquatic forms at the lower level of the food chain has been useful and accepted for water quality management.

Several studies have been conducted in assessing the toxicity of metals to the aquatic biota. Effects have also been made to use certain bivalve species as bio-indicators of metal contamination of freshwater bodies. The present investigation has been planned and executed to assess the impact of organotin compound, tributyltin chloride on toxicity and physiology of the freshwater bivalve, *L. marginalis*.

Organotin has a larger number of its organometallic derivatives in commercial use than any other element. This gave rise to an increase of worldwide production of organotin compounds during the last 50 years. Due to the wide industrial applications considerable amount of the organotins entered in aquatic ecosystems. Depending on the nature and the number of the organic groups bound to the tin cation, some organotins show specific toxic effects to different organisms even at very low concentrations. Elemental Sn and its inorganic compounds are nearly non-toxic for all living organisms (Kuballa *et al.,* 1996). The release of organotins into terrestrial and aquatic environments has decreased recently, but inputs still occur and previously contaminated sites continue to act as sources (Ritsema, 1994, Stäb *et al*., 1995).

Several reviews on the tributyltin compound, which cover the production, use, chemistry, toxicity, fate and hazards of TBT in the aquatic environment (WHO 1990; Clark *et al.,* 1988; Gibbs and Bryan 1996b; Hall and Bushong 1996; Laughlin *et al.,* 1996; Maguire 1996; Waldock *et al.,* 1996). Effects on blue mussels exposed to tributyltin chloride were studied by Valkirs *et al.,* (1987)

These compounds are known to be harmful to many, "non-target" aquatic organisms, particularly molluscs (Horiguchi *et al.,* 1997). Because TBT tends to accumulate in sediments, which are considered a sink for TBT, they may have become a source, and will continue to have this function in the future.

Molluscs have been used extensively as bioindicators of heavy metal pollution in aquatic system. According to Elder & Collins, (1991), freshwater mussels and snails have the potential to be very useful for biomonitoring studies.

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Perusal of literature reveals paucity of information on acute toxicity of tributyltin chloride on fresh water bivalve, *L. marginalis*. Hence the present study has been focused to evaluate the acute toxic effects of tributyltin chloride to freshwater bivalves, *L. marginalis* as bioindicator, of local importance from Maharashtra state in Godavari river at Paithan.

Material and Methods

The freshwater bivalves, *Lamellidens marginalis* were collected from the Godavari river at Paithan, 45 km away from Aurangabad city. The bivalves were brought to the laboratory and cleaned to remove the fouling algal biomass and mud. The bivalves kept in plastic troughs containing dechlorinated tap water for 3 to 4 days to acclimatize to the laboratory conditions.

The bivalves were exposed to diffused day light during the daytime, where the daily photoperiod was about 10-12 hrs. Pilot experiments were conducted to find out the range of the toxicity of the toxicant used tributyltin chloride. The chosen range of concentration was such that it resulted in 0 to 100% mortality.

1-ppm stock solution was prepared in acetone, Laughlin *et al*., (1983). The Series of statistic bioassay were conducted under laboratory condition as described by Finney (1971).

Acute toxicity tests were conducted over 96 hrs. The experimental troughs containing 5 litres dechlorinated water were used to keep the animals. For each experiment ten bivalves, *L. marginalis* of approximately similar size (50-55mm in shell length) were exposed to different concentrations of tributyltin chloride. After every 12 hours the polluted water was changed by the fresh solution of the same concentration. The behaviour and mortality of the bivalves were recorded before each change of water. The resulting mortality was noted in the range of 10 to 90% for each concentration for the duration of 24, 48, 72 and 96 hrs. Each experiment was repeated thrice to obtain constant results.

The data collected was analyzed statically by means of probit method on transforming toxicity curve (% mortality vs. concentration), which allows the average median lethal concentration of LC_{50} to be calculated for 24, 48, 72 and 96 hrs. Dead bivalves were counted individually.

Results

The LC_{50} values were calculated for 24, 48, 72 and 96 hours by Finney's method (1971).

The LC_{50} values decreased with increase in exposure period. Therefore the LC_{50} values and exposure period showed a direct relationship. The LC_{50} values, regression results, Chi square, variance and 95% fiducial limits, lethal concentration and safe concentration are shown in Table- 1.

The LC_{50} values obtained for tributyltin chloride exposed for 24, 48, 72 and 96 hours exposure were 4.6557 ppm, 3.3954 ppm, 2.6535 ppm and 1.7211ppm respectively. The result shows that LC_{50} values decreases with increasing periods of exposure of tributyltin chloride.

Table 1. Relative toxicity of TBTCl to the freshwater bivalve, *Lamellidens marginalis*

Time of exposure (Hrs.)	Regression equation $Y=\bar{y}+(X-\bar{x})$	LC50 Values in ppm.	Variance V	Chi-square	Fiducial limits		Lethal dose	Safe conc.(ppm)
					m1	m2		
24	Y =18.346X-7.2543	4.6557	0.0000984304	0.09663091	0.6425	0.6814	111.7368	
48	Y=9.9262X-0.2689	3.3954	0.000353332	0.0012706	0.4666	0.5402	162.9792	
72	Y=10.3037X+0.6340	2.6535	0.00031242	0.09498295	0.3777	0.4470	191.052	0.3611

From the above results it appears that the freshwater bivalve, Lamellidens marginalis is highly sensitive to organotin Tributyltin chloride.

Discussion

Mortality of *L. marginalis* is a more sensitive measure of toxicant. The percent survival rate of the bivalves decreased with increasing concentration and period of exposure. The evaluation of LC_{50} concentration of pollutants is an important step before carrying out further studies on physiological changes in animals.

In the present study the *L. marginalis* exposed to tributyltin chloride, the acute toxicity level was expressed in terms of LC_{50} values. The LC_{50} values were found to be 4.6 ppm, 3.4 ppm, 2.6 ppm, and 1.8 ppm at 24, 48, 72, and 96 hours respectively.

The lethal concentration of TBT to *Daphnia magna* over 24 and 72 hr. were 0.12 mg / lit and 0.06 mg / lit, respectively. The LC_{100} was 0.15 mg / lit for 72 hr.

Effects on common oyster larvae exposed to 0.02-100 g/L tributyltin acetate were studied by His and Robert (1985), as a result, in the group of larvae exposed to tributyltin acetate at 0.05 g/L (0.05 g/L in terms of tributyltin chloride) or over, growth was inhibited and deaths were observed within 10 days.

Beaumont and Budd (1984) exposed veliger larvae of the mussel (*Mytilus edulis*) to TBTO for 15 days. No larvae survived longer than 5 days in 10 µg/L TBTO, or longer than 10 days in 1 µg/L TBTO. About half the larvae exposed to 0.1 µg/L TBTO were dead on Day 15 (i.e., 15-d LC_{50} approximately 0.1 µg/L TBTO), and most surviving larvae were moribund and had grown significantly more slowly than controls.

Holwerda and Herring, (1986) it was found that the freshwater clam *Anodonta anatine* could not survive exposure to tributyltin oxide in a concentration equivalent to 5µg Sn/L for longer than 6 weeks. Dode, (1993) reported that LC_{50} values of all the five size groups of fresh water prawn, *Macrobrachium kistnensis* exposed to different concentrations of cuprous oxide for 24, 48, 72 and 96 hours, they show that relative toxicity increases with increasing exposure time since LC_{50} values decreased as the exposure period increased. Kungolos *et al*., (2001) studied the toxicity of four organotin compounds towards freshwater crustacean, *Daphnia magna.* Tributyltin chloride proved to be the most toxic among all four organotin compounds. Kungolos *et al*., (2004) studied toxicity tests were performed in order to determine the toxic properties of four organotin compounds to freshwater crustacean; *Daphnia magna* tributyltin chloride was found to be the most toxic substances on test organisms.

Shejule *et al*., (2006) reported LC_{50} values of the organotin tributyltin chloride exposed to freshwater prawn, *Macrobrachium kistnensis*; up to 96 hours. They showed the LC_{50} values decreased with increase in exposure period. Kharat, (2007) shows the same results of LC_{50} values of the organotin tributyltin chloride exposed to freshwater prawn, *Macrobrachium kistnensis.*

The effect of tributyltin chloride on freshwater organisms is quite insufficient compare to marine organisms, so in the present work it is attempted to study the effect of tributyltin chloride on survival of freshwater bivalve, *L. marginalis*.

References

Kuballa J., Jantzen E., Wilken R.D. (1996): Organotin compounds in sediment of the rivers Elbe and Mudle [in:] Sediments and Toxic Substances, *Calamano W., Förstner U., (Eds), Springer, Berlin,* 245-70

Ritsema R. (1994): Dissolved butyltins in marine waters of the Netherlands three years after the ban, *Appl. Organomet. Chem.,* 8: 5-10.

Stäb J.A., Frenay M., Freriks I.L., Brinkman U.A.T., Cofino W.P. (1995): Survey of nine organotin compounds in the Netherlands using the zebra mussel, *Dreissena polymorpha* as biomonitor, *Environ. Toxicol. Chem.,* 14: 2023-32.

WHO. (1990): International programme on chemical safety environmental health criteria for tributyltin. *World Health Organization* (ICS/EHC/89.29), *Geneva, Switzerland.* 229 pp.

Clark, E.A., R.M. Sterritt and J.N. Lester. (1988): The fate of tributyltin in the aquatic environment. *Environ. Sci. Technol.* 22:600-604.

Gibbs, P.E. and G.W. Bryan. (1996b): TBT-induced imposex in neogastropod snails: masculinization to mass extinction. In: *Trybutyltin: case study of an environmental contaminant.* S. J. de Mora (Ed.) *Cambridge University Press.* pp. 212-236.

Hall, Jr., L.W. and S.J. Bushong. (1996): A review of acute effects of tributyltin compounds on aquatic biota. In*: Organotin: Environmental Fate and Effects*. Champ, M.A. and P.F. Seligman (Eds.). Chapman and Hall, *London*. pp. 157-190.

Laughlin, Jr., R.B., J. Thain, B. Davidson, A.O. Valkirs and F.C. Newton, III. (1996): Experimental studies of chronic toxicity of tributyltin compounds. In: Organotin: *Environmental Fate and Effects.* Champ M.A. and P.F. Seligman (*Eds*.). Chapman and Hall, London. pp. 191-217.

Maguire, R.J. (1996): The occurrence, fate and toxicity of tributyltin and its degradation products in fresh water environments. In: *Tributyltin: Case study of an environmental contaminant*. S.J. de Mora (Ed.). *Cambridge University Press*, UK. pp. 94-138.

Waldock, M.J., J.E. Thain and M.E. Waite. (1996): An assessment of the value of shell thickening in *Crassostrea gigas* as an indicator of exposure to tributyltin. In: *Organotin: Environmental Fate and Effects.* Champ, M.A. and P.F. Seligman (Eds.). Chapman and Hall, *London*. pp. 219-237.

Valkirs,A.O.,Davidson,B.M. and Seligman,P.F.(1987): Sublethal growth effects and mortality to marine bivalves from long-term exposure to tributyltin. *Chemosphere*,16,201-220

Horiguchi, T., Shiraishi, H., Shimizu, M. and Morita, M. (1997): Effects of triphyenyltn chloride and five other organotin compounds on the development of imposex in the rock shell, Thai clavigera, *Environ. Pollut*. 95: 85-91.

Elder, J.F. & Collins, J.J. (1991): Freshwater molluscs as indicators of bioavailability and toxicity of metals in surface-water systems. *Rev. Environ. Contam. Toxicol.,* 122: 37-79.

Laughlin, R. B. JR., W. French., and H. E. Guard. (1983): Acute and sublethal toxicity of tributyltin oxide (TBTO) and its pu- tative environmental product, tributyltin sulfide (TBTS) to zoeal mud crabs, *Rhithropanopeus harrisii. Water, Air, and Soil Pollution* 20:69-79.

Finney, D. J. (1971): Statistical methods in biological assay. *3rd edition. -Cambridge University Press*, London, England. Pp. 1-333.

His, E. and Robert, R. (1985): Developpement des veligeres de Crassostrea gigas dansle Bassin d'Arcachon, etudessurles mortalities larvairres. *Rev. Trav. Inst. Peches Marit*., 47,63-88.

Beaumont,A.R. and Budd,M.D.(1984): High mortality of the larvae of the common mussel at low concentrations of tributyltin. *Mar. Pollut. Bull.,* 15, 402-405.

Holwerda, D.A. and H.J. Herwig. (1986): Accumulation and metabolic effects of Di-n-Butyltin Dichloride in freshwater clam, *Anadonta natina. Bull. Environ. Contam. Toxicol*. 36: 756-762.

Dode C. R. (1993): Effect of organotin constituents copper on the physiology of freshwater prawn, *Macrobrachium kistnensis*: Ph. D Thesis, Marathwada University, Aurangabad.

Kungolos, A. Hadjispyrou, S. Samaras, P. Petala, M. Tsiridis, V. Aravossis, K. and Sakellaropoulos, G. P. (2001): Assessment of toxicity and bioaccumulation of organotin compounds *Proceedings of the 7th International Conference on Environmental Science and Technology*, pp. 499 – 505, Sept. 2001

Kungolos, A., Hadjispyrou, M., Petala,V., Tsiridis, P., Samaras and Sakellaropoulos G.P. (2004): Toxic properties of metals and organotin compounds and their interactions on *Daphnia magna* and *Vibrio fischeri* water, *Air, and Soil pollution:* Focus 4: 101-110.

Shejule, K.B., Kharat P.S., Kale, R.S. (2006): Toxicity of organotin tributyltin chloride to freshwater prawn, *Macrobrachium kistensis, Jon. Aquacult*. Vol. 7. (1). 141-144.

Kharat P.S. (2007): Some physiological aspects of freshwater prawn, *Macrobrachium kistnensis* exposed to organotin tributyltin chloride. Thesis, Dr.B.A.M.U.Aurangabad.1-185.