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Investigation of acute toxicity of pyrethroid insecticide, lambda cyhalothrin to *etroplus suratensis* (bloch)

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ABSTRACT

In recent years, the use of pesticides in agriculture has been increasing steadily. The pesticides which are liberated into the aquatic environment have a deleterious effect on fish and subsequently to man. Pyrethroids insecticides, including lambda-cyhalothrin (trade name Karate) are widely used for the control of insect pests all over the world to increase the production of food grain and other agricultural products. It may also be used in public health applications to control insects such as cockroaches, mosquitoes, ticks and flies may act as a disease vector. However, with the steadily increasing use of lambda-cyhalothrin, there is an urgent need to identify their possible effects on living organisms. Majority of the studies concerning effects of pesticide have been confined to the acute toxicity tests with the death of fish as an end point. Acute toxicity tests aimed at estimating the effect of toxicants on organisms in a short period of time. The static bioassay procedure was used to study the toxicity of lambda-cyhalothrin on Etroplus suratensis. The experimental fish E.suratensis were exposed to different concentrations of lambda-cyhalothrin. Ten healthy fishes were introduced into each concentration and the mortality was observed after 24, 48, 72, 96 and 120 hrs of exposure. The 96 hrs LC_{50} value of lambda-cyhalothrin to E.suratensis was 0.107 ppm respectively. The results showed that, the mortality rate of E.suratensis increased with the increase in the concentration of lambda-cyhalothrin, but, this phenomenon was not observed in control. Based on the result, lambda-cyhalothrin is highly toxic to Etroplus suratensis, therefore its use near fish farms or in areas close to aquatic bodies should not be encouraged.

Introduction

Rapid industrialization, technological advancements and successful green revolution in both developed and developing countries have resulted in the introduction of a variety of toxic chemicals into the environment. Man-made toxic chemicals are released into the environment during production, transportation as well as utilization, and thus pose a threat to living biota. In the last 50 years, there has been a steady growth in the use of synthetic organic chemicals such as pesticides. Pesticides have been a major contributor to the growth of agricultural productivity and food supply (Sexton *et al*., 2007). According to the Food and Agriculture Organization (FAO), agricultural lands comprise 50% of all useable land worldwide (FAO, 2001). About 60% population in India is involved in agricultural sector which contributed to a very important part of Indian economy. In India, there are 165 pesticides registered for use and there is a sequential rise in the production and consumption of pesticides during last three decades. Although the use of pesticides has led to increased agricultural production but, their use has also been associated with several concern, including risk to human health and environment (Ejaz *et al*., 2004). The harmful effects of many pesticides, such as organochlorines, organophosphates and carbamates, have led to the use of pyrethroides as alternatives. For more than 30 years, pyrethroids are use for home formulations and agricultural purposes and these insecticides cover nearly one-fourth of the worldwide market (Ahmad *et al*., 2012 b).

Lambda-cyhalothrin (trade name Karate) is a pyrethroid insecticide. Lambda -cyhalothrin has the same spectrum of insecticidal activity as cyhalothrin, but is more active. Lambda -cyhalothrin was first approved for use in the UK in 1988 (Advisory Committee on Pesticides, 1988). Lambda-cyhalothrin is highly toxic to many fish and aquatic invertebrate species (Radhakrishnan Nair, 2002; Ram Yadav *et al*., 2003; Nelson and Cox, 2005; Lehninger principles of biochemistry, 2008; Shweta Agrahari and Krishna Gopal, 2009). Lambda-cyhalothrin is extremely toxic to many aquatic organisms, including fish such as the blue gill and lake trout, with LC_{50} values less than 1.0 µg/L (Mueller- Beilschmidt, 1990). Majority of the studies concerning effects of pesticide have been confined to the acute toxicity tests with the death of fish as an end point. The objective of an acute toxicity test is to determine the concentration of a test material or the level of an agent that produces a deleterious effect on a group of test animals during a short- term exposure under controlled conditions. 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. Several studies have been conducted in assessing the toxicity of pesticide to the aquatic biota especially in fishes (Verma *et al*., 1982; Ravikrishnan *et al*., 1997; Alam, 2000; Vasait and Patil, 2005 and Susan Anita *et al*., 2010).

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The present study was conducted to determine the acute toxicity of the largest market-selling and multipurpose pyrethroid insecticide, lambda-cyhalothrin to the pearlspot, *Etroplus suratensis* fish using the static bioassay test procedure.

Materials and methods

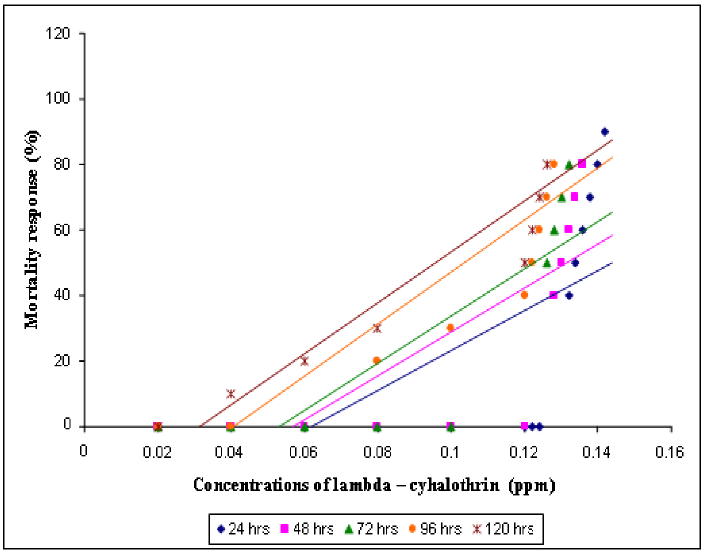
The experimental animal for the present study was the *Etroplus suratensis* fish. The *E.* suratensis (Bloch), commonly known as 'Pearlspot' is an important brackishwater fish belonging to the family Cichlidae. It inhabits both freshwater and brackishwater and is endemic to the Peninsular India and Sri Lanka. The physico-chemical characteristics of the water used for experiment were: temperature 28.4±2ºC, pH 7.17±0.12 and dissolved and oxygen 4.14±0.35 mg/l determined following the procedures described by (APHA, 1985). Moreover, water quality parameters were monitored during the experimental period with no substantial changes recorded throughout acclimation and experimental period. The water was continuously aerated to maintain the level of dissolved oxygen.

For toxicity determination, static bioassay test (APHA, 1985) using the technical grade synthetic pyrethroid insecticide, lambda-cyhalothrin (5% EC) marketed by Syngenta India Ltd, Tata Road, Mumbai was done. The acclimated healthy fishes of weight 6-7 g and size 4-5 cm from both sexes were selected randomly for the acute toxicity studies. The experimental fish, *Etroplus suratensis* was exposed to different concentrations of pyrethroid insecticide, lambda-cyhalothrin ranging from 0.02 to 0.144 ppm and control with no toxicant for the static bioassay test. The test fishes were not fed during the period of study. Ten healthy fishes were introduced into each concentration. The test solutions were removed every 24 hrs. For each bioassay test, triplicates were maintained for each concentration along with the control. The mortality of fishes in different concentrations was recorded from 6, 12, 24, 48, 72, 96 and 120 hrs of exposure. Fishes were considered dead when the opercular movement ceased and there was no response to gentle probing. Then 24, 48, 72, 96 and 120 hrs LC_{50} values of lambda-cyhalothrin were computed using software by transforming mortalities (percentage values) into probit scale (Finney, 1971). LC_{50} values were calculated for 24, 48, 72, 96 and 120 hrs of exposure to the insecticide lambda-cyhalothrin and idealized using lower and upper fiducial limits.

Results and discussion

Without proper water quality maintenance, one cannot get a good fish production. It affects the growth of fish and shrimp to a large extent (Hepher, 1988). Various physical factors and chemical reactions influence the water quality, to a great extent. The 24, 48, 72, 96 and 120 hrs LC_{50} values of lambda-cyhalothrin for *E.suratensis* were estimated at 0.134, 0.130, 0.128, 0.107 and 0.094 ppm and were represented in Table 1 and Figure 1. In *E. suratensis* exposed to different concentrations of lambda-cyhalothrin, the percentage of mortality increased significantly when the concentration and the time of exposure were increased. No mortality was observed in the control group during the experiment. Fish in the control experiment appeared active and healthy throughout the study period. The results of the present toxicity studies clearly indicate that, lambda-cyhalothrin is highly toxic to *E.suratensis*. In the same way, the present study was also agreement with the results of other workers with different fishes. The reported 96 hrs LC_{50} values of karate to *Cyprinus carpio* and *Oreochromis mossambicus* 0.125 and 0.551 ppm (Radhakrishnan Nair, 2002) respectively. The 96 hrs LC_{50} values of 9.7% lambda-cyhalothrin (product name-Demand CS) for rainbow trout (*Oncorhyncus mykiss*) and bluegill sunfish (*Lepomis macrochirus*) were reported to be 0.24 and 0.21 µg/L respectively, in proposed regulatory decision document (Pest Management Regulatory Agency, 2003). The 96 hrs LC_{50} value for mosquito fish, *Gambusia affinis* was estimated as 1.107 µg/ l (Utku Guner, 2009). Lambda-cyhalothrin is very highly toxic to many fish and aquatic invertebrate species (Paul and Simonin, 2006). Reported LC_{50} in these species are as follows: bluegill sunfish, 0.21 µg/l (Kidd and James, 1991); rainbow trout, 0.24 µg/l (Anomouse, 1998); *Daphnia magna*, 0.36 µg/l (Anomouse, 1998); Mysid shrimp, 4.9 ng/L (Anomouse, 1998); Sheepshead minnow, 0.807 ng/L (Anomouse, 1998).

Figure 1: LC_{50} values of lambda-cyhalothrin to *E.suratensis*



The compliance of the present study may be observed by having a look at various earlier reports of LC_{50} values with different formula grade lambda-cyhalothrin and different pesticides for 96 hrs treatment period. In many case lambda-cyhalothrin LC_{50} levels is less than 1.0 µg/ L for many fishes such as the blue gill and lake trout (Anomouse, 1991). Hill (1985a, b) found 96 h LC_{50} values of 5% EC lambda-cyhalothrin for *Salmo gairdneri* and *Cyprinus carpio* to be 0.93 and 0.50 µg 1^{-1}, respectively. However, with technical grade lambda-cyhalothrin, the 96 h LC_{50} value for *Cyprinodon variegates* was found to be 0.81 µg 1^{-1} (Hill, 1985c). Many biosit LC_{50} levels were determined for mosquito fish in various pesticides. The reported LC_{50} values 0.35 ppm for parathion and 13.45 ppm for methyl parathion (Chambers and Yarbrough, 1974). The LC_{50} for chlorpyrifos is 0.15 ppm (Scott and Chambers, 1996).

The present work, fish mortality increased significantly when the concentrations and the time of exposure were increased; while the LC_{50} values decreased. Similar observations had been made for various pesticides by some authors (Sadhu, 1993; Thakur and Sahai, 1994; Das and Mukherjee, 2000). The decrease in LC_{50} value suggested decreasing resistance of the fish with increasing exposure duration, as signified by the co-efficient of the fitted regression equation. Vasait and Patil (2005) investigated the LC_{50} values of organophosphate pesticide to *N. botia* and calculated for 7 and 14 days exposure period. The result indicates decrease in LC_{50} value with concentration and duration of exposure increase.

From this study, effects of insecticide on *Etroplus suratensis* indicated that lambda-cyhalothrin is toxic to fish even at low concentration.

Table 1: Toxicity parameters of lambda-cyhalothrin to *E.suratensis* (log-dose/probit regression analysis)

Exposure period (hrs)	LC_{50} (ppm)	Regreesion equation	Regression coefficient (b)	95%fiducial limits		Chi-square test	
				Lower (LFL)	Upper (UFL)	X^2	Critical value
24	0.134	Y=-0.006+3.246X	3.246	1.121	1.133	0.88	4.89
48	0.130	Y=-0.008+3.422X	3.422	1.107	1.119	0.91	4.22
72	0.128	Y=-0.012+3.684X	3.684	1.100	1.113	0.93	4.16
96	0.107	Y=-0.014+3.924X	3.924	0.988	1.069	0.92	3.84
120	0.094	Y=-0.018+4.102X	4.102	0.909	1.033	1.37	3.42

The aquatic organisms such as fish may serve as an excellent toxicity indicator of environmental toxicity in non-target vertebrates. The LC_{50} values of lambda-cyhalothrin were in the ppm level and therefore this pyrethroid insecticide to be highly toxic to fish. In conclusion, lambda-cyhalothrin contamination is dangerous to aquatic ecosystems and this fact should be taken into consideration when this insecticide is used in agriculture.

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