DETERMINATION OF LAMBDA CYHALOTRIN (TEKVANDO 5EC) 96 HOUR LETHAL CONCENTRATION 50 AT Gambusia affinis (Baird & Girard, 1853)

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Abstract: Lambda cyhalothrin (TEKVANDO 5EC) belongs to a group of chemicals called synthetic pyrethroids and pesticides and potential toxic pollutant contaminating aquatic ecosystems, was investigated in the present study for acute toxicity. Mosquito fish, Gambusia affinis (Baird & Girard, 1853) were selected for the bioassay experiments. The experiments were repeated 3 times and the 96-h LC50 was determined for the fish. The static test method of acute toxicity test was used. Water temperature was regulated at 20 ± 1 °C, water pH 8.31 total conductive was 621 μS. Data obtained from the lambda cyhalothrin acute toxicity tests were evaluated using the probit analysis statistical method. The 96-h LC50 value for mosquito fish was estimated as 1.107 μg/l.

Keywords: Lambda cyhalothrin, Gambusia affinis, Lethal Concentration 50

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**Introduction**

Not only, pesticides play an important role in modern agriculture by providing dependable, persistent and relatively complete control against harmful pests with less expense and effort but also they have, no doubt, increased crop yields by killing different types of pests, which are known to cause substantial or total crop damage. On the other hand, these chemicals are considered as potent pollutants of the water environment with undesirable effects on non-target organisms such as fish and water animals (Atamanalp and Yanık 2001; Anomouse 1988, 1991).

Lambda cyhalothrin is a pyrethroid insecticide, highly active against a wide range of species of Lepidoptera, Hemiptera, Diptera, and Coleoptera (Bao et al, 2007). Lambda-cyhalothrin has the same spectrum of insecticidal activity as cyhalothrin, but is more active. The compound is a stomach and contact insecticide. It shows adulticidal, ovicidal and particularly, larvicidal activity (Anomouse 1991).

Apart from agricultural uses, lambda cyhalothrin also has public and animal health applications in which it effectively controls a broad spectrum of insects including cockroaches, flies and ticks. And also it is used in the vector control such as mosquito control by direct spraying in the water bodies (Velmurugan at al, 2007).

Pyrethroids Insecticides such as lambda cyhalothrin is extremely toxic to many aquatic organisms, including fish such as the blue gill and lake trout, with LC50 values less than 1.0 μg/L (Mueller-Beilschmidt, 1990). Due to their lipophilicity, pyrethroids have a high rate of gill absorption, which in turn would be a contributing factor in the sensitivity of fish to aqueous pyrethroid exposures (Polat et al, 2002). Lambda cyhalothrin is not only toxic for many fish but also toxic many aquatic invertebrate species (Paul and Simonin 2006, Taplo 1). Reported LC50s in these species are as follows: bluegill sunfish, 0.21 μg/L (Anomouse, 1991 1998); rainbow trout, 0.24 μg/L (Anomouse 1991, 1998); Daphnia magna, 0.36 μg/L; mysid shrimp, 4.9 ng/L; sheephead minnow, 0.807 ng/L (Anomouse 1998). A median effect concentration, EC50 (i.e. the concentration at which the effect occurs in 50% of the test population), for the eastern oyster of 0.59 ng/L has been reported (Anomouse 1998).

Bioconcentration is possible in aquatic species for lambda cyhalotrin, but bioaccumulation is not likely because of rapid depuration (elimination) (Wauchope et al., 1992). A bioconcentration factor of 858 has been reported in fish (4 species unspecified) for lambda cyhalothrin, but concentration was confined to non-edible tissues and rapid depuration was observed (Anomouse 1998).

Pyrethroids have become widely used on rice in some countries (Bao et al., 2007, Anomouse 1998, 1991), but their application in paddy Weld have been prohibited in China because of their high toxicity to aquatic animals (Köprücü and Aydin, 2004; Çakmak and Gorgon, 2003). In Turkey especially Turkish Thrace, the use of Lambda cyhalotrin has been increased on same kind of insect (such as Lepidoptera, Hemiptera, Diptera and Coleoptera) in some years (Erkin and Kişmir 1996). About 20 percent of pesticent were used in Turkish thrace. Lambda cyhalothrin run-off from agricultural fields killed natural fish in masses in various parts of the world also, research has shown that exposure to lambda cyhalothrin, even at sublethal doses, induces behavioral and biochemical changes in fish (Bao et al., 2007, Anomouse 1998, 1991).

Since Gambusia affinis are widespread and use for biological control of mosquitoes and also one of the most used animals for determinations of LC50 values, therefore, this study was undertaken to calculate LC50 value of lambda cyhalothrin for 96 hour in Gambusia affinis.

<table>
<thead>
<tr>
<th>Insecticide Pyrethroids</th>
<th>Concentration of active ingredient (g/m2)</th>
<th>Duration of effective Action (mouths)</th>
<th>LC50s μg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-Cypermethrin</td>
<td>0.02–0.03</td>
<td>4–6</td>
<td>79</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>0.02–0.05</td>
<td>3–6</td>
<td>250</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>0.5</td>
<td>4 or more</td>
<td>250</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>0.01–0.025</td>
<td>2–3</td>
<td>135</td>
</tr>
<tr>
<td>Etofenprox</td>
<td>0.1–0.3</td>
<td>3–6 or more</td>
<td>&gt; 10 000</td>
</tr>
<tr>
<td>Lambda-Cyhalothrin</td>
<td>0.02–0.03</td>
<td>3–6</td>
<td>56</td>
</tr>
<tr>
<td>Permethrin</td>
<td>0.5</td>
<td>2–3</td>
<td>500</td>
</tr>
</tbody>
</table>
Materials and Methods

Test Animals

*Gambusia affinis* (Baird and Girard, 1853) belongs to family Poeciliidae (Poeciliids), sub-family Poeciliinae and inhabits slow-flowing water; most common in vegetated ponds and lakes, backwaters and quiet pools of streams. *Gambusia affinis* feeds on zooplankton, small insects and detritus and used as live food for carnivorous aquarium fishes (Page and Burr 1991).

**Figure 1.** Male, female *Gambusia affinis* and test chambers (D1-D4 concentration, K control).

**Figure 2.** Lambda-cyhalothrin (Tekvando 5EC) 50 g/L : (S)-α-cyano-3-phenoxynylbenzyl (Z) - (1R,3R) - 3 -(2-chloro-3,3,3-trifluoroprop-1-enyl) -2,2-dimethylcyclopanecarboxylate + (R)-α-cyano-3-phenoxynylbenzyl (Z)-(1R,3R) - 3 -(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopanecarboxylate (1:1)

**LC₅₀ test**

About 200 adult *Gambusia affinis* specimens were collected from Gülapoğlu Lake, Edirne city. The fish used were adults, both females and males between 25 and 35 mm total length (about <1 g). They were transferred to four glass aquarium (50x50x100 cm, 100 l) in the aquarium room and maintained at 20 °C and 16:8 light: dark regime. This arrangement was left undisturbed for seven days, during which animals became accustomed to room conditions.
Table 2. Result of LC50 tests (T1, T2 and T3 replikans)

<table>
<thead>
<tr>
<th>Concentrations</th>
<th>Number Exposed</th>
<th>Mortalities</th>
<th>T 1</th>
<th>T 2</th>
<th>T 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000 ppm</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.010 ppm</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>0.015 ppm</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>0.020 ppm</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0.025 ppm</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 3. Trimmer Sperman-Karber Method LC50 96 hour test result (version 1.5).

<table>
<thead>
<tr>
<th>Concentrations</th>
<th>Number Exposed</th>
<th>Mortalities</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000 ppm</td>
<td>10</td>
<td>0</td>
<td>%0</td>
</tr>
<tr>
<td>0.010 ppm</td>
<td>10</td>
<td>4</td>
<td>%40</td>
</tr>
<tr>
<td>0.015 ppm</td>
<td>10</td>
<td>8</td>
<td>%80</td>
</tr>
<tr>
<td>0.020 ppm</td>
<td>10</td>
<td>10</td>
<td>%100</td>
</tr>
<tr>
<td>0.025 ppm</td>
<td>10</td>
<td>10</td>
<td>%100</td>
</tr>
</tbody>
</table>

Spermann-Karber Trim: %40.00
Spermann-Karber estimates LC50 value: 1.107 ppm
%95 lower confidence : 0.867 ppm
%95 upper confidence : 1.413 ppm

The experiments were conducted in 2 l glass tanks, each contained 2 l solution with different concentrations of test substances or negative control, and 10 organisms were tested in one glass tank (Figure 2). All experiments were performed with three replicates. Tap water was aerated for dechlorinating pretreatment by air pump for over 24 h (Figure 1).

Semi-static exposure to the testing substances was applied, with replacement of testing solution every 48 hours. The exposure lasted for 96 hour, and symptoms and mortality were recorded at 24, 48, and 96 hour post treatment.

Chemical

Lambda-cyhalothrin (mixture 1:1 of S and R isomers); molecular Formula C23H19ClF3NO3 (CAS no: 91465-08-6), emulsion concentration is 50 mg/l (Figure 2). Commercial grade lambda cyhalothrin (Tekvando 5EC) (proved by Sefa Tarm A.S, Turkey) was used in this study.

Statistical Analysis

Statistical analysis was performed using LC50 Trimmed Spearman–Karber Program (1.5 versions). The median lethal concentrations, LC50 (96 hour) and 95% confidence interval were calculated statistically by the Trimmed Spearman–Karber method (Martin et al., 1977).

Results and Discussion

Water parameters during the experiment remained constant as follows: dissolved oxygen 13.13±1.71 mg/l, temperature 20 ±1 °C, pH 8.30 ±0.24, and conductivity 621.68 ±11.13 µhos.

LC50 experiments were performed with three replicates (Table 2). At end of 96 hour, lethal concentration 50 calculated special computer program (Martin et al., 1977) (Table 3).

The median lethal concentration, LC50 (for 96 hour) and 95% confidence interval were calculated as table 2.

Under laboratory conditions of constant toxicant concentrations, lambda-cyhalothrin was highly toxic for fish and aquatic invertebrates. The LC50s (for 96 hour) for fish ranged between 0.2 and 1.3 µg/L; the LC50s (for 48 hour) for aquatic invertebrates ranged between 0.008 and 0.4µg/L. Lambda cyhalothrin is very highly toxic to many fish and aquatic invertebrate species (Paul and Simonin 2006). Reported LC50s in these species are as follows: bluegill sunfish, 0.21 ug/l (Kidd and James 1991); rainbow trout, 0.24 ug/l (Anomouse 1998); Daphnia magna, 0.36 ug/l (Anomouse 1998); mysid shrimp, 4.9 ng/L.
(Anomouse 1998); sheepshead minnow, 0.807 ng/L (Anomouse 1998). A median effect concentration, EC50 (i.e. the concentration at which the effect occurs in 50% of the test population), for the eastern oyster of 0.59 ng/L has been reported (Anomouse 1998).

Because agricultural insecticides have potential to disrupt biological control of mosquitoes, we quantified whether an insecticide used in rice fields causes mortality of mosquitofish. Laboratory studies have shown that lambda-cyhalothrin (Tekvando 5EC) is very toxic to fish; however, some studies report low field toxicities of pyrethroids to fish because they degrade rapidly and adsorb to soil. At the same time some research shows that Warrior (another lambda-cyhalothrin pesticide like Tekvando 5EC) kills mosquitofish under field conditions. Replicated enclosures in a rice field were either sprayed with Warrior at 5.8 g active ingredient/ha or were untreated. Mosquitofish were either added before the spray or 7 days later. Of those added before the spray, none survived. Most fish added 7 days later, survived (Lawler et al, 2003).

Many biosit LC50 levels were determined for mosquitofish. The reported LC50's for are 0.35 ppm for parathion and 13.45 ppm for methyl parathion (Chambers and Yarbrough, 1974). The LC50 for chlorpyrifos is 0.15 ppm (Scott and Chambers 1996). In many case lambda cyhalothrin LC50 levels is less than 1.0 μg/L for many fishes such as the blue gill and lake trout (Anomouse 1991).

Result of 24 h LC50 test for Gambusia at static condition is 0, 18 μg/L for Gambusia at static condition (Mohsen at al, 1989). Under laboratory conditions lambda-cyhalothrin are highly toxic for fish, aquatic arthropods, and honeybees. However, under field conditions, lasting adverse effects are not likely to occur under recommended conditions of use (Anomouse 1991, 1998; Bao et al, 2007).

According to Delistraty (2000) in the study of examining relationships among physicochemical properties and acute toxicity endpoints of some chemicals (such as pesticides) in rats and trout concluded that trout aquatic LC50 was predicted from rat inhalation LC50 with moderate success. Therefore such data are useful in ecological risk assessment but there are limitations and uncertainties. Further work with toxicity testing methods directly on fish will be very useful in assessing possible ecological risk of these pesticides because of changing physicochemical parameters and chemical properties of pesticides.

Conclusions
The present study evaluated lethal concentration for 96 hours effects of one of most used pesticide (lambda-cyhalothrin) on mosquitofish. The calculated value of the 96-hour LC50 of Lambda solution was 1.107 μg/L (Table 3).

References


