Middle-East Journal of Scientific Research 13 (2): 133-136, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.13.2.813

A Comparative Toxicity Evaluation and Behavioral Observations of Fresh Water Fishes to Fenvalerate™

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Abstract: Toxicity of Fenvalerate™ a synthetic pyrethroid to some fresh water fish species was evaluated. The toxicity is determined by using both static and continuous flow through systems and also noticed some specific behavioral characteristics during the experimentation periods in different time intervals. The LC_{50} values were calculated for 24h, 48h, 72h and 96h respectively. The compared toxicity levels were given for the selected fresh water fishes.

Key words: Toxicity · Behavioral characters · Fenvalerate™ · Static and continuous flow through systems · LC_{50}

INTRODUCTION

Synthetic pyrethroids are a new class of broad spectrum organic insecticide which is widely used in agriculture, domestic purposes and also in veterinary applications. An account these are being used more than 30% among the world. Fenvalerate™ (RS Alpha cyano 3-Phenoxy Benzyle, RS 2-4 (Chloro-phenyl) 3 Methyl Butyrate) is one of the fourth generation and the most widely used synthetic pyrethroid insecticide. (Talekar [1], Bradbury [2], Tilak *et al.* [3],[4] and [5].

Fenvalerate is extremely toxic to non-target organisms particularly to fish. In some cases even lower than those recommended for controlling pestiferous insects. Toxic effects are associated primarily with its isomers later they are exacerbated at low temperatures. But Birds, Mammals and terrestrial plants are having some what little bit tolerate than fish populations (Edwards[6], Tilak *et al.,* [7].

Since aquatic environment is the ultimate sink for all pollutants, aquatic toxicity testing has become an integral part of the process of environmental hazard evaluation of toxic chemicals. Generally, the potential impact of pollutants is more on the aquatic organisms, than in terrestrial environment Murthy [8].

During the last 50 years to increase the agricultural productivity thereby to meet the needs of ever-increasing population, it has became imperative to resort to increased use of pesticides and insecticides to curb agricultural and stored grain losses. The use of highly potent and potable pyrethroid pesticides and insecticides has been increased.

The increasing awareness of the environmental hazards of pesticides and insecticides is necessitated to testing of toxicity of different aquatic organisms. The present investigation was undertaken to determine the toxicity evaluation and behavioral observations of Fenvalerat ™ e by using static and continuous flow through systems to some selected fresh water fish species.

MATERIALS AND METHODS

The present study was conducted at Department of Zoology, Acharya Nagarjuna University situated at Guntur, Andhra Pradesh, India, situated at 16° 18' N and 80° 27' E. fresh water fish (size and weight are given in Table 1, of the Cyprinus carpio communis (Linnaeus), Puntius sophore (Halmiton), Ctenopharyngodon idellus (Valencienneus), Channa punctatus (Bloch), Anabas testudineus species were compared in the present study. The fish were brought from local fish farms and fisherman. The same size and weight were collected for each species. The fishes were acclimatized to the laboratory conditions in well aerated and with the non-chlorinated tap water at the test medium conditions. During the period of acclimatization and experimentation the fishes were not fed. If the number of deaths exceeded 5% in any batch of the fish during acclimatization, that batch was discarded. The toxicity studies were conducted using the technical grade formulation and also commercially available formulation of Fenvalerate and employing static and

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Table 1: The LC_{50} values and their 95% confidence limits of Fenvalerate ™ technical grade and commercial formulation of 20% EC to fresh water fishes for 24h, 48h, 72h and 96 hours of static and continuous flow through systems

Name of the fish	Length of the fish (cm)	Weight (mg)/g	24h. static (mg/L)	24h. C.F (mg/)	48h. static (mg/L)	48h. C.F.(mg/)	72h. static (mg/L)	72h. C.F. (mg/L)	96h. static (mg/L)	96h. C.F. (mg/L)
Cyprinous	5-6	700-1000	3.418	3.085	3.202	2.671	2.702	2.294	2.171	1.775
carpio			(2.70-2,37)	2.52-2.46	(2.63-2.39)	(2.54-2.31)	(2.56-2.30)	(3.47-1.25)	(2.39-2.29)	(2.5-2.01)
communis (T.G)			0.3020	0.3004	0.2794	0.2925	0.259	0.2639	0.2432	0.1571
20%EC.			(1.66-1.30)	(1.56-1.40)	(1.55-1.34)	(1.68-1.25)	(1.52-1.31)	(1.66-1.18)	(1.60-1.18)	(1.40-0.10)
Puntius	5-6	700-1000	3.425	2.79	2.741	2.378	2.237	2.066	1.789	1.415
sophore (T.G)			(2.60-2,44)	(2.5-2.4)	(2.5-2.38)	(2.49-2.26)	(2.5-2.14)	(2.37-2.20)	(2.43-2.02)	(2.74-1.49)
			0.4972	0.4085	0.4061	0.3525	03636	0.3109	0.3362	0.2934
20% E.C.			(1.8-1.6)	(1.56-1.45)	(1.77-1.44)	(1.69-1.34)	(1.62-1.5)	(1.65-1.25)	(1.56-1.44)	(1.66-1.28)
Ctenopharyngodon	5-6	700-1000	3.902	3.338	3.313	2.778	2.627	2.121	2.627	2.121
idellus (T.G)			(2.68-2,49)	(2.61-2.43)	(2.56-2.47)	(2.52-2.36)	(2.51-2.32)	(2.4-2.24)	(2.52-2.31)	(2.4-2.24)
			0.695	0.5342	0.5624	0.4551	04666	0.3841	0.3575	0.3232
20% E.C.			(1.94-1.74)	(1.85-1.59)	(1.73-1.57)	(1.70-1.63)	(1.70-1.63)	(1.63-1.53)	(1.70-1.40)	(1.57-1.44)
Channa	6-9	6.5-7.5gr.	197.3	187.2	164.0	159.3	167.0	127.7	128.1	110.7
punctatus			(4.38-4.20)	(4.42-4.11)	(4.40-3.93)	(4.31-4.01)	(4.39-4.05)	(4.23-3.97)	(4.28-3.85)	(4.21-3.78)
(Bloch) (T.G.)			24.37	25.71	21.47	17.83	22.78	16.43	12.66	10.66
20% E.C.			(3.57-3.20)	(3.59-3.22)	(3.55-3.10)	(3.63-2.86)	(3.43-3.18)	(3.32-2.96)	(3.30-2.90)	(3.22-2.59)
Anabas	6-9	7-10gr	882.0	706.5	722.3	591.6	581.6	467.7	472.5	376.0
testudineus (T.G.)			(5.07-4.81)	(4.88-4.81)	(5.05-4.66)	(5.05-4.66)	(4.88-4.64)	(4.71-4.62)	(4.76-4.58)	(4.61-4.53)
			146.9	118.8	119.9	100.6	101.5	82.5	80.78	65.75
20% E.C.			(4.22-4.11)	(4.12-4.01)	(4.09-4.05)	(4.05-3.95)	(4.05-3.95)	(4.07-3.85)	(3.95-3.86)	(3.92-3.71)

continuous flow through systems as recommended in the report of the committee on methods for toxicity tests with aquatic organisms EPA[9]. Solutions of desired concentrations were prepared in 95% acetone to get the stock solution as well as working solution as 100mg/100ml and 1mg/1ml of toxicant chemical Fenvalerate in both technical formulation and commercial formulation. The other precautions such as use of acetone in control as recommended by EPA [9].

Pilot experiments were conducted to determine the concentrations causing 10% to 90% mortality of test fish. Then for each concentration, 10 fishes were (same size and same weight and same age group) taken for every test and the experiment was repeated thrice and the average mortality rate at each concentration derived was converted as percent mortality values. For this, the probit mortality values were obtained from Finney [10] table as recommended by Roberts and Boyce [11] was followed to calculate the LC_{50} values. Technical grade of Fenvalerate ™ and 20% EC were supplied by Searle (India) limited, Mumbai.

For the flow through system, test solutions of desired concentrations were prepared once in every five hours in glass reservoirs and let into the test containers through thin walled polyethylene tubes. The flow rate was adjusted with regulators such as 4 L of water passed through containers in one hour. The conditions of the test medium were maintained as temperature 28° ± 2° C, Oxygen 6-8 ppm, Hardness 80mg/L, Alkalinity 425mg/L and PH.8.3 etc., All the precautions laid down in the report of committee on toxicity tests were followed EPA [9].

In view of this, the effect of lethal and sub lethal concentrations of Fenvalerate ™ a synthetic pyrethroid insecticide as the general behavioral pattern of the five different fresh water fishes were studied.

RESULTS AND DISCUSSION

The LC_{50} values for static and continuous flow through system for 24, 48, 72 and 96 hours of both technical grade and 20%EC were given in Table: [1]. The differences between observed and calculated values were tested for significance. The values within the parenthesis are confidential limits. The values are tested for chi-square and found to be not significant at $P< 0.05$.

The signs of Fenvalerate™ poisoning in fish include loss of schooling behavior, swimming near the water surface, hyper activity, erratic movements, loss of buoyancy, elevated cough rates increased gill mucus secretion, flaring of the gill arches, head shaking and restlessness and finally the fish is died Braudbury and coats[12] Tilak *et al*. [7].

In the present study, the static values of LC_{50} are higher than the continuous flow through systems. The higher values are in agreement with the earlier authors report. The 20% E.C. formulation is more toxic than technical grade. This indicates the involvement of other ingredients in enhancing the toxic action than the technical grade.

The sensitivity of the fishes in the present study of technical grade Fenvalerate ™ and 20% E.C. formulations was in the order of toxicity levels against toxicant is

Cyprinous carpio communis > Puntius sophore > Ctenopharyngodon idellus > Channa punctatus > Anabas testudineus respectively.

The environmental factors such as temperature are well known for their influence in the toxic response of biota to chemicals. Higher mortality rates are almost double during winter seasons was noticed (average temperature is 18 ± 2°C but in summer it is 32. ±3°C)

Adams and Miller [13], Tilak *et al*. [7] was reported that at higher temperature the fish was in hyper-excitability condition and less mortality was noticed but it is exactly different in winter seasons. Harris and Kinoshita [14] demonstrated similar inverse relationship between temperature and toxicities of four pyrethroids to insects. Similar observations were reported by Bradbury *et al.* [15] for two Fenvalerate™ formulations on Fat head Minnows.

Behavioral Studies: The following behavioral observations were noticed in between the normal fish which is in control tub and the treated fish.

Normal Fish: Control fishes maintained a fairly compact schooling behavior, covering about one third of the bottom in the first five days of the experiment. By fifth day, the school became less compact covering up to two thirds of the tank area. Five fishes were observed that they are scraping the bottom surface. They were sensitive to light and moved to the bottom of the tub when light was passed in to the tub. They are exhibiting Normal lip movements so that it can take dissolved Oxygen maximum and also very active. Except these there is no other extraordinary behavior was observed.

Exposed Fish: When the fish were exposed to sub lethal and lethal concentration of Fenvalerate™, technical grade and 20% EC., they were migrated to the bottom of the Test chamber immediately. This is because of the toxic stress. Their Schooling behavior was totally disturbed and they are swimming independently and this was followed by irregular, erratic and dangling movements with the imbalanced swimming activity. The swimming behavior was in a cork screw pattern and rotating along horizontal axis and followed by "S" jerks, sudden, rapid and non-directed sport of forward movement likely to be busted swimming. The fish were exhibited peculiar behavior that is the fish were trying to leap out from the test chamber which can be viewed as escape phenomenon. Respiratory disruption was observed due to cough and yawning this is because of toxic stress. They often barrel rolled or spiraled at regular intervals and engulfed the air through mouth before respiration ceased. A change in color of the gill lamellae from reddish to light brown with coagulation of excess mucous on the gill lamellae was observed.

Besides causing high mortality Fenvalerate™ also to induce behavioral changes such as tumors, convulsions and erratic swimming in the tad pole larvae of M.ornata, L.limnocharis, B.melanosticus, Dey and Abhishek Gupta. [16]

Shanmugam. *et al*. [17] observed that the hyper-excited ness, Uncoordinated movements and paralysis conditions in the crab B.cunicularis exposed to Endosulfan.

The symptoms of Fenvalerate™ poisoning in the fish include loss of schooling behavior, swimming near the water surface, hyper activity, erratic swimming. Seizures, loss of buoyancy, elevated cough rate, increased gill mucous secretion, flaring of the gill arches, head shaking and restlessness before death. Bradbury and Coats[18], [19].

ACKNOWLEDGEMENTS

The author thanks Dr. Ayele Taye, previous Dean, FNS and Dr. Mulugeta Kebede, Head of the department of Biology for providing facilities. And I also should say thanks to my guide Prof.K.S.Tilak and I am very thankful to Searle India Ltd., Mumbai for supplying the pesticide for my research. Last but not the least; I am thankful to my wife and my children for their encouragement.

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