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BIOCONCENTRATION OF FENVALERATE INSECTICIDE IN FRESH WATER FISH *Channa striatus*

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Modern agriculture heavily relies on chemicals such as different types of fertilizers, herbicides, fungicides and insecticides. These chemicals have an impact on aquatic organisms Fenvalerate was selected for the study. *Channa striatus* was selected as a model fish to test the bioconcentration in different organs. *C. striatus* was collected from a pond far from Kuttanad and transferred to laboratory. 20 healthy fishes were selected for experimental tanks. The fishes were fed with fish meal and rice flour in 1:1 ratio for once every two days. 25% of water were withdrawn from each tank and the pesticide content in the experiment tank was maintained at the same level. Based on the AOAC 2012 standard procedures, the analysis was carried out using a Perkin-model 5890 Gas Chromatography connected with a Ni 63 electron capture detector. The present investigation concludes that the bioconcentration of fenvalerate insecticide affect the gills, liver and muscles of the *C. striatus.* Insecticide fenvalerate shows a greater sublethal concentration in *C. striatus* is 0.188906 ppm/1. Fenvalerate is concentrated in the liver, gills and muscle tissues.

Keywords: Fenvalerate; bioconcentration; *Channa striatus*; Kuttanad.

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1. INTRODUCTION

Synthetic chemicals, such as various fertilisers, insecticides, and herbicides or weedicides, are largely used in modern agriculture. In rice and cropping systems based on rice, pesticide treatment is a common practise. The widespread use of pesticides has a negative impact or effect on most of the delicate ecosystems. In addition to changing the physico-chemical features of aquatic systems, pesticides and weedicides also have an impact on the aquatic animals as a whole [1] and [2]. There is widespread concern about the possible risks of pesticides to both individuals and the environment because of their poisonous nature [3]. Pesticide use in excess results in unwanted and unnecessary residues, which are a serious hazard to aquatic life [4]. An insecticide fenvalerate is a part of the synthetic pyrethroid family. Fish are much more sensitive to fenvalerate's toxicity than other organisms like mammals [5]. Fenvalerate enters fish bodies mostly through the mouth and gills, and the leftover amount causes toxicity [6]. Additionally, it was discovered that fenvalerate impacted fish larvae. Studies on the toxicity of fenvalerate on various types of fresh water fish [7]. In several parts of Kuttanad, fisherman utilize pesticides by dumping deadly chemicals right into the water's surface in the hopes of easy catching. Fenvalerate was found to be persistent in the surface water samples from Kuttanad, according to the current investigation. However, the tissue samples that were taken straight from the device had undesirable bio concentration values. Thus, the current work is an effort to investigate the potential for bio concentration in fish *Channa striatus* in a laboratory setting using a chosen insecticide fenvalerate among pyrethroids and organophosphates that are frequently used in Kuttanad.

2. MATERIALS AND METHODS

Fenvalerate was chosen for the study after a preliminary survey was undertaken to determine the most frequently used insecticides in the study site. *Channa striatus* was selected as a model fish to test the chances of insecticide residue entry to various organs. The sturdy fish *C. striatus* has additional accessory respiratory organs that enable it to survive drought conditions. In Kuttanad, the fish is frequently seen in paddy fields, ponds, tributaries, and rivers. Additionally, locals and fisherman both consume *C. striatus*. *C. striatus* for the study was collected from a distant pond far from Kuttanad with the help of a local fisherman to prevent any potential contamination. Fish that are healthy and uninjured were selected from the group, transported to the lab in closed water filled buckets, and allowed to acclimate to the ambient laboratory temperature of 280. 20 °C in a sizable stock tank. Uninjured healthy fishes of almost similar size and weight were chosen from the lot and transferred to the laboratory in closed water filled bucket and acclimatized to the ambient laboratory temperature of 28 ± 0.20ºC in a large stock tank. Twenty healthy fish were selected from the stock tank after seven days of acclimatisation, and ten of each were transferred to the experimental tanks. The tanks were rectangular-shaped and had dimensions of 120 cm in length, 90 cm in width, and 60 cm in depth.100 litres of fresh water were obtained from a nearby well and used to fill the tanks. Tank A considered as the experimental tank while Tank B served as the control. Fishes were starved for two days prior to the actual experiment. At regular intervals, the pH temperature, and dissolved oxygen of water were recorded (temp 28º ± 1ºC, pH 6.5 ± 0.5, and DO 7 ± 0.5mg/l). Bio assay studies were conducted for *C. striatus* using fenvalerate (96hrs) and sub lethal doses were obtained. Fish in tank A were exposed to sub lethal doses of fenvalerate (0.188906µl/l) for 21 days. 0.188906µl/l fenvalerate concentration is maintained in experimental Tank A. Commercial grade pesticides namely manufactured by Segentia India Ltd, Mumbai and Megafen (fenvalerate 20% EC) manufactured by KPR Fertilizers Ltd, AP. were used in the study. Fishes in the control tank were maintained properly without any contamination. Since the experiment lasted 21 days, the fish was fed with fish meal and rice flour in 1:1 ratio for once every two days. Throughout the duration of the study, the tanks were closely monitored. Dead fish were removed right away, and safety measures were followed to ensure that there was minimum mortality rate in the tanks. Every two days, 25 litres of water were withdrawn from each tank and the pesticide content in the experimental tank was carefully controlled to remain at the same level. The fishes were collected from control and experimental tanks after 21-days of experimental period, sacrificed and dissected. Gills, liver, and other tissues were removed, washed, and maintained in separate containers before being removed and brought to the lab under refrigeration (-20ºC). Acetone mixture and GC grade hexane in 1:2 ratio is used for the extraction of pesticide from the tissue [8]. According to the AOAC 2012 standard procedures, the analysis was carried out using a Perkin-model 5890 Gas Chromatography connected with a Ni 63 electron capture detector [9]. The experiment was repeated for 3 times.

3. RESULT AND DISCUSSION

The tables (Tables 1 and 2) and Figs. 1 and 2 show bioconcentration investigations of pyrethroid and organophosphate insecticides in the gills, liver, and

muscle of the *C. striatus*. Regardless of the kind of sample tissues, ppm concentrations were detected in all samples. Sub lethal dose of 0.188906 ppm/l, fenvalerate was concentrated in the gills, liver, and muscles (0.081 ± 0.006, 0.076 ± 0.008, and 0.031 ± 0.005 mg/kg, respectively) and the results are shown in Table 1 and Fig. 2. The gills, liver, and muscles showed bio concentration factors of 0.428, 0.402, and 0.164, respectively (Table 1 and Fig. 2).

Table 1. Bio concentration of fenvalerate in various tissues of *C. striatus* (0.188906ppm/l) in the experimental medium)

Tissues	Control	Experimental (mg/kg)	Detection Limit (mg/kg)
Gill	0	0.081 ± 0.006	0.01
Liver	0	0.076 ± 0.008	0.01
Muscles	0	0.031± 0.005	0.01

Table 2. Bio concentration factors of fenvalerate in various tissues of *Channa striatus*

Tissues	Experimental (mg/kg)	Concentration of exposure (ppm/l)	Bio concentration factor
Gills	0.081 ± 0.006	0.188906	0.428
Liver	0.076 ± 0.008	0.188906	0.402
Muscles	0.031± 0.005	0.188906	0.164

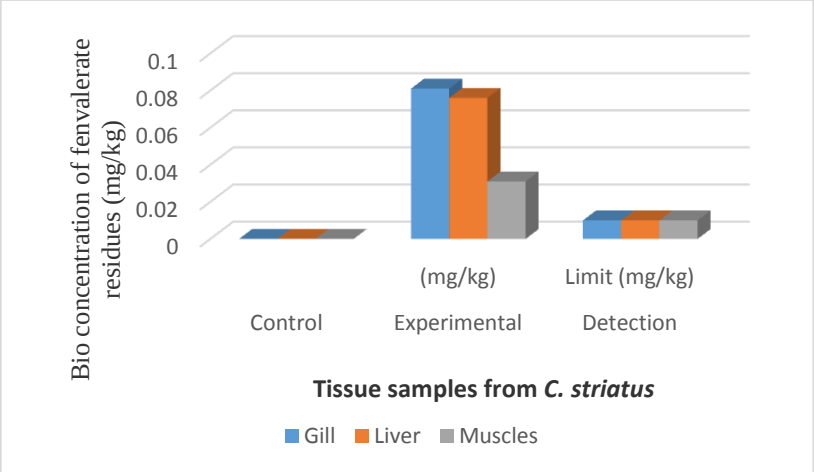

Fig. 1. Bio concentration of fenvalerate in *C. striatus* (mg/l)

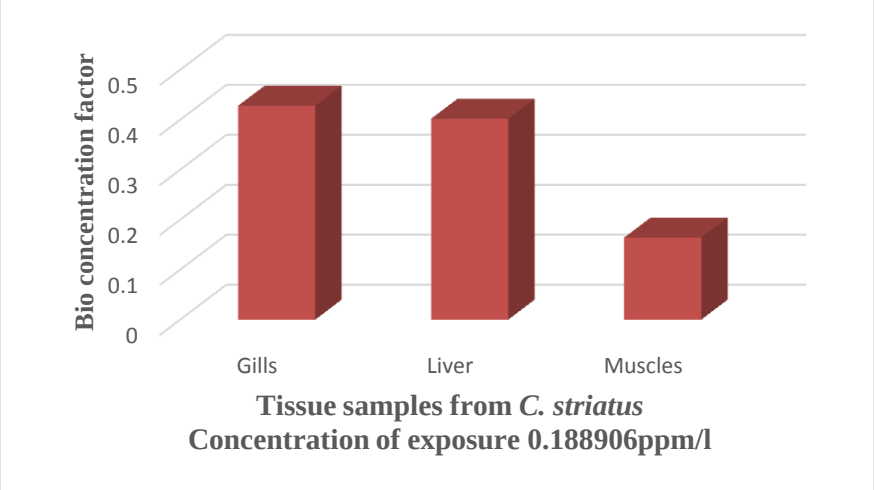

Fig. 2. Bio concentration factor- fenvalerate

Aquatic species easily absorb and incorporate xenobiotic chemicals that are fat soluble from the water, sediments, and food sources [10]. Aquatic organisms are liable to bioconcentrate hydrophobic xenobiotic chemicals. In this study pyrethroid insecticide, fenvalerate, displayed a pattern that accumulating in the gills at 0.081 ± 0.006 mg/kg (BCF 0.428), the liver at 0.076 ± 0.008 mg/kg (BCF 0.402), and the liver at 0.031 ± 0.005 mg/kg (BCF 0.164). Bio concentration factor is the proportion between the amount of a chemical in an organism and its concentration in its surroundings.

In comparison, fenvalerate has a greater sub-lethal concentration (0.188906 ppm/l) and is less hazardous. The pyrethroid shows a tendency to concentrate their residues in the muscles, while fenvalerate can overcome the detoxifying processes of liver and accumulated in the fish's muscles and other tissues above the ADI for human intake (0.02 mg/kg). In zebra fishes, fenvalerate accumulation can alter the structure of intestine and affect the specificity of enzymes such as amylase and protease on substrate activity [11].

This will raise the possibility of insecticides to enter the food chain. The chemicals may concentrate and go through bio magnification if the residues can pass through the next trophic level's detoxifying systems. The bioassay investigations carried out in the current work also showed that the sub lethal dose of fenvalerate given to *C. striatus* was 0.188906ppm/l. The current finding of a little higher concentration of fenvalerate accumulating in the fish's different organs may be indicative of the concentration and dose used. The EC of pesticides also varied as fenvalerate showed an EC of 20%. To catch fish and prawns, fishermen in Kuttanad spray fenvalerate directly into the water. This approach is more damaging to the environment and will immediately poison the system. The microbial breakdown of Pyrethroid insecticides is a relatively slow process [12]. The pyrethroid pesticides have an impact on fish reproduction [13] [14] and spraying pesticides can potentially harm the reproductive success of fishes and other aquatic creatures [15]. Fenvalerate toxicity is harmful for the fishes at biochemical and haematological level [16]. The toxic properties of fenvalerate causes vascular degeneration and liver cell necrosis [17].

Bio transformation by fish appears to limit bio concentration. The current study shows a considerable decrease in the concentration of pesticide residue in flesh, which may be the result of bio transformation. It's possible that the toxicology profiles seen under extended, continuous exposure in the lab don't correctly reflect toxicological reactions [18]. However, studies like these serve as warning signs about the probability that, the careless usage of these kind of pesticides will infiltrate the food chain. The study of Velmurugan shown that even at low doses of fenvalerate, the histological alterations could be clearly seen [19]. Whenever a contaminant enters the food chain at a lower trophic level, it may have negative consequences on higher trophic level animals, including humans. Sub lethal concentrations of various insecticides in water and food may accumulate in fishes especially in paddy fields and ponds. The surrounding embankments in paddy fields may prevent fish from avoiding pesticides, forcing them to stay in the field. This could make paddy fields more likely to experience bioconcentration than rivers and streams. If chemicals permeate into the pond from the neighbouring rice fields, the pond can act similarly. The poisoning of fenvalerate causes hyper activity, increased mucus secretion in gills, imbalance in swimming and also affects schooling behavior of fishes [20].

The majority of people in Kerala dependent on fish and fish-based products to meet their daily nutritional needs. In Kuttanad, fishing provides a significant portion of people's income, particularly for those who are under poverty line. They sell high-value fish like *E. suratensis* and *Wallago attu* while consuming low-value fish like *Anabas testudineus*, *Etroplus maculatus*, and *C. striatus*. The consumption of these fish creates the possibility of pesticides entering the body. In the Kuttanad region, areas of agricultural land, particularly paddy fields, surround the rivers and the Vembanad lake. The pesticides used on the crops may leaches into the rivers and generate bioconcentration from long-term exposure. During the time when Thanneermukkom Bund is closed, the Vembanad Lake serves as a large pool (from half of December to half of April at least). Sublethal pesticide doses in a lake over extended periods of time can accumulate over time in fish and other creatures, harming both the organisms themselves and humans who consume them.

4. CONCLUSION

In the current study pyrethroid pesticide fenvalerate toxicity effects on *Channa striatus* show many behavioral changes and morphological changes. It might lead to a number of physiological issues in fishes and other aquatic organisms. The pyrethroid pesticide shows a tendency to accumulate in the muscles, liver and other tissues of fish. This will raise the possibility of insecticides to enter in the food chain. Pesticides are widely used in Kuttanad for catching fishes and also foe agricultural activities. For that reason, the use of these pesticides are a major threat for the environment and should minimize the usage of pesticides.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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