Deltamethrin's toxicological Impact on Freshwater crab *Barytelphusa cunicularis*

Abstract:

The present study investigates the toxicological impact of deltamethrin, a widely used synthetic pyrethroid insecticide used in agriculture, specifically targeting the freshwater crab *Barytelphusa cunicularis*. The research delves into the insecticide's mechanism of action and acute toxicity on the crab species. With the persistent presence of deltamethrin in soil disrupting microbial activity and water contamination posing threats to aquatic ecosystems. The investigation aimed to determine the lethal toxicity concentration of pesticide. The experiment reveals LC50 values at 24, 48, 72, and 96 hours, indicating concentrations of 0.0125, 0.0075, 0.006 and 0.0049 ppm respectively. The findings demonstrate a correlation between increased pesticide concentration and exposure period with a rise in percentage mortality. Adverse effects observed on *B. cunicularis* populations underscore the need to comprehend deltamethrins impact on non-target organisms. This research contributes significant insights into deltamethrins toxicology, offering valuable information for decision-making and in promoting sustainable pest management practices.

Keywords: Deltamethrin, toxicity, Acute toxicity, LC50 values, Environmental footprint.

Introduction:

Deltamethrin, introduced in the United States in the early 1970s, initially served as a synthetic pyrethroid insecticide with broad applications. Its primary purpose was pest control in agricultural settings and public health applications (Rehman, 2014). Specifically, deltamethrin demonstrated efficacy in managing pests in crops and controlling disease vectors. However, concerns have been raised regarding its environmental persistence and potential adverse effects on non-target organisms (Noor, 2021).

The utilization of deltamethrin for pest management has been extensive, targeting a variety of agricultural pests. It has been employed to control insects such as beetles, mosquitoes, and agricultural pests like aphids and caterpillars. Despite its efficacy, deltamethrin exhibits characteristics that pose risks to the environment (Lu, 2019).

One major concern is the potential for pesticide pollution, recent research shows that just 0.1% of applied deltamethrin actually reaches the target organism., while the majority contaminates the surrounding environment (Rafique et al., 2016). Common sources of contamination include agricultural runoff, industrial effluents, and municipal sewage, which introduce deltamethrin and its residues into natural water bodies through surface runoff or floodwaters (Khelfi, 2019).

As a type II pyrethroid insecticide, deltamethrin has been linked to a number of harmful impacts on diverse organisms. (Rehman et al., 2014). For instance, studies have demonstrated its neurotoxicity in rats, leading to oxidative stress and decreased acetylcholinesterase activity (Sharma, et al., 2015). In crayfish, deltamethrin has been shown to silence motor output and modify synaptic transmission (Meng, 2016). Additionally, the impact of deltamethrin on blood parameters, such as White Blood Cell (WBC) count, Hemoglobin content (Hb), Hematocrit percentage (PCV), Mean Corpuscular Volume (MCV), and Mean Corpuscular Hemoglobin (MCH), has been observed in certain species (Karatas, 2016).

Although deltamethrin has been extensively studied for its toxicological effects on aquatic organisms, its specific impact on freshwater crabs, such as *Barytelphusa cunicularis*, remains unclear. These crustaceans play a crucial role in freshwater ecosystems, acting as keystone species (Wacker, 2021). The potential variations in deltamethrin toxicity, influenced by factors like water quality, underscore the complexity of the interplay between pesticide characteristics and environmental conditions.

In light of these considerations, our research on the toxicological impact of deltamethrin on *B. cunicularis* is essential. The investigation aims to provide a comprehensive understanding of the acute toxicity mechanisms, lethal concentration values, and the correlation between pesticide concentration, exposure duration, and mortality rates in freshwater crabs. Using the results of this study, we hope to develop informed conservation strategies and sustainable pest management practices, which will enhance the health and resilience of freshwater habitats.

Material and Methods:

Experimental Animal

The fresh water crab *B. cunicularis* were collected from Godavari River basin, Kopargaon, Ahmednagar (Maharashtra state)**.** Crabs were acclimatized to the laboratory conditions prior to the experiment and were exposed with constant supply of water and good lighting system. They were maintained in well-aerated tubs (10 L capacity), which was dechlorinated and sustained with fresh water flow and waste water discharge.

Preliminary Tests

Based on the recommendations of APHA (1998), the physico-chemical features of tap water were estimated. Using a standardised approach, the water temperature ranged from 28 ± 2°C throughout the trial, while the water's oxygen saturation varied between 70% and 100% and its pH was 7.6.

Chemical

Deltamethrin(S)-α-cyano-3-phenoxybenzyl(1R,3R)-3-(2,2-dibromovinyl)-2,2 dimethyl cyclo propane carboxylate, a technical grade pyrethroid insecticide, was purchased from an agrochemical store.

Evaluation of the LC50, or median lethal concentration

One millilitre of pesticide was dissolved in one thousand millilitres of tap water to create the deltamethrin stock solution, from which other doses were made. Crabs of about the same size were employed in the experiment. The crabs were separated into several batches, with ten crabs in each batch. Every group of crabs was kept in plastic troughs with one litre of water in it. The crabs were individually subjected to varying concentrations of deltamethrin insecticide, and after 24, 48, 72, and 96 hours of exposure, the mortality rate was noted.

Statistical Analyses

Every experiment was repeated three times. Probit Analysis (Finny, 1971) and SPSS 19.0 statistical analysis software were both used to analyse the data. Additionally, the best-fit line, the correlation between mortality and concentrations, and the LC50 value (with 95% confidence limits) were obtained.

Results:

Table 1 and Graphs 1, 2, 3, and 4 provide a summary of the investigation's outcomes. Environmental parameters were maintained at pH 7.6, hardness of about 219 ml/L, and the temperature was 28 ± 2°C. The Lc50 values of *B. cunicularis*, a freshwater crab, exposed to pesticide deltamethrin were calculated. Table 1 shows the final regression equation for 24 to 96 hours along with the 95% confidence limit. The percentage mortality increased progressively up to 96 hours. The Lc50 values decreased with increasing the exposure period showed an inverse relation. For 24, 48, 72, and 96 hours, the deltamethrin pesticides' Lc50 values were determined to be 0.0125, 0.0075, 0.006, and 0.0049 ppm, respectively. The current experiment demonstrates that the percentage mortality increases as pesticide concentration and exposure duration increase. Following exposure to deltamethrin insecticides, behavioural research on crabs reveals the following response:

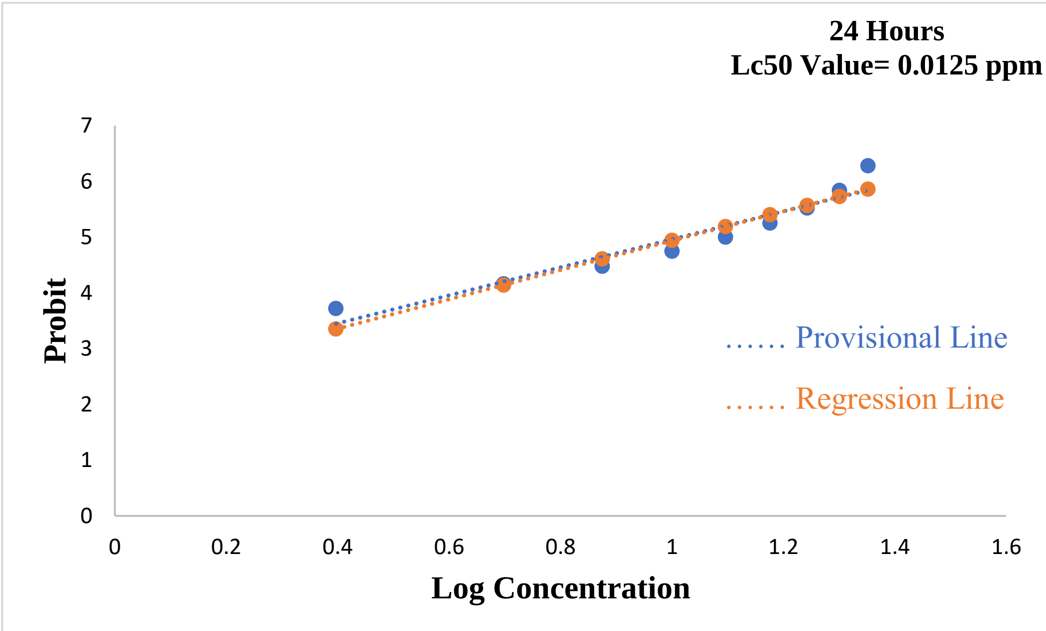
1) Movement Patterns: The crab *B. cunicularis* exhibited excitement and an increase in movement rate following a 24-hour exposure to 0.0125 ppm of deltamethrin pesticides.

2) Response towards food: When treated crabs were added to the second trough containing tap water and earthworm pieces, it was found that the crabs were unable to detect the food, in comparison with the untreated control crabs in the first troughs that contained only tap water.

3) Response to Light: It was found that pre-exposed crabs were more sensitive to light and that they favoured relatively dark places when exposed to continuous light.

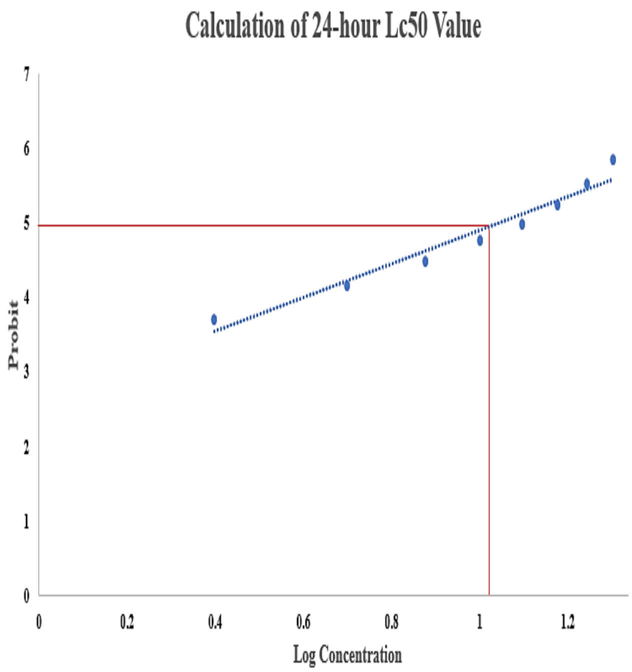
Sr. No.	Exposure	Lc50 Value	Regression Equation	Lower Confidence limit	Upper Confidence limit
1.	24	0.0125 ppm	y = 119.07x + 3.5117	0.008	0.014
2.	48	0.0075 ppm	y = 111.76x + 3.9989	0.005	0.010
3.	72	0.006ppm	y = 143.31x + 4.0993	0.002	0.009
4.	96	0.0049 ppm	y = 177.6x + 4.092	0.001	0.007

Table 1: Relative toxicity of Deltamethrin pesticide when fresh water crab *Barytelphusa cunicularis* exposed to acute concentration (24Hrs to 96Hrs)

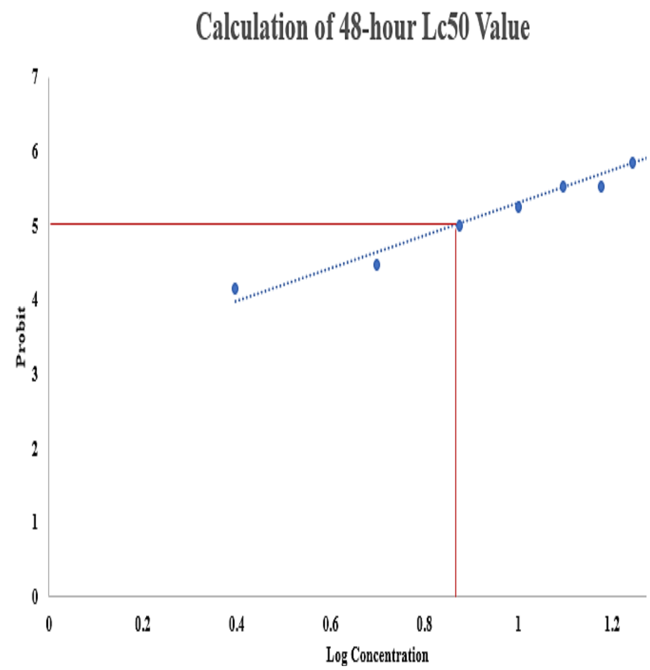


Graph-1

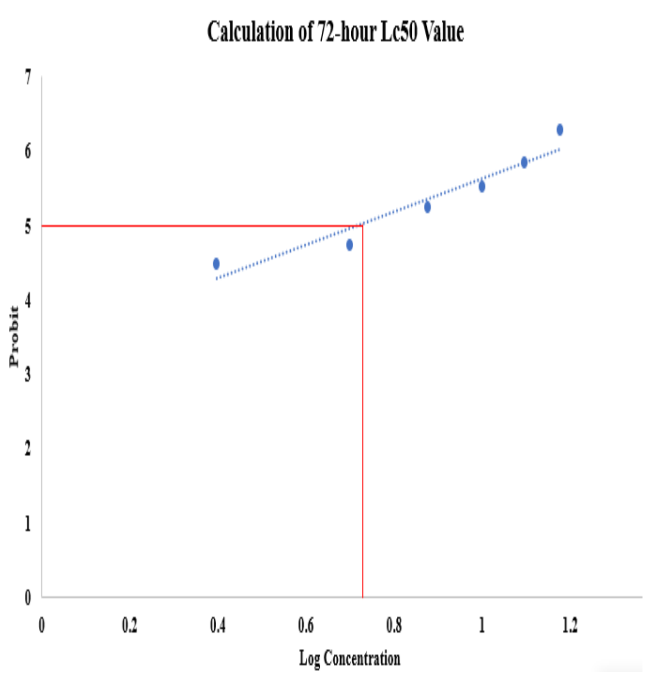
Calculation of 24-hour Lc50 Value and regression line



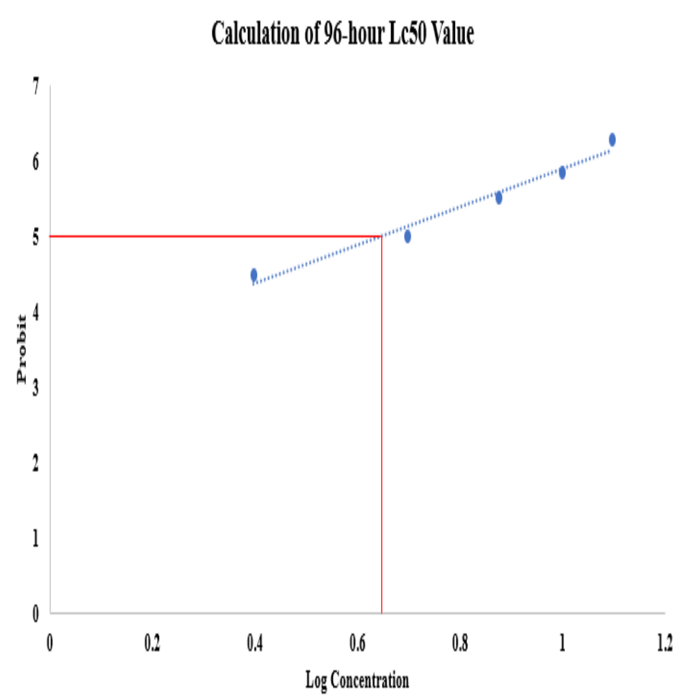
Graph- 2 Calculation of LC50 Value of 24 hour



Graph- 3 Calculation of LC50 Value of 48 hour



Graph- 4 Calculation of LC50 Value of 72 hour



Graph- 5 Calculation of LC50 Value of 96 hour

Discussions:

The toxicological impact of deltamethrin on the freshwater crab *B. cunicularis* is a matter of significant concern, as highlighted by the findings of the present study. The research revealed a clear correlation between increased pesticide concentration and exposure period with a rise in percentage mortality, as evidenced by the calculated LC50 values at 24, 48, 72, and 96 hours. These results highlight deltamethrin's acute toxicity as well as its possible negative impacts on non-target organisms in freshwater environments.

In a study published in 2017, Gebauer showed that cypermethrin had both lethal and sub-lethal effects on the larvae of the non-target crab, Metacarcinus edwardsii, underscoring the pesticide's possible ecological impacts. Additionally, research on *Cyprinus carpio* has demonstrated that exposure to sublethal cypermethrin concentrations can result in changes in biochemical variables, an increase in white blood cell count, a decrease in haemoglobin and red blood cell count, and an increase in white blood cell count (Masud 2013, Bhanu 2015). Similarly, Imidacloprid pesticide exposure has been linked to changes in the prawn metabolome, moulting frequency, and survival rate (McLuckie 2020, Al-Badran 2019). Furthermore, the use of pesticides, particularly Azamethiphos and deltamethrin, has been found to have a significant impact on lobster larvae, with both compounds being acutely toxic to these stages (Parsons, 2020).

In the context of existing literature, this research contributes valuable insights into deltamethrin's ecotoxicology, particularly its specific impact on freshwater crab species. By shedding light on the acute toxicity of deltamethrin on *B. cunicularis*, this study provides essential information for informed decision-making in promoting sustainable pest management practices and formulating conservation strategies that safeguard the resilience and health of freshwater ecosystems.

Conclusion:

In summary, our study investigated the toxicological impact of deltamethrin on the freshwater crab Barytelphusa cunicularis. We determined the lethal concentration values (LC50) of deltamethrin at different exposure durations, highlighting its harmful effects on crab populations. Behavioral observations revealed immediate responses to deltamethrin exposure, emphasizing its disruptive nature.

Our findings underscore the need for proactive environmental management and regulation of pesticide use. By understanding the risks associated with deltamethrin, we can develop informed conservation strategies and promote sustainable pest management practices. This research contributes to ongoing efforts to safeguard freshwater ecosystems and mitigate the adverse effects of pesticide pollution.

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