ASSESSMENT OF TOXICITY IN ZEBRAFISH UNDER ACUTE DELTAMETHRIN STRESS

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Introduction:

Deltamethrin is a synthetic pyrethroid widely used for controlling pests in agriculture and public health programs (Bhattacharjee and Das, 2011). It is highly toxic to a wide range of non-target organisms, including mammals, birds and fish. Mammals and birds can be exposed to deltamethrin through contaminated food, water or direct contact with the pesticide. (Rehman et al.,2014). Deltamethrin is also toxic to fish and can cause acute and chronic toxicity. Deltamethrin exposure can lead to increased mortality rates and can cause acute toxicity in humans and animals leading to symptoms such as convulsions and respiratory distress (Belyaeva et al., 2018). The toxicity of deltamethrin to aquatic organisms is due to its lipophilic nature, which allows it to accumulate in the fatty tissues of aquatic organisms and remain there for a long time (USEPA, 2009).

Zebrafish (*Danio rerio*), a freshwater fish belonging to the Cyprinidae family, emerged as a valuable vertebrate model in recent years and offers several advantages for screening a large number of compounds in drug discovery and toxicological studies (Alavinezhad et al., 2020). Despite anatomical and physiological differences between zebrafish and humans, many organs in zebrafish perform similar functions to their human counterparts and share ~70% similarity with the human genome (MacRae and Peterson, 2015). The present study is to understand the effect of deltamethrin toxicity on acute exposure to adult Zebrafish and to investigate the alteration in behavioural (swimming and feeding), histopathological and biochemical changes.

Objectives:

1. To correlate morphology and behavioural changes in Zebrafish on exposure to deltamethrin.
2. To study the histopathology of affected organs like gills, kidney and liver.
3. To evaluate the difference in biochemical parameters - GST and esterase.

Methodology:

Maintenance and culture of *Zebrafish*

Freshwater Adult *Zebrafish* (*D. rerio*) 5- 6 months old, 3-4 cm in length, ~50:50 males: female ratio and weigh about 1.0±0.78g) were collected from ornamental fish hatchery. *Zebrafish* was kept with 12 h/12 h light and dark cycle in a glass tank. The glass aquarium (60 cm × 30 cm × 25 cm) was maintained with dechlorinated water. They were fed with commercial feed twice a day. About 20 individuals were maintained for each set of experiment and acclimatized prior to the experiment at 28°C ± 1°C.

Standardization of Deltamethrin for LC_{20}

Deltamethrin stock solution was prepared and then different concentrations of deltamethrin were added for the adult *Zebrafish* exposure, the suspensions were prepared for the nominal test concentrations in the aquaria were 1,1.5, 2, 2.5, 3µg/L and 0 µg/L as control. Fish were exposed for 72hrs in different concentrated of deltramethrin to find LC_{20}.

Further fishes were treated with LC_{20} for 72hrs and used for analysis like behavioural, histopathological and biochemical analysis. Mortalities and visible abnormalities related to appearance and behaviour were recorded. ANOVA is used for data recorded in SPSS software package.

Result and Conclusion:

The estimated LC_{20} of deltamethrin for *Zebrafish* was found to be 1.5µg/L. The fishes were treated with 1.5µg/L of deltamethrin for 72hrs in addition with control. The results obtained from deltamethrin exposure on *Zebrafish* in swimming, feeding behaviour and morphological abnormalities. The swimming behavior of the test fish was recorded and observed after 24hrs. The difference in swimming pattern was not observed for 24hrs between treated and control but after 40hrs treated fishes were started swimming maximum at the water surface, Rapid gill movement, affected shoaling behaviour, while the control remains stable.
Treated fishes become less active after 60hrs, remaining on one side and in some cases at the bottom of the tank. Average body weight of treated fishes was reduced by 60.71% when compared to control and also observed spinal deformity in few fishes as a morphological defect.

In conclusion, *Zebra fish* exposure to acute dose of deltamethrin gradually shown abnormalities in swimming, feeding behaviour and morphological abnormalities indicating strong acute toxicity if treated for longer duration.

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Future Scope:

The future scope of this project includes the study on acute toxicity of deltamethrin in zebrafish provides a foundation for further advanced research. Future studies can be extended to evaluate the chronic effects of deltamethrin exposure, particularly focusing on bioaccumulation, growth, reproduction, and long-term survival. In addition, molecular-level investigations such as gene expression analysis and DNA damage studies can be carried out to understand the underlying mechanisms of toxicity. Furthermore, multi-generational studies can help in understanding the heritable effects and teratogenic effects caused by pesticide exposure. Comparative studies involving other aquatic organisms will provide a broader ecological perspective.