Toxicity assessment of beta-cyfluthrin with impact on haematology of fish, *Channa punctatus* 
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ABSTRACT

Beta-cyfluthrin, a synthetic pyrethroid pesticide, is commonly used in agriculture for pest control and as household insecticide. It is relatively safe to mammals and birds but highly toxic to non-target aquatic organisms including fish. The 96-hour LC$_{50}$ was determined using standard toxicity assessment tests. Alterations in haematological parameters were recorded after exposure to two sublethal concentrations of beta-cyfluthrin for a period of 15 and 30 days. The results showed a significant decrease in total erythrocyte count, haemoglobin concentration, haematocrit percentage and increase in total leucocyte count in exposed groups. The results of present study indicate a significant toxicological impact of beta-cyfluthrin on *Channa punctatus* with marked alterations in haematological parameters.

Figures: 05 References: 21 Table: 01

KEY WORDS: Beta-cyfluthrin, *Channa punctatus*, Haematological, LC$_{50}$, Parameters, Pesticide.

Introduction

Pesticides are chemicals used in agriculture to control various kinds of pests and also as household insecticides. In recent past, there have been a decline in use of traditional pesticides such as organophosphates, organochlorines and carbamates. However, the production of pyrethroids is on the rise as they are potent and efficient pest control agents and relatively harmless to mammals and birds. Pyrethroids are synthetic analogs of pyrethrins, the toxic component present in the flowers of *Chrysanthemum cinerariaefolium*.

Beta-cyfluthrin is a commonly used type II synthetic pyrethroid. It is the refined form of cyfluthrin and has about 2-5 times more acute toxicity than cyfluthrin. It is currently used in many formulations all over the world to control a wide range of indoor and outdoor pests. Pyrethroids have been reported to be extremely toxic to aquatic organisms including fish. Due to improper handling these pesticides can enter water bodies where they alter the physical and chemical properties of aquatic ecosystem. These pesticides may damage the biochemical and physiological process of fish organs.

Haematological parameters serve as important indicators of the physiological status of organisms. Any physical or chemical changes in the aquatic environment are reflected in the components of fish blood. The presence of toxicants in the water results in deviations from the normal range of haematological indices. Therefore, haematological tests serve as important tools in toxicological studies. Erythrocyte and leucocyte counts, haemoglobin concentration and haematocrit are some of the most important blood parameters of diagnostic significance.

*Channa punctatus* is a very common freshwater fish found in India. It is a carnivorous, hardy, easily manageable and very economical fish. It can be easily maintained under laboratory conditions and very suitable for toxicological studies.

Material and Methods

Healthy specimens of *Channa punctatus* were obtained from a local source. The fish were treated with 1% KMnO$_4$ to avoid any dermal infections. Before the start of experiment, the fish were acclimated to laboratory conditions for 10 days. Fish were fed commercial fish food pellets. Physico-chemical parameters like water temperature, pH, dissolved oxygen and hardness were constantly monitored during the experiment.

Technical grade beta-cyfluthrin of >95% purity was

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used in this study. Range finding studies were conducted to find out the different concentrations of beta-cyfluthrin for the acute toxicity tests. Beta-cyfluthrin was dissolved in acetone to prepare a stock solution which was diluted to prepare 5 different test concentrations viz., 1, 2, 3, 4 and 5 µg/L, respectively. Five groups of fish (each containing 10 fish) were exposed to a range of these five different test concentrations. This acute toxicity test was conducted in triplicates. Fish mortality was recorded, and 96-hour LC$_{50}$ value was obtained by probit analysis method$^8$.

For haematological studies, fish were divided into 3 groups. Group I was the control group. Group II and Group III were the experimental groups. Fish in experimental groups were exposed to two sublethal concentrations of beta-cyfluthrin (0.154 µg/L and 0.304 µg/L) for 15 and 30 days. These concentrations of beta-cyfluthrin were 5% and 10% of the 96 h LC$_{50}$, respectively. Feeding was stopped 24 hours prior to blood collection. For the study of haematological parameters blood was collected after 15 days and 30 days. Haematological parameters were estimated by standard methods. Total erythrocyte count and total leucocyte count were estimated by improved haemocytometer, haemoglobin concentration was estimated by Sahli’s haemoglobinometer and haematocrit was measured$^{21}$. The data were analyzed with the help of SPSS statistical software.

### TABLE - 1: Toxicity evaluation of beta-cyfluthrin for *Channa punctatus*

<table>
<thead>
<tr>
<th>Experimental animal</th>
<th>Experimental Compound</th>
<th>Regression equation</th>
<th>LC$_{50}$ (µg/L)</th>
<th>Variance</th>
<th>Fiducial limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Channa punctatus</em></td>
<td>Beta-cyfluthrin</td>
<td>Y=5.15+5.52 (x’-0.52)</td>
<td>3.08</td>
<td>0.0014</td>
<td>m$_1$=(+)0.49074</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>m$_2$=(-)0.48525</td>
</tr>
</tbody>
</table>

![Fig. 1: Regression line for determination of LC$_{50}$ for *Channa punctatus* after beta-cyfluthrin treatment](image)


**Results**

The results are shown in Table and graphs. LC$_{50}$ value of beta-cyfluthrin was 3.08 µg/L with variance 0.0014, fiducial limits $m_1 = (+)0.49074$ and $m_2 = (-)0.48525$ and regression equation $Y=5.15+5.52(x'-0.52)$ for the fish *Channa punctatus* (Bloch.) (Table-1 and Fig. 1).

The results of haematological studies are depicted (Figs. 2-5). Total erythrocyte count, haemoglobin concentration and haematocrit percentage (packed cell volume) showed a dose dependent decrease after exposure to beta-cyfluthrin for 15 and 30 days. TEC values showed a significant decrease in both the lower and higher concentrations of beta-cyfluthrin when compared to the respective control fish. The decrease in TEC in higher concentration was 7.5 % and 11.8 % more in comparison to lower concentrations of beta-cyfluthrin after 15 and 30 days, respectively. The values of Hb concentration showed a significant reduction in both the lower and higher concentrations of beta-cyfluthrin when compared to the respective control fish. The decrease in Hb conc. in higher concentration was 10.4 % and 16 % more in comparison to lower concentration of beta-cyfluthrin after 15 and 30 days, respectively. Haematocrit percentage showed a significant decrease in both the lower and higher concentrations of beta-cyfluthrin when compared to the respective control fish. The decrease in haematocrit value in higher concentration was 5.73 % and 13.4 % more in comparison to lower concentration of beta-cyfluthrin after 15 and 30 days, respectively. Total leucocyte count showed a significant increase in both the lower and higher concentrations of beta-cyfluthrin when compared to the respective control fish. The increase in TLC in higher concentration was 4.52 % and 14.14 % more in comparison to lower concentration of beta-cyfluthrin after 15 and 30 days, respectively.

**Discussion**

This study was conducted to assess the acute toxicity of beta-cyfluthrin by LC$_{50}$ and also the effects of sublethal exposure of beta cyfluthrin to *Channa punctatus* fish by using selected haematological parameters.

Several workers reported the acute toxicity values for type II pyrethroids in various fishes. Workers$^{20}$ reported 96 h LC$_{50}$ value as 4.83µg/L for deltamethrin in *Catla catla*, while others$^{16}$ reported 96 h LC$_{50}$ value as 0.75 µg/L for deltamethrin in *Channa punctatus*. Some workers$^{13}$ reported 96 h LC$_{50}$ as 4.0 µg/L for cypermethrin in *Labeo rohita* and reported cyfluthrin toxicity$^6$ in various fish species as 0.68 µg/L in rainbow trout, 1.5 µg/L in blue

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**Fig. 2**: Total Erythrocyte Count (TEC) (million/mm$^3$) in *Channa punctatus* after sublethal treatment of beta-cyfluthrin for 15 and 30 days
Fig. 3: Total Leucocyte Count (TLC) (cell/mm³) in *Channa punctatus* after sublethal treatment of beta-cyfluthrin for 15 and 30 days.

Fig. 4: Haemoglobin Concentration (g/dl) in *Channa punctatus* after sublethal treatment of beta-cyfluthrin for 15 and 30 days.
gill, 22 µg/L in carp (Cyprinus carpio) and 3.2 µg/L in golden orfe. An investigator³ reported 96 h LC₅₀ value as 21.07 µg/L for cyfluthrin in Nile tilapia fry (Oreochromis niloticus). The 48 h LC₅₀ value for cyfluthrin in guppy fish was estimated as 8.07 µg/L.¹⁷

Haematological parameters are important screening tools for toxicological research. The study of haematological parameters can be very useful in evaluation of general health of fish and may be used as indicators of toxic stress. In the present study a dose dependent decrease in total erythrocyte count, haemoglobin concentration and haematocrit percentage (packed cell volume) in Channa punctatus was observed after exposure to beta-cyfluthrin for 15 and 30 days. These results are in line with previously reported studies for cyfluthrin and other type II pyrethroids in fishes.

There were reduced levels of erythrocyte count, haemoglobin concentration, haematocrit and elevated levels of total leucocyte count in Schixothorax esocinus after exposure to cypermethrin¹ and reduction in WBC count, RBC count and Hb in Oriochromis niloticus after exposure to deltamethrin⁷. Similar findings were reported by others¹⁴ for fenvalerate in C. punctatus, for cypermethrin in Labeo rohita¹⁷. There was significant reduction in total erythrocyte count, haemoglobin and haematocrit in Tor putitora after cypermethrin exposure¹⁹.

Several workers⁵,¹⁰,¹⁷ reported significant increase in total leucocyte count and decrease in total erythrocyte count, haemoglobin concentration and packed cell volume in several species of fishes exposed with cypermethrin, deltamethrin and fenvalerate.

References


