



Review Paper

A REVIEW ON EFFECTS OF PYRETHROIDS PESTICIDES ON FRESH WATER FISH BEHAVIOUR AND FISH REPRODUCTION

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Abstract

Pesticides are the biological toxicants which are required by man to kill insects, pests and also man's fight against the spread of diseases. Now pesticides usage became an indispensable and integral part of world agriculture. Modern agriculture practices even though contributed to enhance crop production but also widely polluted aquatic environment. Agriculture practices along with pest control programmes, the surface runoff and aerial spraying forming the major source for translocation pesticides into aquatic ecosystems. The contamination of water by pesticides may effect on non-target organisms like fish. The fish is a good indicator and highly sensitive in such ecosystem where the water gets contaminated with toxic chemicals. Among the pesticides, the synthetic Pyrethroids are commonly used because of their rapid biodegradability and Non-persistent nature. The article sheds light on pesticides of pyrethroid group deltamethrin and cypermethrin induced various toxicities on fish behaviour and fish reproduction during acute and chronic exposure.

Key words: pyrethroids, deltamethrin, cypermethrin, behaviour, reproduction.

INTRODUCTION

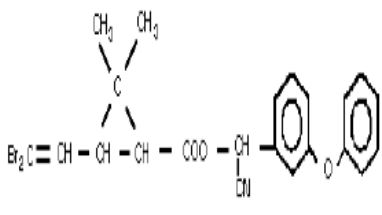
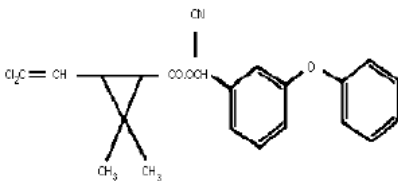
The global pesticide production reached significant levels after the Second World War and rose sharply from approximately 500,000 t/a in the 1950s to over 3 million t/a at the beginning of the 21st century [1] This trend will probably continue over the next decades because of a demand for higher food production as the human population increases, monocultural production for biofuels and potentially introduction of new pests in many areas associated with climate change though introduction of pest-resistant plants and an increase in organic farming and integrated pest management may counter this trend. Among the pesticides, the synthetic Pyrethroids are commonly used because of their rapid biodegradability and Non-persistent nature. These compounds which frequently enter the aquatic ecosystem through agricultural run off and spraying operation adversely affects non target animals such as fishes [2]. Pyrethroids are used preferably over organochlorines, organophosphorous and carbamate due to their high effectiveness, low toxicity to birds and mammals easy biodegradability [3]. Pyrethroids have been shown to be up to 1000 times more toxic to fish than to mammals and birds at comparable concentrations [4]. The hypersensitivity of fish to pyrethroid intoxication is due partly to species specific differences in pyrethroid metabolism, but principally to the increased sensitivity of the piscine nervous system to these pesticides. These lead to changes in

behaviour of the exposed fish such as change in feeding behaviour, attack or avoiding behaviour and reproductive behaviour.

PYRETHROIDS AND ITS TOXIC NATURE:

Pyrethroids are the most used insecticides now a days, these compounds are synthesized from *chrysanthemum* flowers. The keto-alcoholic esters of chrysanthemic and Pyrethroic acid being lipophilic are responsible for its insecticidal properties. Pyrethroids are broadly classified into first (**type 1**) and second generation (**type 2**) pyrethroids. Type 1 containing **Allethrin and Permethrin**; and Type 2 pyrethroids specially Deltamethrin and cypermethrin affects significantly on fish behaviour and fish reproduction (Table 1) [5].

Table 1: Type II pyrethroids, chemical structures and their action, toxicity of Pyrethroids

Group Name Structure Toxicity/Mode of action	Group Name Structure Toxicity/Mode of action	Group Name Structure Toxicity/Mode of action	Group Name Structure Toxicity/Mode of action
Type 2 Pyrethroids	Deltamethrin		Deltamethrin's mode of action is thought to be mainly central in action, or at least originate in higher nerve centers of the brain. Death of insects seems to be due to reversible damage to the nervous system occurring when poisoning lasts more than a few hours.
	Cypermethrin		The major target site of cypermethrin is the sodium channel of the nerve membrane. A sodium channel exposed to cypermethrin can remain open much longer, even up to several seconds (He, 1989)

EFFECTS ON BEHAVIOUR:

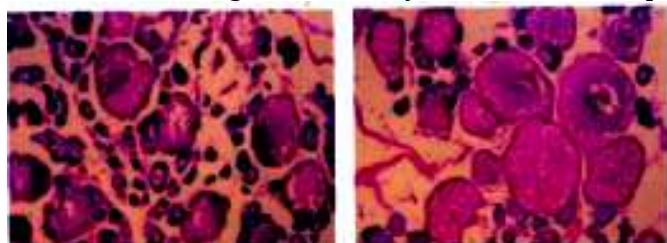
In normal condition fish behave in a natural manner, They are active with well coordinated movements, give response to any slightest disturbance, but in the toxic environment fishes exhibit irregular, erratic and darting swimming movements and they loss equilibrium. They slowly became lethargic, hyper excited, restless and they secrete excess mucus all over their bodies. Opercular movements increase initially in all exposure periods but decreased later steadily in the lethal as compared to sub lethal exposure periods. Gulping air at the surface, swimming on the water surface, disrupted shoaling behaviour is found on the first day itself in the lethal and sub-lethal exposure period and continued throughout the test tenures. Finally the

fish settle down to the bottom of aquarium and died with their mouths open [6]. The acute test for a long time has been a major component in a toxicity testing. In which acute chemical toxicity is determined as a 96 hour LC₅₀ value however the environmental significance of death of individuals after short term exposure to high concentration is questionable. In contrast to this the actual results shows cypermethrin is very toxic even at lower concentration (0.06 µl/L) for 96 hour LC₅₀. Lethality in the present study is compare with the few previously published studies that exist but that LC₅₀s for all species exceeded this concentration. This can be attributed to the inability of the *Labeo rohita* to withstand and metabolize the cypermethrin intoxication. The acute toxicity treatments showed strong negative effects on survival as pesticide concentration increased. This suggests that survival is dose-dependent survival and lethality is concentration graded. The varying degree of mortality reported in this study is consistent with the report of David et al. [7], who reported that differences in an organisms biological adjustment and behaviour response to change in water chemistry. Changed behavioural responses can be taken as index of the stress felt in the fish exposed to cypermethrin by which they try to reduce excess entry of cypermethrin present in the medium or minimize damage to their body tissues. Similar behavioural changes were also observed in guppy fish *Poecilia reticulata*, after exposure to cypermethrin. This occurs because it inhibits the Acetylcholineesterase activity, leading to accumulation of acetylcholine in the cholinergic synapses, leading to hyper stimulation. Mucus secretion in fish forms a barrier between body and toxic media. Thereby probably reduces contact with the toxicant so as to minimize its irritating effect, or to eliminate it through epidermal mucus. Similar observations made by Rao et al. [8] and Parma De Croux et al. [9] in *Prochilodus lineatus* under monocrotophos stress. Opercular movements increased initially in all exposure period but decreased later steadily in lethal compared to sublethal exposure periods. The increased opercular gill movements observed initially may possibly compensate for increased physiological activity under stressful conditions. In sub lethal exposure fish's body became lean towards the abdomen position compared to normal fish and they are found to be under stress, but is not fatal. Leanness in fish indicates a reduced amount of dietary protein consumed by the fish under pyrethroids pesticide stress which is immedietly utilized and not stored as body mass [6].

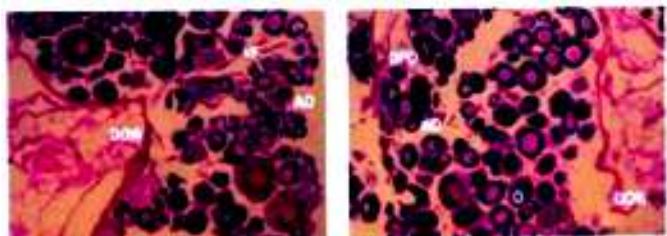
EFFECTS ON FISH REPRODUCTION:

The survival of fish population guarantees by reproduction of fish. Any changes in environmental parameters or physiological conditions of fish can affect its reproductive success. Fishes may be exposed to environmental pollutants, including insecticides, herbicides, heavy metals and other xenobiotics, disorders may occur in their natural reproductive process. Researches showed the disfunction in the reproductive systems of fishes exposed to insecticides. Insecticides effects on reproductive biology of fishes are numerous, and include decreased fecundity, testicular and ovarian histological damage vitellogenesis process impairment and disruption in steroid genesis process delay in gonads maturation impairment in olfactory response and disorder in reproductive migrations as well as disruption in coordinating courtship behavior of male and female fish and time of spawning. Adverse effects of these insecticides on the hypothalamus-pituitary-gonads axis can also play a significant role in causing reproductive failures in fish [10]. In fishes, chronic toxicity can change sex steroid hormone levels in plasma. Due to insecticides and their metabolites disrupt reproductive systems through activation or inhibition of key enzymes which participated in the steroid hormone biosynthesis in fishes. Impact of Insecticides can also cause adverse effects on gonad histology, morphology and its growth. In addition, there are significant relationships between blood sex steroid hormone concentrations, sperm or oocytes quality, rate of fecundity and histopathological alterations in ovary (Figure 1) and testis of fish exposed to different insecticides. Banaee et al. [11] reported that diazinon inhibits steroidogenesis in testis of male carp by histopatological alterations. Research results showed that direct toxic effects of insecticides on seminiferous tubules or Leydig cells may be the most important parameter for the low quality of sperms in fish [10]. Fresh water fish *channa striatus* exposed to sublethal concentration of cypermethrin showed flabbyed and degenerative ovarian follicles.It showed

degeneration and necrosis in oocytic cells. Also showed shrinkage and interfollicular oedema in oocyte. The yolk of oocyte cells showed damage and rupture member of oocyte. Stromal hemorrhage were observed as compared to normal fish ovary. Treated fish ovary showed atretic oocyte, irregular shaped of oocyte. Also showed floating of contents due to rupture of cell membrane, so vacuole formed at the center of oocyte. The ovarian follicle rupture, ooplasm of the ovarian cells was disorganized. The stromal hemorrhage clearly observed. Primary and secondary growth of oocyte was highly effected due to this pesticides. Atretic oocyte membranes of degenerated oocyte were observed [12]

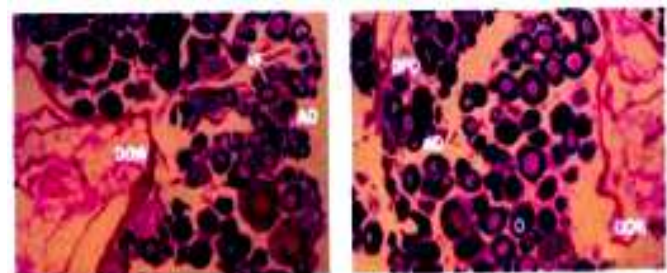


a.



b. [24 Hours]

b. [72 Hours]



c. [72 Hours]

c. [96 Hours]

BO: BREAKAGE OOCYTE
YFO: YOLK FLOATS OUT SIDE
OPD: OOPLASM DISRUPT
DMC: DISRUPT OF MATURE
FOLLICLE
V:
VACULATION

AO: AYRETIC OOCYTE
DOM: DISORGANISED
MEMBRANE
VF: VACUOLE
FORMATION
DOW:
DISORGANISED OVARIAN WAY
O: ODEMA

Figure: 1. a. Ovary of control *Channa striatus*; b., c. Effect of sublethal concentration of cypermethrin exposed to fresh water fish *Channa striatus* at different hours [12].

CONCLUSION

Toxicological problems resulting from the widespread use of pesticides in agriculture have raised concerns. Pesticide toxicity of the pyrethroids deltamethrin, cypermethrin in fish has been studied by several workers who have shown that at chronic level, it causes diverse effects on behaviour and reproduction of fish. With reports of toxicants usage and its adverse effects on non-target organisms like fish, it has become necessary to formulate strict rules against indiscriminate use of this pesticide. Since pesticide is present in the environment with other similar organophosphate compounds, additive responses to organophosphate compounds may induce lethal or sublethal effects in fish. It is, therefore, a matter of great public health significance to regularly monitor the pesticide residues in foods and humans in order to assess the population exposure to this pesticide. For safe use of pesticide more experimental work should be performed to determine the concentration and time of exposure that do not harm the fish and other higher animal community..

ACKNOWLEDGEMENT

Thanks to my teacher HOD, Dept.of Zoology, Sidho-Kanho-Birsha University, Purulia to encourage me and providing all necessary facilities for conducting this study.

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