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Research Article

EFFECT OF DELTAMETHRIN ON TIME COURSE (OXYGEN CONSUMPTION) IN FRESH WATER TELEOST FISH *LABEO ROHITA* (HAMILTON)

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ABSTRACT

Indiscriminate and wide use of pesticides to wipe out pests, careless handling, accidental spillage of pesticides and pesticides released from manufacturing industrial units are carried by wind or percolate through water and finally washed down and find their way into water bodies, would equally affect non-target organisms like fish, which represent an important component of aquatic life and serves as a staple food for human beings. Hence, it is felt necessary to conduct toxicological studies which indicates the sequence of events in physiological and biochemical systems providing information on the nature and completion of compensatory mechanisms during toxic stress. The present investigation is aimed at estimating impact of Deltamethrin on Time course in the Indian major carp *Labeo rohita.* In the present study in relation to control the time course in rate of oxygen consumption initially elevated at 24hrs and declined thereafter at 7 and 15 days of exposure periods. Further towards the end of the 30th day exposure there was a rise in oxygen consumption from its early maximum suppression and came nearer to the control.

Keywords: Pesticides, Water bodies, Fish, Deltamethrin, *Labeo rohita*, Oxygen consumption.

INTRODUCTION

Pesticides have prevented untold misery in many countries, through the control of disease carrying insects and other diseases (WHO official record, 1971) and contributed immensely to boost the agricultural production and protected households against damaging beetles, moths and other bugs. Generally, they have provided a higher quality of life for man. Modern agricultural practices even though contributed to enhance crop production also widely polluted aquatic environment (Pandey *et al.,* 2000) and also leads to the problems like pest resistance, higher cost of cultivation and ecological imbalance. The widespread use of pesticides in agriculture has detrimental effects on lakes and rivers due to surface runoff from fields, posing risks to both animals and humans owing to their ability to bioaccumulate and disrupt the food chain (Lushchak *et al.,* 2018; Bodnar *et al.,* 2022). Fish, is the integral part of freshwater and marine ecosystems, as they play a crucial role in maintaining ecological balance (Okwuosa *et al*., 2019). Due to their agility and relatively long lifespan, fish are considered good bioindicator of long-term toxic effects and various habitat conditions (Falfushynska *et al.,* 2014; Falfushynska *et al.,* 2019). Certain reports suggest that few teleost and zebra fish species exhibit metabolic traits resembling those of humans, making them potential alternative animal model for mechanistic research into cellular events triggered by physical and chemical stimuli (Hahn and Sadler, 2020).

Insecticides such as pyrethroids are the synthetic analogs of naturally occurring pyrethrins from the flowers of Chrysanthemum species. These are considered as effective insecticides due to their high insecticidal toxicity with low mammalian toxicity (Elliott *et al.,* 1974). Synthetic pyrethroids, including the newly synthesized insecticide called Cypermethrin & Deltamethrin, are types of pesticide that has been widely used. The use of these insecticides has raised concerns as they not only affect target pests but also affect the biology of non-target species (Elliot and Janes, 1978; Reddy and Yellamma, 1991). Particularly, they are highly toxic to fish and aquatic invertebrates even at very

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low concentrations. This enhanced toxicity has notable consequences on the health of ecosystems and their biodiversity (Madara Ranatunga *et al.,* 2023). The physiological status of an animal would be appropriately assessed by the rate of oxygen consumption. Environmental stress differs from one to divided another. The environmental stress including pollution stress, mainly divided into two categories. Immediate or short-term responses in which abrupt rise or fall in the respiratory activity and other one the long term responses which involve a gradual stabilization of respiratory rate. The stabilized respiratory rate results as consequence of prolonged exposure of the animal to the pollution stress (Bashamohideen and Kunnemann, 1978) which provides information on the nature and the completion of adaptation of the animal to the stress medium, with changes that are generally recoverable in their nature.

Alternations in the rate of oxygen consumption serve as a very good indicator of pollution stress. Fish has the capacity to adapt to the pollution's, this is supported by various evidences in literature available in that a conceptional model of the possible effects of pesticides and other poisonous substances as proposed by John Couch as biological systems (Duke and Dumas, 1974). The capacity of a fish population to compensate for the effect of a pesticide malathion were demonstrated by Coppage and Duke (1972). The detoxifying enzymes of the microsomes from liver and gills in the air breathing cat fish Clarias batrachus were enhanced during sublethal exposure of malathion after 30 days (Mukhopadyay and Dehadri, 1978). Increased resistance to lethal ammonia level was shown by the Salmo gairdneri were demonstrated by Llyed and Orr (1969). The rate of oxygen consumption is a very sensitive indicator of pesticide pollution. Great deal of work has been turned out on these lines of approach during the past few years with reference to lethal and sublethal concentrations of pesticides in marine organisms including fishes (Vernberg and Vernberg, 1972; Vernberg *et al.,* 1978). Much work has been carried out on time course studies with reference to Pesticides (Indira, 1985; Obilesu, 1985; Prasad, 1986; Ramanadevi, 1987; Nisar Ahamed, 1994; Giridhar, 1997). No further attempt has been made in economically important edible fish *Labeo rohita* on time course studies of sublethal of exposure of Deltamethrin which indicate events leading to compensatory mechanisms. Studies should be carried out to determine acceptable levels of water pollution that would facilitate long term exposure of the fish fauna which accounts major aquatic population.

MATERIAL AND METHODS

Animal Selected

The Indian major carp, *Labeo rohita* (Hamilton) is an economically important edible fish having great commercial value. It is abundantly available in the fresh water tanks in and around Ananthapuramu. Besides its wide availability and commercial importance, this carp is known to have adaptability to laboratory conditions and appear to be suitable experimental animal for toxicity studies (Sreenivasan and Swaminath, 1967; Nair and Sherief, 1998). Hence, this fish has been selected as the ideal animal for the present investigation of toxicity studies.

Pesticide Selected

The pesticide selected for the present investigation is synthetic pyrethroid Deltamethrin, belonging to "third generation pesticides". widely used in and around Anantapur district on diverse agriculture crops to control pests of crops, flies and mosquitoes. It has been widely used because of its high photostability, degradability, non-persistent nature and low mammalian toxicity. Deltamethrin has commercial name Decis. The commercial grade Deltamethrin (EC 2.8%) of liquid formulation was procured from local agrochemical stores.

Experimental design

Fresh water fish *Labeo rohita*, weighing 10±2 gm were procured from local fisheries department and stored in spacious aquaria. The temperature in aquaria was 28 ± 2 °C and the same is maintained as normal temperature throughout the course of this investigation. The fish were fed daily with groundnut cake as well as with rice bran. Before the experiments have been executed the fish were adapted to the laboratory conditions for a period of one week. After determination of LC 50/96 hrs (00.1µg/lt), the fish were exposed to sublethal concentration of Deltamethrin (1/10th of LC50/96hrs i.e. 0.01 µg/lt) for five exposure periods i.e 1, 7, 15, 20 and 30 day.

Pesticide Exposure-Time Course of Oxygen Consumption

The time course in the rate of oxygen consumption (O2/ml/hr) was measured by the improved Winkler's method as developed by Bashamohideen and Kunnemann (1978).

RESULTS AND DISCUSSION

The data for time course in the rate of the oxygen consumption of individuals of *Labeo rohita* during exposure to the sublethal concentration of Deltamethrin besides control are presented (table 1). For comparison, the differences in the rate of oxygen consumption obtained between the controls and experimentals were converted as percentages of the corresponding control and these percent values are also presented in the same table and plotted against exposure periods in figure. The percent recovery in the rate of oxygen consumption is calculated in relation to the rate of oxygen consumption in the control medium which is fixed at 100%. In the major carp, *Labeo rohita* in relation to control the time course in rate of oxygen consumption initially elevated at 24hrs and declined thereafter at 7 and 15 days of exposure periods. Hence, the percent suppression in oxygen consumption was progressive at 7th day and reached maximum percent

suppression (P<0.001) at 15-day exposure period. Further towards the end of the 30th day exposure there was a rise in oxygen consumption from its early maximum suppression and came nearer to the control, thus this major carp exhibited a fairly good amount of recovery in its oxygen consumption at the end of 30 days' exposure period. The vital physiological parameter that is generally used for assessing the metabolism of an animal is respiration. The physiological status of an animal would appropriately assess by the rate of oxygen consumption. The first physiological activity to be affected is oxygen consumption in the aquatic animals. The variations in the oxygen consumption can be accounted for the modulation in the metabolic status of animal (Natrajan, 1981; Bashamohideen, 1985). The uptake of oxygen rate is invariably considered as a good index for overall physiological activity and an indicator of physiological stress of the animal.

In the present investigation, the time course in the rate of oxygen consumption of *Labeo rohita* during sublethal 30-day exposure period of Deltamethrin has been studied. The rate of oxygen consumption initially elevated at 24 hr period from its level in the control during sublethal exposure in Labeo rohita. The suppression in oxygen consumption of the fish in further sublethal exposure was seen through 7-day period and it reached maximal percent suppression at 15-day exposure of total 30-day exposure period. The inhibition of oxygen consumption is seen from 7-day sublethal exposure period onwards. The initial elevation in the oxygen consumption at 24 hr exposure period is due to increased locomotor activity arising out of the animal tendency to escape from the new medium which is a stress medium and this situation is called "Escape reaction" of the animal as suggested by Potts (1954), Grass (1957), Bashamohideen and Parvatheswara Rao (1972). Similar trend in the time course in the rate of oxygen consumption reported in *Catla catla* exposed to sublethal concentration of Deltamethrin (Nisar Ahmed, 1994), in *Catla catla* exposed to sublethal concentration of fenvalerate (Shah Nawaz, 1996), in *Labeo rohita* exposed to sublethal concentration of Nuvan (Giridhar, 1997), in Cyprinus carpio exposed to malathion (Latha Charles, 2000), were coincides with the present trend in the rate of oxygen consumption. Inhibition of oxygen consumption was seen in *Labeo rohita* through 7-day exposure period, thus recorded maximum percent suppression at 15-day exposure period. But, during the 30-day exposure period the oxygen consumption gradually elevated from its earlier maximal percent inhibition at 15-day period. Hence, the suppression in oxygen consumption was removed and the fish has recovered from the toxic effects of Deltamethrin towards the end of 30 day period and the oxygen consumption came nearer to the control medium, indicating that these fishes have the capacity to compensate to pollution stress, resulting due to sublethal Deltamethrin exposure, most probably by enhancing the activation of detoxifying enzymes which bring about the biodegradation of synthetic pyrethroid Deltamethrin on the whole, these findings on the time course of oxygen consumption i.e., the rate of oxygen consumption of the fish during sublethal exposure of Deltamethrin could be attributed ultimately to the compensating mechanisms proposed by John Cough in his conceptional model (Duke and Dumas, 1974), where a pesticide could be considered to have an adverse effect if it temporarilyor permanently altered the normal steady state of a particular biological system to such a degree as to render the homeostatic (compensatory mechanisms) incapable of maintaining an acceptable altered steady state. Thus in the present study, Deltamethrin could cause a physiological system, oxygen consumption of *Labeo rohita* oscillate outside its normal range of variations mostly suppressive, yet with time, the oxygen consumption could return near to normal state without suffering lasting effects of a pesticide in a fish population and this was suggested by Coppage and Duke (1972) where, the AChE activity returned to normal within 40 days after application of pesticide.

Table 1. Time Course of the rate of Oxygen consumption (Oml/gm/hr) in *Labeo rohita* exposed to sublethal concentration of Deltamethrin for a period of 30 days besides in control medium (fresh water without Deltamethrin). Each point is a mean of six individual measurements.

	Control	Exposure Period in Days				
		1	2	3	4	5
Mean	0.3212	0.4510	0.4326	0.4418	0.4188	0.3812
SD±		0.0512	0.0464	0.0170	0.0812	0.0420
		6	7	8	9	10
		0.3614	0.3412	0.3166	0.3102	0.3093
		0.0452	0.0550	0.0170	0.0312	0.0231
		11	12	13	14	15
		0.2908	0.2780	0.2612	0.2568	0.2468
		0.0714	0.0622	0.0654	0.0516	0.0482
		16	17	18	19	20
		0.2516	0.2552	0.2610	0.2626	0.2662
		0.0402	0.0388	0.0652	0.0608	0.0466
		21	22	23	24	25

0.2670	0.2710	0.2764	0.2660	0.2612
0.0820	0.0890	0.0758	0.0720	0.0470
26	27	28	29	30
0.2692	0.2716	0.2758	0.2770	0.2782
0.0374	0.0852	0.0712	0.0428	0.0466

CONCLUSION

The vital physiological parameter that is generally used for assessing the metabolism of an animal is respiration. The first physiological activity to be affected is oxygen consumption in the aquatic animals. The uptake of oxygen rate is invariably considered as a good index for overall physiological activity and an indicator of physiological stress of the animal to the imposed toxicity. The variation in oxygen consumption can be accounted for the modulation in the metabolic status of animal.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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