

## ACUTE TOXICITY AND BEHAVIORAL RESPONSE OF THE FOOD FISH *CHANNA PUNCTATUS* (BLOCH) TO AN INSECTICIDE DICHLORVOS

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### ABSTRACT

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Dichlorvos is an organophosphate insecticide and highly toxic pollutant, which adversely affects the fauna of aquatic ecosystems. The aim of the present study was to assess the acute toxicity of Dichlorvos on food fish *Channa punctatus*. The fishes were exposed to different concentrations of Dichlorvos to determine LC<sub>50</sub> values for 96 h and to study their behavioral alterations. The test fishes exhibited erratic swimming, decreased rate of opercular movement, copious mucous secretion, increased surfacing and inability to balance with increasing exposure time.

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### INTRODUCTION

Insecticides are manufactured chemicals employed routinely in the integrated farming practice to protect the crops and animals from insect weeds and diseases. Water pollution by pesticides is a serious problem to all aquatic fauna and flora and also to a considerable extent to man (Ayoola, 2008). Dichlorvos or 2,2-dichlorovinyl dimethyl phosphate is a highly volatile organophosphate, widely used as an insecticide. The United States Environmental Protection Agency first considered a ban on DDVP in 1981. Since then it has been close to being banned on several occasions, but continues to be available. Major concerns are over acute and chronic toxicity. The acute toxicity of Dichlorvos to freshwater fish has been studied in fathead minnow, carp, Japanese killifish, guppy, bluegill, and trout.

The 96-day LC<sub>50</sub> values of these species ranged from 0.17 to 11.1 mg/L. Of the studies with a flow-through or semi-static system and those with estimation based on measured concentrations, the lowest value was 0.340 mg/L in carp (Verma *et al.*, 1981). In marine fish, the acute toxicity of Dichlorvos to sheep head minnow, Atlantic silverside, striped mullet and Atlantic herring has been reported. The lowest 96-day LC<sub>50</sub> was 0.122 mg/L in Atlantic herring (McHenery *et al.*, 1991). The long-term toxicity of Dichlorvos has been reported in toxicity studies of early life stage from fertilized eggs to hatches in fathead minnow and Japanese killifish. The 28-day NOEC for growth of larval fish was 0.070 mg/L in fathead minnow (Brooke, 1991) and the 40-day NOEC for death and growth was 0.375 mg/L in larva of Japanese killifish (MOE/Japan, 2002).

## MATERIAL AND METHODS

The fresh water fish, *Channa punctatus* was collected from local fish market and washed with 0.5% KMnO<sub>4</sub> Solution to prevent it from infection and kept in an aquarium of capacity 20 litres, for acclimatization under laboratory conditions for 2 weeks. During this period fishes were fed with rice bran mixed with mustard oil cake. Water was renewed on alternate days to maintain water quality. After two weeks of acclimatization fishes were exposed to different concentrations of Dichlorvos. Stock solution of 1mg/mL Dichlorvos was prepared in absolute alcohol. Fishes of similar sizes (15 ± 5 cm) and weight (± 160.25 g.m.) were sorted out and separated into 5 groups of 20 fish each. They were exposed to 0.5, 0.1, 0.15 and 0.2 mg/L of Dichlorvos in 20 litre glass aquaria. To determine LC<sub>50</sub> values for 24, 48, 72, 96 hours, four replicates were taken from each groups along with a control run simultaneously. During this period no feed was administered to fish (Reish, 1987). Mortality in each group was recorded and dead fish were removed. Fish mortality was analyzed by Probit analysis Finney. Behavioral responses of fishes were noted during first 6h and at 24, 48, 72, 96h after exposure.

## RESULTS AND DISCUSSION

Within a few minutes of exposure, vigorous swimming across the aquarium was observed along with disruption in schooling behavior. Within 1-2 h of exposure they calmed down and started swimming slowly. While, surfacing frequency and gulping of surface water with occasional coughing was increased remarkably in exposed fishes.

Opercula movement was observed to decrease with increasing concentration of the toxicant. The exposed fishes exhibited heavy mucous secretion along with imbalance in posture and loss of equilibrium. Finally they succumbed to the toxicant with mouth and operculum wide open and body slime covered. At lower concentrations, however changes in behavior were not as conspicuous. The fish secreted copious mucus in order to neutralize the adverse effects of a large amount of the toxicant. Irregular erectand darting swimming movements, hyper excitability, loss of equilibrium and sinking to bottom were also observed. It is generally known that organophosphorous compounds induce neurotoxicity. Ataxia and a reduction in neurotoxic esterase (NTE) activity were reported (Aldridge and Johnson, 1971; Johnson, 1978). In contrast, several studies showed no delayed neurotoxicity in oral and dermal administration studies of dichlorvos in female chickens (Aldridge and Barnes, 1966; Aldridge and Johnson, 1971; Durham *et al.*, 1956; Johnson, 1969, 1975a, b, 1978, 1981; Lotti and Johnson, 1978). Acute effects of dichlorvos in humans are weakness due to severe anemia and a severe reduction in plasma cholinesterase activity in patients who were given dichlo-

**Table 1.** Percent mortality during the exposure to different concentrations of Dichlorvos

Sr. No.	Treat-ment	No of fish taken	% Mortality after exposure to toxicant			
			24 H	48 H	72 H	96 H
1.	CON	20	00	00	00	00
2.	0.5 mg/L	20	30%	40%	20%	10%
3.	1 mg/L	20	045%	50%	5%	-----
4.	1.5 mg/L	20	65%	35%	-----	-----
5.	2 mg/L	20	100 %	-----	-----	-----



**Fig. 1** Erratic swimming



**Fig. 2** Rapid movement

**Table 2.** Behavioral changes in *C.punctatus* in response to different concentrations of Dichlorvos

Duration of Exposure	Behaviour AI Changes			
	0.5 Mg/L	1 Mg/L	1.5 Mg/L	2 Mg/L
24	Surface movement, erratic swimming	Move towards surface	Movement very fast, Surfacing, loss of equilibrium	Heavy mucous secretion, erratic swimming, increased opercula movement, fins spread .
48	Fishes collected on one side of the glass tank, increased rate of opercular movement.	Heavy mucous secretion	Heavy mucous secretion, eyes bulging, slow movement, erect posture	.....
72	Increased rate of opercular movement	Movement very slow, heavy mucous secretion.	.....	.....
96	Movement very slow, inactive stop feeding		.....	.....

rvos as anthelmintic at doses of 6 to 12 mg/kg. Severe toxic symptoms (anticholinergic symptoms) and delayed neurotoxicity (axonal degeneration neuropathy) were observed in high-dose patients. A worker was exposed to Dichlorvos on the skin during pest control and developed dizziness, dyspnea and weakness. Chronic and short-term effects are effects on the gastrointestinal tract and central nervous system associated with the reduction in cholinesterase activity induced by repeated dose of 8 to 32 mg/kg/day for 2 to 7 days. In the plant workers who were exposed to Dichlorvos by inhalation for a long period showed a reduction in plasma cholinesterase activity immediately after the initiation of exposure.

The behavioural and morphological changes observed in the present work, may be due to the inhibition of acetylcholinesterase activity. Irregular, erratic and darting swimming movements, hyper excitability, loss of equilibrium and hitting to the walls of the test tank before finally sinking to the bottom just before death all reveal neurotoxicity. Increased mucus secretion may be considered a protective method to counter the irritating effect of the toxicant.

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