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Evaluation of sub-lethal and lethal concentrations of endosulfan to the fresh water fish *Channa punctatus* and its effects on respiratory system

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Abstract

The sub-lethal and lethal concentrations of endosulfan and its effect on the respiratory system of *Channa punctatus*, a freshwater fish that serves as rich proteinacious diet of people in southern India,was studied. The experiment revealed that 0.8 ml of endosulfan/l of water was found to be a sub-lethal concentration (LC_0) up to 120 h and 2.4 ml was lethal (LC_{100}) in 24 h. During the experiment, the fish showed responses such as erratic swimming with jerky movements and attempt to escape from the toxic medium. Opercular movement, an indicator of respiratory rate, was found increased with increasing concentration of endosulfan.

Key words: Endosulfan, organochlorine pesticide effect, *Channa punctatus*

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INTRODUCTION

W ater pollution is a serious problem ever since sewage and industrial effluents are disposed into water sources. Addition of pollutants changes the natural quality of the water. Modern agriculture and industrial activities although increased food production and economy, also caused adverse impact by leaving the pesticides and heavy metals residues into the aquatic ecosystem (Ongley 1996). Most of the pesticide chemicals used in agriculture, horticulture and veterinary fields become highly toxic to many non-target organisms, as they are let into freshwater in biologically significant amounts (Holden 1972, Ozkara *et al*. 2016). Use of pesticide is increasing ever since the Green Revolution took place in India. According to a report submitted to Government of India by Surber (1967), 67,000 metric tones of various pesticides were used in India during 1964–65, and this amount rose to more than two lakh metric tones in 1968–69. Currently, over hundred different pesticides are used in India, of which 44 are indigenously manufactured and the rest imported from countries like UK, USA, West Germany, Switzerland, Sweden and Japan. In USA, the annual production of pesticide has raised from 300 million pounds in 1954 to over 1200 million in 1973. Today there are about 1,000 pesticides and chemicals are in common use around the world, of which about 250 are used for agriculture purposes and India uses around ~53000 tons annually (2017 usage – h ttps://ourworldindata.org/pesticides #pesticide-production-by-type).

Studies show that pesticides change the physiological, biochemical and behavioural activities of a quatic organisms (Mazeaud *et al*. 1977, Holden 1972, 1973) and also cause depression of photosynthesis in planktons. Fish represent higher trophic level in the aquatic food chain. Therefore, persistence of the use of toxic chemicals leads to increased concentration in their bodies when compared to other organisms in the aquatic environment (Mazeaud *et al*. 1977). Further, pesticides through the food chain also affect higher vertebrates like birds and mammals. Inland fisheries that contribute nearly 50% of the annual fish production of India, is an important rural economic activity providing employment to over 1.75 million people. Fishes are the cheep and important source of proteinaceous diet in India. A thorough understanding of the effects of pesticides on fish would be more rewarding for fish conservation and fisheries management (Holden 1972).

Pesticides are broadly classified into two groups – organophosphorus and organochlorine; both are highly toxic insecticide to living organisms. Endosulfan is an organochloride pesticide, is widely used and is effective against soil insects and

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microorganisms; it is also toxic to fish (Cremlyn 1978). The toxicity of endosulfan on survival rate and impairment of various organisms has been extensively studied (Sinha and Shafi 1982, Prasad and Shafi 1987). Nevertheless, very meager information is available about the effect of endosulfan on the freshwater fish *Channa punctatus*. This paper describes the toxic impact of endosulfan on *C. punctatus* by determining the lethal and sub-lethal concentrations and its effect on the respiratory system.

MATERIAL AND METHODS

Samples of *C. punctatus* (weighing about 2–4 g; length 5–7.3 cm) were collected alive from local fish market and acclimated to the laboratory condition for 15 days. The fish were kept in the aquaria and fed daily *ad libitum* diet of chopped earthworm pieces. The unfed food remains were collected and the medium changed once in two days.

The experiments were devised following the methods of Doudoroft *et al. (*1951) to determine the degree of toxicity of the endosulfan as the mortality of *C. punctatus* was observed within 120 h. A batch of 10 individuals were introduced separately in 12 plastic troughs, each having a capacity about 10 l, containing different concentrations of endosulfan ranging from 0.2 to 2.4 ml/l of water, with a class interval of 0.2 ml/l of water. The oxygen consumption of experimental animal was estimated by Winkler's method (Welch 1948). The opercular movement was calculated per minute with the help of stopwatch.

RESULTS AND DISCUSSION

The average percentage of mortality of *C. punctatus* exposed to different concentrations of endosulfan for different periods is presented in Table 1. The LC_{50}/120 h and LC_{100}/120 h. The LC_{50} concentration of endosulfan pesticide varied from organisms to organisms and is also time dependent. According to Mani and Sexena (1985) time taken for LC_{50} value for freshwater fish *Sarotherodon mossambicaus* varied with concentrations; for example the LC_{50} values for 1, 6, 12, 18, 24, 48, 72, 96 and 120 h of exposure period was observed to be , 0.0500, 0.0460, 0.0367, 0.0330, 0.0286, 0.0228, 0.0210, 0.0175 and 0.0155 ml/l of concentrations, respectively. Similarly, Bharathydasan (1988) reported that for *Esmous dandricus* the Lc_{50} values were 0.00305, 0.00293, 0.00248, 0.00222, 0.00988, 0.00142, 0.00134 and 0.0013 ml of endosulfan /l. respectively in 6, 12, 18, 24, 48, 72, 96 and 120 h., respectively. These differences in the values of LC_{50} are attributed to the differences in assay technique, purity of pesticides, size and age of the experimental specimens (Sandor *et al.*, 1983), nutrient (Arunachalam *et al.,* 1989) and the chemical nature (Maruthanayagem and Sharmila 2001) of the test solution of water.However, the same pesticide action may differ. from species to species and for the same species for various kinds of chemicals and pesticides. For example, Prasad and Shafi (1989) reported the LC_{50}/96 h and LC_{100}/98 h concentration of the endosulfan was as 1.4 ml/l and 2.0 ml/l, respectively, for the experimental fish *Lepiedocephalus guntea* (Prasad and Shafi, 1989). Similarly, Prasad and Shafi (1989) have earlier reported that1.5 ml/l and 1.8 ml/l of phenolic waste as Lc_{50}/96 h and Lc_{100}/96 h doses, respectively, for *L. guntea.* Variation in the Lc_{50} values for the same species with various kinds of chemical and pesticides was reported in many investigations. Maruthanayagam *et al.* (2000) reported that the *C. punctatus* exposed to detergent had LC_{50} valuse of 0.4 % and LC_{100} value of 0.7% for 24 h.

In the present study, opercular movement was observed to increase from 134.4/minute to 210.3/minute with increase in endosulfan concentrations (Table 2). It was 134.4/ minute in water without pesticide and increased to 154.6, 185.4 and 210.3/m in endosulfan concentrations of 0.6, 0.8, and 1.0 ml/l, respectively (Table 2). Increase in opercular beats when exposed

Table 1. Percentage mortality of fresh water fish *Channa Punctatus* exposed to different levels of endosulfan pesticide concentrations recorded in the study

Endosulfan concentration (ml/l)	Period of exposure (hours)					
	12	24	48	72	96	120
0.8	0	0	0	0	0	0
1	0	0	0	0	0	0
1.2	0	0	0	2	2.5	4
1.4	3.4	7.5	10	12	14	15
1.6	7.5	13	17	20	22	25
1.8	10	25	33	46	49	52.4
2	13.4	35	42	54	63	63.2
2.2	40	54	63	70	72	84
2.4	57	75	90	100	100	100

Table 2. Opercular movement and O_2 consumption of freshwater fish *C. punctatus* with different concentrations

Endosulfan concentration (ml/l)	Opercular movement	O_2 consumption (ml/O_2/g/h)
0	134.4	2
0.6	154.6	1.3
0.8	185.4	1
1	210.3	0.8
1.2	245.4	0.6

to chemical substances has been recorded earlier for *Channa striatus* (Baskaran and Palanichamy, 1990). In the present study, the rate of O_2 consumption in endosulfan-treated fish decreased with increase in concentration. The decreased O_2 intake may be due to injury caused to red blood cells as reported by Ganapathi and Alikunhi (1950). Hingorani *et al*. (1979) have reported that toxic chemicals present in the pollutants interfered with respiration by coagulation of gill and inhibition of enzyme system at mitochondrial levels resulting in the reduction of O_2 consumption. Similar findings have also been also reported in *Oreochromis mossambiccus* exposed to industrial effluents (David and Ray, 1966) in freshwater prawn *Macrobrachium lamarrei* exposed to tannery effluents (Maruthanayagam *et al*., 1996) and in *C. striatus* exposed to pesticides (Reddy and Gomathi, 1977). Sukumar and Karpagaganapathy (1988) suggested that pesticides cause tissue hypoxia and de-arrangement of metabolic functions, which results in death of the animal. It is thus suggested that pesticide as a waste and industrial effluent should not be allowed to be released into the adjoining water bodies of aquatic ecosystem to check pollution hazards and for conservation of valuable aquatic biota.

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