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Acute Lethal Toxicity and Behavioural Effects of DDT (Dichlorodiphenyltrichloroethane) on the Freshwater Fish *Channa gachua* (Hamilton, 1822)

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Abstract: Dichlorodiphenyltrichloroethane commonly known as DDT, is a colorless, tasteless, and almost odorless crystalline chemical compound. DDT is a non-degradable polymer, in aquatic ecosystem it affects on aquatic biota by entering in the food chain. It causes biological magnification. *Channa gachua* were exposed to different concentration doses (0.1- 0.4 mg/l) of DDT for a period of 96 h with four observations (24, 48, 72 and 96h). The result revealed different mortality rate which ranged from 0 to 100% at various doses of concentration, suggesting that mortality rate fully depends on insecticide dose and time. Result shows that the mortality rate of the fish had gone higher (50% in 24 h to 100% in 96 h at the dose of 0.4 mg/l) with the increase of exposed duration doses of DDT. Lower doses up to 0.1 mg/l had 50% mortality at 96 h. The fish showed typical changes in behavioural i.e. opercular movement against DDT at different doses.

Keywords: DDT, *Channa gachua*, LC_{50}, LC_{90}, Behaviour, Toxicity

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Introduction

Human population is being increasing rapidly in the recent green revolution era. Simultaneously forests have been used for adopting construction and agricultural purposes that deteriorating environmental balance (Hussain *et al*., 2002). Agrochemicals, also known as pesticides include nematicides, molluscicides, rodenticides, herbicides, fungicides and insecticides, can control pests, weeds, fungi, rodents, etc. The use of agrochemicals is essential for controlling pests and increasing food production for the universal population (Al-Mamun, 2017). The accumulation of pesticides in the food chain and water has harmful effects on humans and animals

(Amenyogbe *et al*., 2021).

There is a growing hazard to human wellbeing, includes chronic respiratory disease, damage to organs (e.g., brain, lung, heart, liver and kidneys) and algal bloom in many water bodies, are some of the pesticidal effects (Al-Mamun, 2017). Globally, serious concerns have been raised about the existence of these toxic chemicals in both aquatic and terrestrial environments and ecosystems (Alrumman *et al*., 2016). The existence of several agrochemicals popularly known as pesticides in water bodies such as dams, lakes, streams, and rivers generates a multifarious exposure of these chemicals hypothetically poisonous to aquatic organisms (Covert *et al*., 2020). World Health Organization (WHO) reported that approximately 300,000 people died per annum as a result of pesticide poisoning (Gunnell and Eddleston, 2003). This happened as a result of inhalations or consumption of pesticides by a person above the threshold via accident or occupation (Sharma *et al*., 2020). Pesticide poisoning occurs as a result of relatively ignorance or unawareness of detrimental effects via inhalation of these chemicals by people. On the other hand, work-related poisoning known as occupational poisoning occurs as a result of the usage of these chemicals in the field of agriculture, manufacturing industries by the people in their daily activities (Gangemi *et al*., 2016).

The entrance of pesticides into aquatic environments has many implications. Fish are affected directly or indirectly by the use of pesticides. The vulnerable parts of fish to chemical exposure are liver, kidney, brain and gills (Mahmood *et al*., 2016). The extensive usage of pesticides has several implications, such as bioaccumulation, genotoxicity, the immune system effects, protein effects, chromosomal effects, behavioral effects, enzymes effects, growth and changes in blood biochemical parameters of humans and other organisms.

Dichlorodiphenyltrichloroethane (DDT), is an organo-chloride which is a colorless, tasteless, and almost odorless crystalline chemical compound, . DDT is a non degradable polymer, in aquatic ecosystem it affects on aquatic biota by entering in the food chain. It causes biological magnification. Water sources, such as rivers, ponds, etc., hold pesticides at the bottom, planktons mostly collect the pesticidal residues, which are transferred to fish and other invertebrates (Pereira *et al*., 2013; Tulgar, 2018). DDT are circulating in the biosphere and concentration also increasing in living body through biological magnification.

Since DDT is one of the most effective insecticidal toxicity and is harmful in physiological activities of the aquatic organisms including fish and also effect on human body through food chain, it is most essential to investigate the effects of DDT on locally available fishes and their behavior and mortality. Therefore, to understand the toxic effect on mortality and behaviour of DDT, a freshwater fish *Channa gachua* which is available in the wetlands of Kokrajhar, Assam, India is taken for the present study.

Materials and Methods

Experimental species:

In the present study, *Channa gachua* (12-16 cm length; 24-30 g body weight) were used. Healthy fishes were collected from the local wetlands of the Kokrajhar district. Collected fishes were reared in glass aquarium in the laboratory of Zoology Department, Science College, Kokrajhar.

LC_{50} and LC_{90} Determination:

LC_{50} is that concentration of a toxicant at which 50% of the test animal is killed in a specified time and in LC_{90} also 90% population is killed due to toxicant. To determine LC_{50} and LC_{90} of DDT (toxicant) for *Channa gachua* following procedure was adopted:

Collected fishes were maintained in 6 glass aquaria arranged in a line on the laboratory table and then marked them as I, II, III, IV, and V. Then aquaria were filled up with 8 liters of tap water. Then toxicant is added at the rate of 0.1 mg/l, 0.2 mg/l, 0.3 mg/l, and 0.4 mg/l, in aquaria marked

Table 1: Mortality rate of *Channa gachua* in different concentration of DDT

Aquarium No.	No. of test animals (*Channa gachua*)	Concentration of toxicant (DDT) in mg/l	Mortality during							
			24 h		48 h		72 h		96 h	
			No.	%	No.	%	No.	%	No.	%
I	10	Control	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
II	10	0.1	1	10	2	20	3	30	5	50
III	10	0.2	2	20	3	25	5	50	7	70
IV	10	0.3	4	40	6	50	7	70	9	90
V	10	0.4	5	50	7	70	9	90	10	100

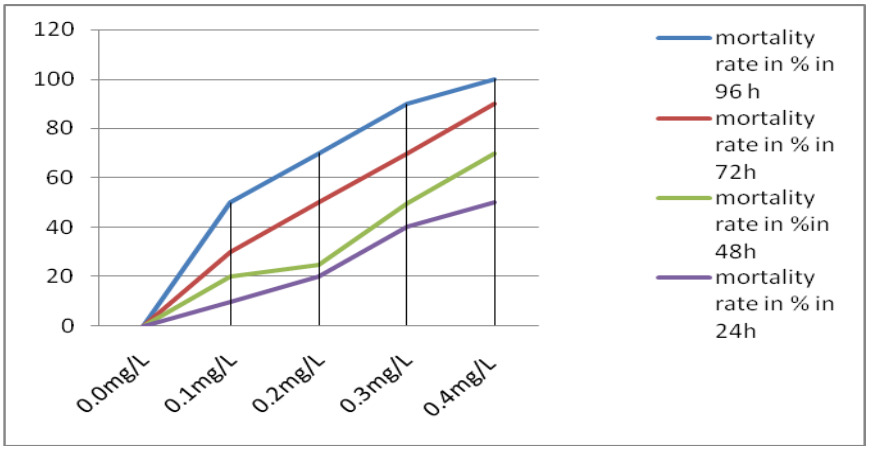

Fig. 1: LC_{50} and LC_{90} of *Channa gachua* at different concentration of DDT.

number II, III ,IV , and V, respectively. Aquarium number I was not added with toxicant and used as as control while other aquaria were experimental ones. Then 10 fishes were released in each aquarium including the control and observed mortality at 24, 48, 72 and 96 h. LC_{50} and LC_{90} were analyzed by cumulative curve.

Opercular movement:

In the present study behavioural response refers to the opercular movement, related to the mechanism of respiration of *Channa gachua* when it is subjected to different doses of DDT. Five glass troughs were taken to study the opercular movements of the fish under the different doses of DDT and arrange them in line mark, then number I, II, III, IV and V. Filled the trough with 8 liters of tap water separately. Then 0.1 mg/l, 0.2 mg/l, 0.3 mg/l, and 0.4 mg/l of DDT was added in trough numbers II, III, IV and V, respectively. Trough number I is not added with any amount of DDT, hence, it is the control trough. To restrict the movement of fish in the troughs, kept some cotton in each trough. Then released one fish in each trough including the control. With the help of stop watch, observed the opercular movements of the fish in these troughs per minute and keep the record.

Results

Mortality rate:

Channa gachua were exposed to different concentrations (0.1- 0.4 mg/l) of DDT for a period of 96 h with four observations (24, 48, 72 and 96 h). The result of different observation revealed different mortality rate ranged from 0 to 100% in various doses of concentration, suggesting that mortality rate fully depends on insecticide dose and time. The cumulative mortality of *Channa gachua* is presented in Table 1 and Figure 1. Result

Table 2: LC_{50} and LC_{90} of DDT for *Channa gachua* at different duration

Hours	LC_{50} mg/l	LC_{90} mg/l
24	0.4	00
48	0.27	00
72	0.2	0.4
96	0.1	0.3

Table 3: Opercular movement of *Channa gachua* at different concentration of DDT

Trough No.	Doses of DDT in mg/l	Opercular movement			Average opercular movement/minute
		First minute	Second minute	Third minute	
I	Control	72	70	76	73
II	0.1	69	70	71	70
III	0.2	69	68	67	68
IV	0.3	67	66	66	66
V	0.4	62	60	59	60

showed that the mortality rate of the fish had gone higher (50% at 24 h to 100% at 96 h at the dose of 0.4 mg/l) with the increase of exposed duration doses of DDT. Lower doses up to 0.1 mg/l had 50% mortality at 96 h.

Lethal Concentration:

The LC_{50} and LC_{90} values at different duration are given in Table 2 and Figure 1. In the present study LC_{50} for *Channa gachua* was recorded as 0.4 mg/l, 0.27 mg/l, 0.2 mg/l and 0.1 mg/l at 24 h, 48 h, 72 h and 96 h, respectively. The actual value of LC_{50} and LC_{90} were found from the cumulative frequency curve (Fig. 1).

Behavioural Study:

The fish showed typical changes in behavioural i.e. opercular movement against DDT at different doses (Table 3). Opercular movement of normal condition was 72 per minute which decreases with the increased doses of DDT (0.1-0.4 mg/l).

Discussion

The present study showed the mortality rate of *Channa gachua* increased with the increase of concentration of DDT. The result of the present study showed that 10%, 20%, 30% and 50% of *Channa gachua* died in 0.1 mg/l at 24 h, 48 h, 72 h and 96 h, respectively. 20%, 30%, 50% and 70% fishes died at 24 h, 48 h, 72 h and 96 h, respectively in 0.2 mg/l dose. In 0.3 mg/l dose of DDT 40%, 60%, 70% and 90% species of *Channa gachua* died at 24 h, 48 h, 72 h and 96 h, respectively. 50%, 70%, 90%, and 100% fishes died at 24 h, 48 h, 72 h and 96 h in 0.4 mg/l concentration of DDT. A similar trend of mortality was observed by Islam *et al*. (2019) on *Labeo rohita* exposed to Malathion.

Salwa (2008) conducted an experiment on toxicity of DDT and its impact on the activity of acetylcholinesterase in different tissues of grass carp, *Ctenopharyngodon idella*. They reported that the acute toxicity (LC_{50} values) were 3.73 mg/l, 2.84 mg/l, 2.44 mg/l and 2.14 mg/l at 24 h, 48 h, 72 h, and 96 h, respectively. They also reported that fishes showed typical changes in behaviour with various concentration including progressive lethargicity, loss of equilibrium, difficulty in respiration, exhibited convulsions, dashing against the wall of the test aquaria and bottom settling before death. Rauf (2015) exposed malathion to Indian carp (*Cirrhinus mrigala*) and reported LC_{50} values at 1 h, 24 h, 48 h, 72 h and 96 h as 14.55

mg/l, 12.48 mg/l, 11.56 mg/l, 10.85 mg/l and 9.32 mg/l, respectively. In the present study LC_{50} for *Channa gachua* was recorded as 0.4 mg/l, 0.27 mg/l, 0.2 mg/l and 0.1 mg/l at 24 h, 48 h, 72 h and 96 h, respectively.

Conclusion

DDT is an insecticide used in India mainly to kill mosquito's larva. This used DDT when drained by rain water it mix with many water resources like rivers, ponds, beels, flooded lands, paddy fields etc. Then it enters in food chain of aquatic ecosystem and cause biological magnification. The present study was done only to analyze toxicity of DDT on fish which is considered as our one of the most nutritional diet. DDT has strong lethal effect on fish and also in behavior. Therefore, DDT a non-degradable insecticide should not be used near fish culture water reservoirs.

Ethical Statement

The authors confirm that all ethical issues have been dealt with the research ethics guidelines provided by the Department of Zoology, Science College, Kokrajhar, Assam 783370, India.

Author Contributions

Each author has contributed equally to the study's planning, analysis, writing, and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflicts of interest.

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