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Mortality of *Cirrhinus mrigala* exposed to different concentration of Sevin and Furadan

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Abstract- In the present study, during bio-assay tests, the percent mortality decreased and survival of the fish (*Cirrhinus mrigala*) decreased with an increase in the concentration of both the pesticides i.e. Sevin & Furadan (Carbofuran) as the fish exposed to lowest concentration of both pesticides showed a comparatively less reaction than that of the fish exposed to higher concentrations, while in highest concentration of both pesticides, rapid rate of mortality observed during the present study, might be due to their hyper-activeness and/or due to injury in some vital organs or due to some metabolic changes in the fish. The fish exposed to different concentrations of both pesticides showed abnormal behaviour depended on the concentration & exposure periods as hyper activeness & restlessness, vigorous swimming on the water surface, trying to jump out loss of equilibrium, uncoordinated movements followed by abnormal posture & swimming on one side, coma followed by mucus formation & death.

Key words: Mortality, *Cirrhinus mrigala*, Sevin, Furaden.

INTRODUCTION

For the last few years both organophosphate & Carbamate pesticides are used in place of organochloride pesticide and the carbamates are latest arrival in the field of cholinesterases pesticides. As present many new carbamate based pesticides are still in process of being marketed. These pesticides are least toxic than that of organophosphates and also bio-degradable in general, carbamate pesticide are synthetic derivative of phycostigmine the principle alkaloids of the plant, *Physostigma venenosum* with rapid degradability nature. The most common and widely used carbamate pesticide is carbaryl under the trade name of Sevin. It has low mammalian toxicity as an acute Le_{50} in rats is of 500-700 mg/kg body weight; whereas, the second, carbofuran with trade name of Fumdan ranks number two in U.S. list of carbamates to highly toxic with an acute oral Le_{50} value in rate of 5mg/kg body weight, These are powerful anticholinesterase agent. Operhuizen *et al.*, (1985)[1], Rao (1989)[2], Rao *et al.*, (2003)[3], Vineet Kumar *et al.*, (2008)[4] studied about lethality of different pesticides on fishes.

The aim of the present work is to study mortality/ survival rate of in an important fresh water teleostean fishes exposed to Pesticide- Sevin and Furadan for different duration and in different concentrations in male and female fishes. Besides an attempt was also made to correlate the effect of each pesticide on changes with their mode of life.

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MATERIALS AND METHOD

Collected fishes were bathed for 15 minutes in 0.1 % aqueous potassium permanganate solution, followed by at least three wash in fresh ground water and then acclimatized for ten days in large aquaria/plastic tanks containing ground water in the laboratory. During this period, fish were provided artificial food prepared in the laboratory by following procedure at least three hours prior to change of ground water daily.

Stock solution of both Sevin & Furadan was prepared individually. A known amount of pesticides was first dissolved in minimum amount of Acetone (separately). The required concentrations were prepared by adding suitable aliquot of stock solution to ground water in a plastic tank/ drum & finally transferred to test tanks. Acetone was used as a solvent since it is known to be non toxic up to 1,0 ml/ 1 concentration, whereas, the minimum amount of acetone in any concentration of the pesticides during this experiment was not more than 0.8 ml/l even in highest concentrations of the pesticides solution.

The total mortality at 24, 48, 72 & 96 hr. of exposure in each concentration of both pesticides were recorded. It is pertinent to mention here that the bioassay test of Sevin and Furadan was done on different days i.e. a gap between them was of ten days.

The percent mortality and probit kill of the fish in different concentrations of Sevin and Furadan were analysed by probit analysis method.

Probit analysis method: - In this method, percent mortality values are transformed in to probits with the help of "Probit table" and are plotted as ordinate.

RESULT AND DISCUSSION

It is known that when a pesticide or any pollutant is introduced into the environment there is a reasonable chance that it will ultimately finds its way in to the surrounding aqua-systems. Hence, aquatic system represents one of the most important complex environment as far as describing the fate & behaviour of the pollutants. Zooplanktons, comprising a large portion of living matter in natural waters, play an important role in biogeochemical cycles. Perhaps, these planktons can accumulate the toxicants at a higher level and at the same time, being primary consumers, they are assumed to be important organisms transferring such accumulated toxicants to higher trophic levels especially to fishes.

It is well known from the works of Doudoroff & Katz (1953)[5] & Khangarot & Ray (1987)[6] that the physico-chemical properties of water have a definite role on the toxicity of heavy metals, but their effect on the toxicity of pesticides is relatively little known. Lloyd & Herbert (1962)[7] have reported an increase in the toxicity of pesticide at higher temperature due to their metabolic rates. The resistance capacity of a fish to poison varies greatly between the individuals of the same species as larger fish have comparatively more tolerance power than the smaller fish of the same species (Weiss & Botts, 1957)[8]. Further, Larson *et al.* (1977)[9] have stated that the resistance capacity of a fish to poison is depended on various factors like species, age, size, sex, life-cycle stages and metabolism.

Fishes were first explored by small scale exploratory bioassay test (APHA 1985)[10]. Then the logarithmic series of the doses were used to prepare various concentrations of the pesticides with the concentration factor of 1.25. Accordingly, ten fish (in each concentrations with control) were exposed to nine concentrations of Sevin ranged in between 10.0 mg/1 to 59.6 mg/1 and nine concentrations of Furadan ranging in between 6.0 mg/1 to 35.7 mg/1. The whole experiments along with controls were repeated to see the changes if any.

As no mortality was observed in controls, the data were not subjected to Abott's formula. The fish, which showed no respiratory movements & not responding prodding with a glass rod, were recorded dead and removed immediately as delay may affect tolerance limit of other alive fishes. Accordingly, the mortality of the fish in each concentrations were observed at three to four hours of interval upto 24 hrs & three or four times from 24 to 96 hr. The total mortality at 24, 48, 72 & 96 hr. of exposure in each concentrations of both pesticides were recovered and presented in Tables-1 and 2.

The toxicity of the chemicals is normally classified in to extremely toxic (1mg/kg body wt.) highly toxic (1 to 50 mg/kg body wt.), slightly toxic (0.5 to 5 gm/kg body wt.) and relatively harmless (more than 15 gm/kg body wt.). Further, several reports have appeared suggesting that, biocides have caused significant changes in metabolic process of fish (Vutukuru, 2005; Singh *et al.*, 2009)[11,12].

Table-1. Mortality of *Cirrhinus mrigala* exposed to different concentrations of Sevin at 24, 48, 72 and 96 hrs. exposure (expressed in both percentage and Probit kill after Finney, (1981)

Concentration (mg/l)	Log value of concentration	No. of fish exposed	Fish Mortality									
			24 hr.					48 hr.				
			No. of survival	No. killed	% survival	% kill	Probit kill	No. survival	No. killed	% survival	% kill	Probit kill
CONTROL	-	10	10	0	100	0	-	10	0	100	0	-
10	1	10	10	0	100	0	-	10	0	100	0	_
12.5	1.097	10	10	0	100	0	-	10	0	100	0	-
15.6	1.193	10	10	0	100	0	-	10	0	100	0	-
19.5	1.29	10	10	0	100	0	-	10	0	100	0	-
24.4	1.387	10	10	0	100	0	-	9	1	90	10	3.7184
30.5	1.484	10	9	1	90	10	3.7184	7	3	70	30	4.4756
38.1	1.581	10	6	4	60	40	4.7467	4	6	40	60	5.2533
47.7	1.678	10	3	7	30	70	5.5244	1	9	10	90	6.2816
59.6	1.775	10	0	10	0	100	8.719	0	10	0	100	8.719
Concentration factor = 1.25												
			72 hr.					96 hr.				
Control	-	10	10	0	100	0	-	10	0	100	0	-
10	1	10	10	0	100	0	-	10	0	100	0	-
12.5	1.097	10	10	0	100	0	-	9	1	90	10	3.7184
15.6	1.193	10	10	0	100	0	-	7	3	70	30	4 4756
19.5	1.29	10	9	1	90	10	3.7184	4	6	40	60	52533
24.4	1.387	10	6	4	60	40	4.7467	1	9	10	90	6 2816
30.5	1.484	10	2	8	20	80	5.8416	0	10	0	100	8719
38.1	1.581	10	0	10	0	100	8.719	-	-	-	-	-
47.7	1.678	10	-	-	-	-	-	-	-	-	-	-
59.6	1.775	10	-	-	-	-	-	-	-	-	-	-
Concentration factor = 1.25												

Average weight of the Fish: 50±3 gm Temp. 25.3±2.7°

Table-2. Mortality of *Cirrhinus mrigala* exposed to different concentrations of Furadan at 24, 48, 72 and 96 hrs. exposure (expressed in both percentage and Probit kill after Finney, (1981)

Concentration (mg/l)	Log value of concentration	No. of fish exposed	Fish Mortality									
			24 hr,					48 hr.				
			No. of survival	No. killed	% survival	% kill	Probit kill	No. survival	No. killed	% survival	% kill	Probit kill
CONTROL	-	10	10	0	100	0	-	10	0	100	0	-
10	0.778	10	10	0	100	0	-	10	0	100	0	-
12.5	0.875	10	10	0	100	0	-	10	0	100	0	.
15.6	0.973	10	10	0	100	0	-	10	0	100	0	-
19.5	1.068	10	10	0	100	0	-	10	0	100	0	-
24.4	1.164	10	10	0	100	0	-	-	1	90	10	3.7184
30.5	1.262	10	9	1	90	10	3.7184	6	4	60	40	4.4756
38.1	1.36	10	7	3	70	30	4.4756	2	8	20	80	5.5244
47.7	1.456	10	3	7	30	70	5.5244	0	10	0	100	8.719
59.6	1.553	10	0	10	0	100	8.719	-	-	-	-	-
Concentration factor = 1.25												
			72 hr.					96 hr.				
Control	-	10	10	0	100	0	-	10	0	100	0	-
10	0.778	10	10	0	100	0	-	10	0	100	0	-
12.5	0.875	10	10	0	100	0	-	9	1	90	10	3.7184
15.6	0.973	10	10	0	100	0	-	7	3	70	30	4.4756
19.5	1.068	10	9	1	90	10	3.7184	4	6	40	60	5.2533
24.4	1.164	10	7	3	70	30	4.4756	1	9		90	6.2816
30.5	1.262	10	3	7	30	70	5.5244	0	10	0	100	8.719
38.1	1.36	10	0	10	0	100	8.719	-	-	-	-	-
47.7	1.456	10	-	-	-	-	-	-	-	-	-	-
59.6	1.553	10	-	-	-	-	*	-	-	-	-	-
Concentration factor = 1.25												

Average weight of the Fish: 50±3 gm Temp. 25.3±2.7°

The fish showed characteristic changes in their behaviours such as increasing restlessness, hyper activities, vigorous swimming to the water surface and jumping to out from the toxicant solutions, loss of equilibrium, uncoordinated movements followed by abnormal postures & swimming on one side, coma & death. In few fishes stretched operculum and hemorrhages were also found in the eyes in the fish exposed to higher concentrations of Furadan. The body surface of the fish were comparatively more slimy due to mucus formation and just prior to death, the whole body surface including gill surfaces were covered by mucus secretion, thus obstructing the diffusion capacity of gills; which might be one of the most important factors of death.

Frequent surfacing, jumping & faster opercular movement/frequency were observed in all the fish exposed to higher concentrations of both the pesticides at the beginning, followed by a rapid decline during later stages and prior to death.

Further, the abnormal behaviour of the fish exposed to different concentrations of both Sevin & Furadan, such as increasing restlessness, vigorous swimming on the water surface & jumping outside, hyperactiveness, loss of equilibrium, uncoordinated movements followed by abnormal postures & swimming on one side, coma followed by death, are in agreement with the findings of several workers using various pesticides (Singh *et al.*, 2009, Gupta, 2004; Kumar *et al.,* 2006,)[12-14]. However, in few fishes exposed to highest / higher concentrations of furadan, stretched operculum and haemorrhages were also recorded.

The toxicity of pesticides based on various forms of Carbamates for fish varies widely as indicated by earlier data (Kumari, 1990)[15]. The 24 hr LC_{50} value of sevin has been reported to be 1.75 ppm for Longnose Killifish & 4.25 ppm for white mullet (Butler, 1963)[16] and 6.7 ppm for three-spine stickleback (Steward *et al.* 1967)[17].

Fish are the most important inhabitants of the aquatic ecosystem both-marine & freshwater in nature. They form one of the most important groups of vertebrates, which influence the human being in various ways. In developing countries like India, millions of people suffer from malnutrition & protein deficiencies. Fish not only provides protein-rich diet & economical source of food, but also provide a measure source to tide over nutritional deficiencies as their flesh are rich in proteins, vitamins A and D1phosphorus, calcium and several other important elements. In addition, they also provide employment to millions of people all over the world who are engaged in fish culture, fishing, their transport, preservation &marketing. Their export also fetches valuable foreign exchange to the countries engaged in such practices.

The scientific development during the last thirty years or so, have not only provided welfare to the society, but are also responsible for the ecological imbalances, detrimental to living being. Due to rapid industrialization and adoption of new technologies in agriculture works related to many fold increase in the use of pesticides, heavy amounts of industrial effluents & pesticide- residues make their way to surrounding water bodies which ultimately disrupts various ecological balances including hydro-ecosystem. Thus, the Irish becomes one of the immediate targets of such pesticides as the fish are more sensitive to biological doses than that of other terrestrial animals.

CONCLUSION

The present investigation entitled, "Mortality of *Cirrhinus mrigala* exposed to different concentrations of Sevin and Furadan" was aimed to find out the impact of toxicity of Sevin and Furadan (Carbamate based pesticides) individually on the fish, *Cirrhinus mrigala* (Ham.) exposed to selected lethal & sublethal concentrations at different periods on the mortality/survival rate of this fish species.

The percent survival of the fish decreased with an increase in concentration of the pesticides and exposure period. The rapid rate of mortality observed, might be due to hyperactivities of the fish and formation of a film of coagulated mucus all over the body surface including gills just prior to death as it would interfere with the respiratory function by obstructing the gas diffusion pathways and/or injury to the gill tissues due to constant exposure of the pesticides.

Effect of Selvin and Furadan on the common Indian Teleostean fishes so as to further the bounds of knowledge in this field, and to make reliable information available to teachers, researchers and students alike.

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