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EFFECT OF DIFFERENT LEVELS OF ORGANOCARBAMATE INSECTICIDE (SEVIN 85 SP) ON FOUR LOCAL FISH SPECIES OF NORTHERN BANGLADESH

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ABSTRACT
To investigate the effect of organocarbamate insecticide (Sevin 85 SP) on four local freshwater fish species the experiment was conducted at Agricultural Chemistry Laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur during April to September 2016. Results showed that the limit of probit was increased with the increment of insecticide concentration and advancement of time for all fish species. The lethal concentration (LC_{50}) of Sevin 85 SP was 30.76 ppm, 29.33 ppm, 25.91 ppm and 23.88 ppm in *Anabas testudineus*, *Heteropneustes fossilis*, *Batasio tengana* and *Channa punctatus*, *respectively*. The results indicate that the Sevin 85 SP was more toxic to *Channa punctatus* while less toxic to *Anabas testudineus* as compared to other two fish species. Qualitative characters of water such as pH, temperature, electrical conductivity and total dissolved solids of the experimental water media were increased but the dissolved oxygen of that was reduced with the increment of insecticide concentration and exposure of time which also negatively affected the fish behaviours. Finally, it can be concluded that the treated fish species can be more affected by the recommended dose of Sevin 85 SP applied in the field as in this lower dose applied in the experiment they were seriously injured.

1. INTRODUCTION

Worldwide insecticide usage has increased dramatically during the past two decades, coinciding with changes in farming practices and increasingly intensive agriculture. Environmental pollution caused by insecticide, especially in aquatic ecosystems, has become a serious problem. The excessive use of these pesticides causes contamination or degradation of the aquatic environment and surrounding ecosystems. It also responsible to human's health hazard and their economic interests (Panigrahi *et al.* 2014). Contamination of water by insecticide, either directly or indirectly, can lead to fish kills, reduced fish productivity, or elevated concentrations of undesirable chemicals in edible fish tissue,

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which can affect the health of humans consuming these fish. Modern agricultural practices, even though contributed to enhancing the crop production, also widely polluted the aquatic environment (Pandey *et al.* 2000). Bangladesh is an over-populated country with its high growth rate. The country mainly depends on agricultural products to feed its people. So a large number of agro-chemicals and insecticides are used to enhance the agricultural production from a limited land to meet the demand of food grains for the country's ever-increasing population. In Bangladesh, more than 300 types of pesticides and insecticides are used for crop protection in agriculture (Uddin *et al*. 2016). By surface runoff and leaching these pesticides reach in the unrestricted agricultural areas like ponds and rivers which alters the physicochemical properties of water and is toxic to aquatic organism and cause deleterious effect or even death to the aquatic animal (Neelima *et al.* 2016). Carbamates are the newest and miscellaneous insecticides. Carbamate ester derivatives used as insecticides are decisive. Hydroxylation of carbamate group insecticides is very slow in acidic and alkali waters. Although carbamate group insecticides cannot remain in the environment for a long time and are not very resolved, they may accumulate in the fish since fish have a slow metabolism. In Bangladesh, up to 64 % of the crop-producing area is treated with carbamates and up to 35 % of the crop-producing area is treated with organophosphates. These substances can be transmitted to freshwater fish and ultimately contaminate the fish (Rahman 2000). The residual effects of insecticides damage most of the important organs viz. kidney, liver, gills, stomach, brain, muscles and genital organs. Sometimes this pollution may cause sudden death of fishes and other aquatic organisms (Rahman and Alam 1997). Keeping this view in mind, the investigation was conducted to know the toxicity level of sevin 85 SP on four local freshwater fish species and to predict the optimum dose of sevin 85 SP for the safety of fish population as well as other aquatic organisms.

2. MATERIALS AND METHODS

2.1 Location

The study was conducted in the Laboratory of Agricultural Chemistry Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh.

2.2 Experimental fish species

Four local fish species viz., Climbing perch (*Anabas testudineus*), Spotted snakehead (*Channa punctatus*, Stinging catfish (*Heteropneustes fossilis*), and *Tangra (Batasio tengana*) collected from unpolluted water body without any injury were selected for the study.

2.3 Collection of insecticides and preparation of test solution

Sevin 85 SP was collected from the authorized dealer of the insecticide in an original sealed container from Dinajpur, Bangladesh and requisite quantity of distilled water was added in order to prepare the desired concentration.

2.4 Fish bio-assay

Eighteen plastic dishes (60 cm × 30 cm × 30 cm) poured with 50 liters of tap water were used in the experiment. For each case, six concentrations (10, 30, 50, 70 and 80 ppm of Sevin 85 SP including a control) with three replications of a particular order were chalked out for definitive tests. In the test dishes desired concentrations of insecticides were poured carefully and mixed gently with a glass rod. Ten fishes of each species were released after proper acclimatization in dishes containing different concentrations of insecticides as well as in control. All tests were done at ambient temperature and the fishes were in starved condition. The behaviour and other external changes in the body of fishes were observed. Dead fishes were removed, and mortality was recorded at 6, 12, 24, 48, 72 and 96 hours of exposure time.

2.5 pH

pH of water sample was measured daily by a digital pH meter.

2.6 Temperature

The temperature of water sample was measured daily by an alcoholic centigrade thermometer with the range 0°C to 110°C.

2.7 Dissolved oxygen

The dissolved oxygen concentrations of the collected water samples were determined immediately by titration method following the Winkler's method (APHA 1976) and therafter, the dissolved oxygen was measured daily.

2.8 Electrical conductivity

The electrical conductivity values of water samples were measured daily by the conductivity bridge (Model 470 Cond meter, UK).

2.9 Total dissolved solids

To convert the electric conductivity of water sample (mS/cm^{-1}) into the relative concentration of total dissolved solids (ppm), the mS/cm^{-1} was multiplied by a conversion factor by using the formula, [Total dissolved solid (ppm) = Conductivity $\mu S/cm^{-1}$ x 0.67].

2.10 Probit analysis

The LC_{50} value for different fish species were calculated for 96 hours of exposure time by probit analysis using the computer program SPSS.

3. RESULTS AND DISCUSSIONS

3.1 General observation

There were no significant changes in the tested fish species under control condition. But with the increasing of the concentration of Sevin 85 SP certain physiological and biochemical processes of the fish species were negatively affected with the advancement of time. The negative effects might be due to insecticide entering into the vital organs of fishes with exposure of time. By the exposure of time the fishes became sluggish, settled at the bottom, opercular activities became slower, ultimately the fish became paralysed and died in increasing order at the higher concentrations of Sevin 85 SP. Some behavioural changes were also observed in the present study. The surfacing phenomenon of fish species observed under Sevin 85 SP at overall exposure. Normal behaviours were observed during the whole experiment under control and low concentration conditions. After 24 hours of exposure significant increase in hyperactivity in terms of surfacing and scraping moments and schooling were observed in fish species in Sevin 85 treated conditions compared to control. At 48h of exposure, the surfacing as well as scraping moments were decreased in fish species but other behaviors like hyper secretion of mucus, mouth opening for gasping, losing scales, hyper activity were significantly increased. After 72 hours of exposure, all the fishes showed decreased surfacing and jerky movements and increased grasping movements, sank to bottom of the test chamber and independency in swimming. Normal shiny color of test fishes was observed in the control groups, whereas the color became light grayish-black in an increasing order towards the higher concentrations at the end of 96 hours. Behavioral and biological responses included loss of reflex, air gulping, erratic swimming, discoloration, hemorrhage and molting were also observed by Ada *et al.* (2012).

Anitha *et al.* (2016) and Haque *et al.* (2018) also concluded that the fish showed uncontrolled behavior like mucus secretion, decreased agility and inability to maintain normal position and erradic swimming in exposure of time of the toxicant.

3.2 Probit analysis

The probit of *Anabas testudineus*, *Channa punctatus*, *Heteropneustes fossilis*, and *Batasio tengana* were different in different concentration i.e. the limits of probit were increased with the increasing rate of concentrations of Sevin 85 SP. In case of *Anabas testudineus* the lethal concentration (LC_{50}) of Sevin 85 SP was 30.76 ppm, where the lower limit was 20.78 ppm, and the upper limit was 40.48 ppm at 95% confidence limit (Table 1). In case of *Heteropneustes fossilis* the lethal concentration (LC_{50}) of Sevin 85 SP was 29.33 ppm where the lower limit was 19.85 ppm and upper limit was 38.50 ppm at 95% confidence limit (Table 2). In case of *Channa punctatus* the lethal concentration (LC_{50}) of Sevin 85 SP was 23.88 ppm, whereas the lower and upper limit was 14.05 and 33.41 ppm, respectively at 95% confidence limit (Table 3). Table 4 shows that the lethal concentration (LC_{50}) of Sevin 85 SP against *Batasio tengana* was 25.91 ppm with lower and upper limit 16.82 and 34.59 ppm, respectively at 95% confidence limit. Results indicate that, the LC_{50} value was gradually decreased with the advancement of time and the mortality rate was increased with the increasing in concentration of pesticide. Similar results were also observed by Karra *et al.* (2015) and Nikam *et al.* (2011).

Table 1. Probit analysis on the effect of Sevin 85 SP to *Anabas testudineus* at 96 hours of exposure

Concentration (ppm)	Log concentration	Number of Organism	Number of Organism dead	Percent kill	Probit	LC_{50} (ppm)	95% confidence Limit	
							Lower (ppm)	Upper (ppm)
00	-	10	00	00	-	30.76	20.78	40.48
10	1.00	10	01	10	3.72			
30	1.47	10	03	30	4.48			
50	1.69	10	07	70	5.52			
70	1.84	10	10	100	7.33			
80	1.90	10	10	100	7.33			

Intercept (a) = -5.722, Regression co-efficient (b) = 3.845, Heterogenicity (X^2) = 5.017 (Not significant)

Table 2. Probit analysis on the effect of Sevin 85 SP to *Heteropneustes fossilis* at 96 hours of exposure

Concentration (ppm)	Log concentration	Number of Organism	Number of Organism dead	Percent kill	Probit	LC_{50} (ppm)	95% confidence Limit	
							Lower (ppm)	Upper (ppm)
00	-	10	00	00	-	29.33	19.85	38.50
10	1.00	10	01	10	3.72			
30	1.47	10	03	30	4.48			
50	1.69	10	08	80	5.84			
70	1.84	10	10	100	7.33			
80	1.90	10	10	100	7.33			

Intercept (a) = -5.902, Regression co-efficient (b) = 4.022, Heterogenicity (X^2) = 4.682 (Not significant)

Table 3. Probit analysis on the effect of Sevin 85 SP to *Channa punctatus* at 96 hours of exposure

Concentration (ppm)	Log concentration	Number of Organism	Number of Organism dead	Percent kill	Probit	LC_{50} (ppm)	95% confidence Limit	
							Lower (ppm)	Upper (ppm)
00	-	10	00	00	-	23.88	14.05	33.41
10	1.00	10	02	20	4.16			
30	1.47	10	05	50	5.00			
50	1.69	10	07	70	5.52			
70	1.84	10	10	100	7.33			
80	1.90	10	10	100	7.33			

Intercept (a) = -4.102, Regression co-efficient (b) = 2.977, Heterogenicity (X^2) = 3.726 (Not significant)

Table 4. Probit analysis on the effect of Sevin 85 SP to *Batasio tengana* at 96 hours of exposure

Concentration (ppm)	Log concentration	Number of Organism	Number of Organism dead	Percent kill	Probit	LC_{50} (ppm)	95% confidence Limit	
							Lower (ppm)	Upper (ppm)
00	-	10	00	00	-	25.91	16.82	34.59
10	1.00	10	01	10	3.72			
30	1.47	10	05	50	5.00			
50	1.69	10	08	80	5.84			
70	1.84	10	10	100	7.33			
80	1.90	10	10	100	7.33			

Intercept (a) = -5.411, Regression co-efficient (b) = 3.828, Heterogenicity (X^2) = 1.898 (Not significant)

3.3 Water quality

Table 5 shows the water quality in case of *Anabas testudineus* against Sevin 85 SP. At control condition temperature, dissolved oxygen, pH, total dissolved solids and electrical conductivity of water were 30.35±0.04 °C, 6.59±0.05 ppm, 6.87±0.01, 192 mgL^{-1} and 322 µS cm^{-1}, respectively. In case of 10 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solids and electrical conductivity of water were 30.6±0.07 °C, 6.41±0.05 ppm, 6.66±0.02, 202 mgL^{-1} and 339 µS cm^{-1}, respectively on the other hand in case of 80 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solids and electrical conductivity of water were 30.81±0.10 °C, 6.08±0.03 ppm, 6.84±0.08, 210 mgL^{-1} and 350 µS cm^{-1}, respectively.

Table 6 shows the water quality in case of *Heteropneustes fossilis* against Sevin 85 SP. At control condition temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 27.69±0.11°C, 7.65±0.24 ppm, 6.87±0.01, 192 and 322 µS cm^{-1}, respectively. In case of 10 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 27.90±0.23 °C, 7.34±0.16 ppm, 6.35±0.08, 202 mgL^{-1} and 339 µS cm^{-1}, respectively on the other hand in case of 80 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 29.55±0.63 °C, 6.58±0.10 ppm, 6.83±0.10, 210 mgL^{-1} and 350 µS cm^{-1}, respectively.

Table 5. Water quality parameters of the test media (Sevin 85 SP) on *Anabas testudineus* during the experimental period

Concentration (ppm)	Temperature (°C)	Dissolved oxygen (ppm)	pH	Total dissolved solids (mgL^{-1})	Electrical conductivity (µScm^{-1})
00	30.35±0.04	6.59±0.05	6.87±0.01	192	322
10	30.6±0.07	6.41±0.05	6.66±0.02	202	339
30	30.6±0.06	6.34±0.04	6.72±0.05	205	342
50	30.68±0.06	6.29±0.05	6.76±0.09	206	344
70	30.76±0.04	6.21±0.06	6.79±0.02	208	348
80	30.81±0.10	6.08±0.03	6.84±0.08	210	350

Table 6. Water quality parameters of the test media (Sevin 85 SP) on *Heteropneustes fossilis* during the experimental period

Concentration (ppm)	Temperature (°C)	Dissolved oxygen (ppm)	pH	Total dissolved solids (mgL^{-1})	Electrical conductivity (µScm^{-1})
00	27.69±0.11	7.65±0.24	6.87±0.01	192	322
10	27.90±0.23	7.34±0.16	6.35±0.08	202	339
30	28.72±0.29	7.16±0.24	6.42±0.01	205	342
50	28.77±0.43	6.89±0.12	6.54±0.12	206	344
70	28.93±0.21	6.72±0.51	6.66±0.17	208	348
80	29.55±0.63	6.58±0.10	6.83±0.10	210	350

Table 7. Water quality parameters of the test media (Sevin 85 SP) on *Channa punctatus* during the experimental period

Concentration (ppm)	Temperature (°C)	Dissolved oxygen (ppm)	pH	Total dissolved solids (mgL^{-1})	Electrical conductivity (µScm^{-1})
00	28.9±0.07	6.70±0.01	6.87±0.01	192	322
10	27.9±0.03	6.54±0.06	6.45±0.11	202	339
30	28.72±0.09	6.51±0.04	6.52±0.09	205	342
50	28.77±0.03	6.39±0.09	6.63±0.02	206	344
70	28.83±0.01	6.32±0.06	6.74±0.07	208	348
80	28.95±0.11	6.29±0.10	6.92±0.03	210	350

Table 7 shows the water quality in case of *Channa punctatus* against Sevin 85 SP. At control condition temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were

28.9±0.07°C, 6.70±0.01 ppm, 6.87±0.01, 192 mgL^{-1} and 322µ S cm^{-1}, respectively. In case of 10 ppm of Sevin 85 SP, of water were 27.9±0.03°C, 6.54±0.06 ppm, 6.45±0.11, 202 mgL^{-1} and 339 µS cm^{-1}, respectively on the other hand in case of 80 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 28.95±0.11. °C, 6.29±0.10 ppm, 6.92±0.03, 210 mgL^{-1} and 350 µS cm^{-1}, respectively.

Table 8 shows the water quality in case of *Batasio tengana* in response to Sevin 85 SP. At control condition temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 28.5±0.42 °C, 6.55±0.15 ppm, 6.87±0.03, 192 mgL^{-1} and 322 µS cm^{-1}, respectively. In case of 10 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 29.6±0.55°C, 6.49±0.12 ppm, 6.75±0.08, 202 mgL^{-1} and 339 µS cm^{-1}, respectively on the other hand in case of 80 ppm of Sevin 85 SP, temperature, dissolved oxygen, pH, total dissolved solid and electrical conductivity of water were 30.71±0.30 °C, 6.24±0.23 ppm, 6.89±0.05, 210 mgL^{-1} and 350 µS cm^{-1}, respectively.

Table 8. Water quality parameters of the test media (Sevin 85 SP) on *Batasio tengana* during the experimental period

Concentration (ppm)	Temperature (ºC)	Dissolved oxygen (ppm)	pH	Total dissolved solids (mgL^{-1})	Electrical conductivity (µScm^{-1})
00	28.5±0.42	6.55±0.15	6.87±0.03	192	322
10	29.6±0.55	6.49±0.12	6.75±0.08	202	339
30	29.9±0.26	6.37±0.40	6.77±0.04	205	342
50	30.38±0.76	6.35±0.28	6.77±0.06	206	344
70	30.65±0.24	6.31±0.16	6.85±0.03	208	348
80	30.71±0.30	6.24±0.23	6.89±0.05	210	350

Temperature, pH, total dissolved solid and electrical conductivity were increased, while dissolved oxygen was reduced in all treated water medias for all fish species with the increasing of concentration of Sevin 85 SP and the advancement of time. The reduction of dissolved oxygen might be due to excessive used of dissolved oxygen by the fish species with the increasing concentration of pesticide and the advancement of time. Gavit and Patil (2016) also observed similar results. Ada *et al.* (2012) also concluded that dissolved oxygen content was reduced, while temperature and pH were increased with increasing of insecticide concentrations. The findings of the present study on water quality are also in a line with the findings of Haque *et al.* (2018). However, the water quality parameters of the test media varied little and were within the desirable range for four fish species.

4. CONCLUSIONS

The order of toxicity of Sevin 85 SP in response to four fish species was *Channa punctatus* > *Batasio tengana* > *Heteropneustes fossilis* > *Anabas testudineus.* Insecticide Sevin 85 SP is used at the rate of 3000 ppm (3000 mg L^{-1}) for 1 hectare of land as a recommended dose. In this experiment six treatments were used including a controlled dose, where the doses were lower than the recommended dose use in the field by farmers. So, it can be concluded that the treated fish species can be more affected by the recommended dose applied in the field as in these lower doses used in the experiment they were seriously injured.

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