

Effect of Cypermethrin, a Pyrethroid Compound on the Nutritive Value in a Freshwater Field Crab, *Spiralothelphusa hydrodroma* (herbst)

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Abstract: The fresh water field crab, *Spiralothelphusa hydrodroma* is an important human food source in parts of South India and the crab is constantly exposed to pesticides, which are used extensively to control agricultural pests. Evaluation of the toxic effect of cypermethrin on the experimental crab for the LC₅₀ value was carried out. Effect of cypermethrin on the quantitative study of nutritive value viz. protein, carbohydrate and lipid in ovary, spermatheca, hepatopancreas, muscle, gills, haemolymph, brain, thoracic ganglia and eyestalk was observed.

Key words: Protein, carbohydrate, lipid, LC₅₀, Cypermethrin, *Spiralothelphusa hydrodroma*

INTRODUCTION

The pesticides include insecticides, herbicides, fungicides, molluscicides and nematicides and heavy metals like copper, zinc, arsenic, lead, cadmium, mercury etc. These [7] pesticides are non-biodegradable and accumulate in the food chain. Mostly they are prone to affect the nervous system causing tumors in living organisms. They are not only neurotoxic but also affect other systems and have shown a high degree of impact on metabolism by altering the protein, carbohydrate and lipid [11, 14]. The trace metal concentration in Queensland estuarine crabs, *Australoplax tridentate* and *Scylla serrata* has been observed [12]. The present work was that the effect of cypermethrin on the nutritive value *Spiralothelphusa hydrodroma*.

MATERIALS AND METHODS

The fresh water field crabs were collected from, in and around the irrigating channels and paddy fields. The crabs were maintained in normal daylight illumination in the laboratory thereby providing normal acclimatization. The crabs were fed with uncooked oats. For all experiments, the crabs were used with carapace length ranging from 3 cm to 4.5 cm and breadth ranging

from 5 cm to 6.5 cm. The water level was maintained carefully so that the crabs were partially immersed. Acute toxicity study was carried out to determine the potency of cypermethrin for static but renewal type of bioassay was adopted in the present investigation to estimate the LC₅₀ values. The cypermethrin, commercial grade was used as the test material since only commercial preparation is used in agriculture. The experiment was carried out to find the range of concentrations for confirmatory evaluation. The mortality was recorded for the crab at 24 hr, 48 hr, 72 hr and 96 hr exposure to cypermethrin; were corrected for natural response by Abbott's formula [1]. The LC₅₀ values for 24 hr, 48 hr, 72 hr and 96 hr of exposure periods were estimated as 2.027, 1.698, 1.452 and 1.315 ppm respectively (Table: 1).

Design of Sublethal Toxic Study: Chronic time course study on the effect of cypermethrin on the crab was conducted by exposing to two sublethal, safe concentrations for 20 days and 40 days. According to [10, 17], 1/3rd and 1/10th of the 96 hr LC₅₀ value represent higher and lower sublethal concentrations respectively. Hence lower (0.1315 ppm) and higher (0.4383 ppm) sublethal concentrations of the insecticide were arbitrarily used. At the end of the treatment period, the control and treated crabs were dissected and the above said tissues were collected to analyse the nutritive value.

Table 1: The LC₅₀ values and regression equations for *S. hydrodroma* treated with cypermethrin

Exposure periods (hours)	LC50 (ppm)	Upper Confidence limits (ppm)	Lower Confidence limits (ppm)	Regression results	Slope function(SF)	r ²
24	2.027	2.561	1.739	Y = - 0.932 X + 0.468	2.973	0.99
48	1.698	1.938	1.345	Y = - 0.658 X + 0.281	3.265	0.98
72	1.452	1.883	1.136	Y = - 0.724 X + 0.391	4.121	0.99
96	1.315	1.763	1.118	Y = - 0.611 X + 0.324	4.973	0.99

Biochemical Analysis: Protein, Carbohydrate and Lipid estimations were studied following the techniques adopted^[2,4,22].

Statistical Analysis: One-way Analysis of Variance (ANOVA) was performed based on the methods of^[1].

RESULTS AND DISCUSSIONS

Effect of Cypermethrin on Protein: Data in Table 2 showed that the maximum decrease of protein content was observed in 40 days of treatment at both concentrations in all the tissues.

Effect of Cypermethrin on Carbohydrate: Maximum decrease of carbohydrate content was identified in 40 days of treatment at both the concentration in all tissues. The data was given in Table 3.

Effect of Cypermethrin on Lipid: The decrease in the lipid content was to the maximum in 40 days of treatment at both the concentration in all tissues as the data provided in Table 4.

The results obtained in the present study of the effect of cypermethrin, a pyrethroid compound on a fresh water crab, *Spiralothelphusa hydrodroma* at two different sublethal concentrations and two different

Table 2: Effect of sublethal concentrations of cypermethrin on protein content in different tissues of *S. hydrodroma*

Exposure period in days	Tissues	Control Mean ± SD	Lower sublethal concentration Mean ± SD	Higher sublethal concentration Mean ± SD	F-Value	P-Value
20	Ovary	84.25 ± 0.67	70.71 ± 2.07	67.83 ± 1.38	99.86**	<0.01
	Spermatheca	65.63 ± 0.77	63.65 ± 1.34	62.10 ± 1.08	28.11*	<0.05
	Hepatopancreas	70.15 ± 1.02	67.87 ± 1.78	64.27 ± 1.06	22.34*	<0.05
	Muscle	55.62 ± 0.78	52.83 ± 1.31	50.02 ± 1.17	36.28*	<0.05
	Gills	60.12 ± 1.27	56.76 ± 1.16	52.87 ± 1.32	49.72*	<0.05
	Haemolymph	85.11 ± 1.36	83.92 ± 1.27	81.16 ± 1.92	15.91*	<0.05
	Brain	63.41 ± 1.84	61.85 ± 1.42	58.08 ± 1.16	30.12*	<0.05
	Thoracic ganglia	63.15 ± 1.40	60.36 ± 1.89	56.77 ± 1.37	36.25*	<0.05
	Evestalk	25.31 ± 0.82	23.56 ± 2.71	19.74 ± 0.96	27.36*	<0.05
40	Ovary	84.98 ± 2.52	68.61 ± 1.21	63.11 ± 0.84	438.56**	<0.01
	Spermatheca	66.32 ± 0.46	62.75 ± 0.97	60.38 ± 1.29	54.18*	<0.05
	Hepatopancreas	70.56 ± 0.84	63.41 ± 1.21	61.82 ± 1.14	60.54*	<0.05
	Muscle	55.98 ± 0.57	51.72 ± 1.22	49.55 ± 0.93	71.26**	<0.01
	Gills	60.35 ± 1.12	52.38 ± 1.33	49.06 ± 0.61	96.42**	<0.01
	Haemolymph	85.42 ± 0.90	82.76 ± 1.17	78.52 ± 1.19	42.36*	<0.05
	Brain	63.76 ± 1.28	57.43 ± 0.79	55.27 ± 1.05	56.92*	<0.05
	Thoracic ganglia	63.52 ± 0.82	57.24 ± 0.58	53.83 ± 0.79	79.77**	<0.01
	Evestalk	25.99 ± 1.22	22.72 ± 1.01	18.61 ± 1.13	82.68**	<0.01

Mean ± SD of six individual observations.

Values are expressed mg/g wet tissue and mg/ml haemolymph.

** indicates significance at 0.01 level * indicates significance at 0.05 level

Table 3: Effect of sublethal concentrations of cypermethrin on carbohydrate content in different tissues of *S.hydrodroma*

Exposure period in days	Tissues	Control Mean \pm SD	Lower sublethal concentration Mean \pm SD	Higher sublethal concentration Mean \pm SD	F-Value	P-Value
20	Ovary	17.67 \pm 1.12	16.02 \pm 0.84	14.54 \pm 0.94	9.72*	<0.05
	Spermatheca	10.32 \pm 1.19	9.72 \pm 1.06	8.56 \pm 1.57	3.13*	<0.05
	Hepatopancreas	17.44 \pm 1.02	16.76 \pm 0.81	15.62 \pm 1.42	7.26*	<0.05
	Muscle	11.22 \pm 0.89	10.67 \pm 1.05	9.23 \pm 0.94	5.06*	<0.05
	Gills	9.71 \pm 0.57	9.03 \pm 0.60	8.25 \pm 0.53	6.94*	<0.05
	Haemolymph	8.11 \pm 0.64	7.71 \pm 0.95	7.02 \pm 0.62	5.03*	<0.05
	Brain	10.07 \pm 0.81	8.43 \pm 0.99	7.04 \pm 0.67	18.24**	<0.01
	Thoracic ganglia	12.63 \pm 0.96	11.32 \pm 0.85	10.48 \pm 0.78	20.42**	<0.01
	Eyestalk	4.15 \pm 0.91	3.69 \pm 0.74	2.75 \pm 0.44	3.76*	<0.05
40	Ovary	17.86 \pm 0.71	15.21 \pm 0.78	13.74 \pm 0.81	16.12**	<0.01
	Spermatheca	10.45 \pm 0.69	8.63 \pm 0.75	7.78 \pm 1.34	5.26*	<0.05
	Hepatopancreas	17.79 \pm 0.81	15.83 \pm 1.44	14.66 \pm 0.64	8.43*	<0.05
	Muscle	11.56 \pm 1.03	9.50 \pm 0.85	8.33 \pm 0.47	15.27**	<0.01
	Gills	9.90 \pm 0.94	8.35 \pm 0.81	7.34 \pm 0.67	21.23**	<0.01
	Haemolymph	8.40 \pm 0.66	7.06 \pm 0.44	6.04 \pm 1.07	10.15*	<0.05
	Brain	10.02 \pm 0.73	8.31 \pm 0.97	6.87 \pm 0.64	21.34**	<0.01
	Thoracic ganglia	12.31 \pm 0.80	10.17 \pm 0.74	9.36 \pm 0.79	20.78**	<0.01
	Eyestalk	4.04 \pm 0.77	3.43 \pm 0.50	2.56 \pm 0.64	4.76*	<0.05

Mean \pm SD of six individual observations.

Values are expressed mg/g wet tissue and mg/ml haemolymph.

** indicates significance at 0.01 level * indicates significance at 0.05 level

exposure periods showed interesting results. Biochemical investigations of protein, carbohydrate and lipid at lower (0.1315ppm) and higher (0.4383) sublethal concentrations of cypermethrin on the ovary, spermatheca, hepatopancreas, muscle, gill, haemolymph, brain, thoracic ganglia and eyestalk revealed highly fascinating informations and also study of bioaccumulation.

Proteins are important organic substances required in tissue building and repair. Under extreme stress conditions, protein supplies energy in metabolic pathways and biochemical reactions [32]. In all the experimental tissues such as ovary, spermatheca, hepatopancreas, muscle, gill, haemolymph, brain, thoracic ganglia and eyestalk the protein content was decreased. The decrease in protein content was drastic in higher (0.4383 ppm) sublethal concentration of cypermethrin for 40 days.

The decline in tissue protein content in a freshwater teleost *Tilapia mossambica* suggested intensive proteolysis in the tissues which contributes to the amino acids to be fed into TCA cycle [23]. [3] reported reduction in protein level and depletion of RNA suggested that RNAase activity was responsible for the depletion of

RNA and protein in *Channa punctatus*. [26] suggested the decline in protein level was due to decreased availability of energy required for protein synthesis. Decrease in protein level was observed in *Barytelphusa guerini* exposed to zinc sulphate [25] and chromium [21] and in *M.lamarrei* in response to copper [8]. The depletion of tissue protein was due to diversification of energy to meet the impending energy demand under toxic stress and altered enzyme activities [18,30]. [6] studied the effect of copper and mercury on *Rieteropneustes fossilis* and observed that the heavy metals reduced the food uptake and growth. [24] reported decrease in protein level in *M.malcomsonii* when exposed to endosulphan. Similarly, in the present investigation, the effects of lower (0.1315ppm) and higher (0.4383) sublethal concentrations of cypermethrin on the biochemical constituents namely protein, carbohydrate and lipid in different tissues of the treated crabs were analysed. In all the tissues namely ovary, spermatheca, hepatopancreas, muscle, gill, haemolymph, brain, thoracic ganglia and eyestalk the protein content decreased in cypermethrin treated crabs.

Table 4: Effect of sublethal concentrations of cypermethrin on lipid content in different tissues of *S.hydrodroma*

Exposure period in days	Tissues	Control Mean \pm SD	Lower sublethal concentration Mean \pm SD	Higher sublethal concentration Mean \pm SD	F-Value	P-Value
20	Ovary	83.96 \pm 1.15	81.78 \pm 1.54	77.24 \pm 1.51	12.17*	<0.05
	Spermatheca	32.12 \pm 0.56	30.35 \pm 1.07	24.83 \pm 0.96	168.81**	<0.01
	Hepatopancreas	90.88 \pm 1.08	85.45 \pm 1.41	69.39 \pm 0.87	574.71**	<0.01
	Muscle	13.21 \pm 1.06	12.42 \pm 1.32	8.07 \pm 0.94	41.92**	<0.01
	Gills	8.87 \pm 1.21	8.22 \pm 0.49	6.93 \pm 0.47	10.23*	<0.05
	Haemolymph	20.16 \pm 0.81	15.53 \pm 1.12	10.36 \pm 1.07	141.47**	<0.01
	Brain	27.36 \pm 1.16	21.08 \pm 1.09	17.28 \pm 1.22	98.94**	<0.01
	Thoracic ganglia	28.96 \pm 0.91	23.16 \pm 1.07	20.34 \pm 0.58	88.64**	<0.01
	Eyestalk	7.77 \pm 0.53	4.56 \pm 0.97	3.63 \pm 0.91	32.53*	<0.05
	40	Ovary	84.34 \pm 1.34	78.91 \pm 1.71	74.53 \pm 2.02	34.48**
Spermatheca		32.54 \pm 0.97	29.36 \pm 0.69	20.22 \pm 1.28	244.85**	<0.01
Hepatopancreas		91.04 \pm 1.06	82.63 \pm 1.11	67.41 \pm 1.08	512.72**	<0.01
Muscle		13.77 \pm 1.03	11.63 \pm 0.98	6.44 \pm 1.71	73.64**	<0.01
Gills		9.22 \pm 0.76	7.75 \pm 0.51	5.98 \pm 0.79	177.55**	<0.01
Haemolymph		20.01 \pm 0.81	12.33 \pm 1.01	9.03 \pm 1.11	181.34**	<0.01
Brain		27.92 \pm 1.27	19.62 \pm 0.92	14.44 \pm 1.25	212.56**	<0.01
Thoracic ganglia		28.77 \pm 0.89	21.47 \pm 0.63	18.40 \pm 0.43	306.47**	<0.01
Eyestalk		7.43 \pm 0.68	4.06 \pm 0.59	3.11 \pm 0.48	74.82**	<0.01

Mean \pm SD of six individual observations.

Values are expressed mg/g wet tissue and mg/ml haemolymph.

** indicates significance at 0.01 level

* indicates significance at 0.05 level

Carbohydrate, an important cellular content and energy rich compound was quantitatively assessed in the present investigation in various tissues namely ovary, spermatheca, hepatopancreas, muscle, gill, haemolymph, brain, thoracic ganglia and eyestalk. Fall in carbohydrate levels after prolonged exposure to heavy metals polluted water was due to the inactivation of the enzyme involved in the carbohydrate metabolism^[13]. The activity of the enzyme phosphorylase in the hepatopancreas and muscle has been shown to reduce the carbohydrate levels in *O.senex*^[16]. Depletion of haemolymph glucose, tissue glycogen and total free sugars were observed in *B.guerini* in response to chromium^[28]. Decline in glycogen content was observed in *B.guerini* in response to zinc sulphate^[25]. Significant changes were observed in the catabolism of carbohydrate in the tissues of the marine prawn, *Metapenaeus monoceros* following exposure to methyl parathion^[20]. The carbohydrate content was decreased in *Scylla serrata* in response to cadmium toxicity^[19] and in *U.annulipes* exposed to cadmium and mercury^[27]. The results of the present study showed that the carbohydrate

content decreased significantly in both the sublethal concentrations of cypermethrin treated crabs. Although decline was observed in both the exposure periods the decrease was maximum in 40 day of treatment in cypermethrin.

In the experimental crabs, the lipid content level decreased in all the tissues tested. ^[14] reported reduction in lipid level in hepatopancreas in *M.kistensis* in response to pesticides. Reduction in lipid content was observed in fish *Sarotherodon mossambicus* when exposed to methyl parathion^[17]. Similar results were observed in *M.idae* in muscle due to cadmium stress^[29], in *B.guerini* in response zinc sulphate^[25]; in *M.malcomsonii* exposed to endosulphan^[24]; in freshwater snail *Thiara tuberculata* and *Parresia corrugate* exposed to copper sulphate^[9] and dichlorovos and in *U.annulipes* exposed to cadmium and mercury^[27]. The accelerated hydrolysis of lipid might be to cope up with the increased energy demand occurring due to metal toxicity. Among the biomolecules, carbohydrates, proteins and lipids represent the principal ones to be utilized at times of stress including metal

toxicity for the derivation of energy. Their role in activation of energy in tissues has been elucidated in several studies on both vertebrates^[15] and invertebrates^[5]. Similarly, in the present study, the reduced lipid content in ovary, spermatheca, hepatopancreas, muscle, gill, haemolymph, brain, thoracic ganglia and eyestalk of the treated crabs in comparison to the control crab, reflects the accelerated hydrolysis of lipid in order to cope with the increased energy demand occurring due to cypermethrin toxicity.

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