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Effect of Carbaryl on Tissue Composition, Maturation, and Breeding Potential of *Cirrhina mrigala* (Ham.)

K. Kaur, A. Dhawan

Department of Fisheries, Punjab Agricultural University, Ludhiana (Pb.), 141 004, India

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Carbaryl is one of the most commonly employed insecticides for controlling the pests of cotton, tobacco, paddy and number of other crops. It is reported to have low persistence in soil (about 4 months; Caro et al 1974) and fresh water (about 60 days; Odeyemi 1982). Carbaryl has also been shown to have low toxicity to fish, but its toxicity to aquatic insect larvae and crustaceans, which form the major part of the food of many important species of fish, is very high (Johnson and Finley, 1980). Since major part of our food fish is taken from natural resources, the gradual pollution of such water bodies is a major concern these days.

In India, most of the work has been restricted to the short term effects of carbaryl on the survival and behavioural changes in fry, fingerlings and adults of freshwater teleosts. However, little work has been done on the effect of this pesticide on the biochemical pararmeters of various tissues of fish (Mohan Rao et al., 1984). So, the present studies were undertaken to study the toxic effect of carbaryl 50% WP on the protein and lipid content of various tissues (flesh, liver and gonads), maturation and breeding potential of a fresh water teleost, Cirrhina mrigala (Ham.).

MATERIALS AND METHODS

Two sets of experiments were conducted, first during preparatory phase (March and April) and second during pre-spawning phase (May and June), for 60 days each. Live fish (Cirrhina mrigala) were collected during different phases of reproductive cycle from the Fish Farm of Punjab Agricultural University, Ludhiana and acclimated to the laboratory conditions 15 days prior to the exposure to 0.002 mg/L (safe) and 0.01 mg/L (sublethal) concentrations of carbaryl 50% WP

Correspondence to: K. Kaur

[1-napthyl-N-methyl carbamate; Sevin*]. These concentrations Of carbaryl were determined by conducting static bioassay experiments (Kaur and Dhawan, 1993). Concentrations were made in terms of the pesticide commercial formulations and not in terms of active ingredient of pure pesticide because only commercial preparation is used in agriculture. Experiments were conducted in glass aquaria (1 X 1 X 0.5 m) with water capacity of 150 L. Dechlorinated tap water (pH 7.2) was used for running experiments and control. 15 fish (12.5 ± 1.5 cm in length and 32.0 ± 3.5 g in weight) were released in each aquaria having 100 L of test water. Fish were fed ad libitum with rice bran and ground nut oil cake (1:3) on alternate days. Water was replaced twice a week. The experiments were run in triplicate.

At the time of exposure five fish were sacrificed and analysed for protein and lipid contents of flesh, liver and gonads which served as initial control. After 60 days of exposure, 5 fish from each treatment and control were sacrificed for various parameters. Total proteins and total lipids were estimated following the methods of Lowry et al. (1951) and Folch et al. (1957), respectively.

At the end of each experiment, gonado-somatic index (GSI) and ova diameter was recorded with the aid of an ocular micrometer. At the end of second experiment the exposed fish were also induced to breed and fecundity, fertilization and hatchability was determined.

The significant differences between control and experimental groups were calculated on Personal Computer using STATGRAPHICS package of software. The differences between various parameters were calculated by one way analysis of variance (p=0.05).

RESULTS AND DISCUSSION

Effect of 0.002 mg/L and 0.01 mg/L concentrations of carbaryl observed on the protein and lipid contents of flesh, liver and gonads of C. mrigala during two reproductive phases are presented in Table I. In the present studies, during both the preparatory and pre-spawning phases of reproduction, both the concentrations of carbaryl reduced the protein and lipid contents of flesh, liver and gonads of both males and females to a significant level as compared to control. Further, within the treatments, the decline was more in 0.01 mg/L concentration of carbaryl than in 0.002 mg/L. Singh (1988) also reported reduction in protein content of liver of Clarias batrachus in response to malathion and Y-BHC. Arunachalan et al.

Table 1. Effect of carbaryl on protein and lipid contents of various tissues of *Cirrhina mrigala*

Biochemical parameters	Tissue	Male			Female		
		Control	Carbaryl conc.		Control	Carbaryl conc.	
			0.002mg/L	0.01mg/L		0.002mg/L	0.01mg/L
Preparatory phase							
Protein (g/100 g of tissue)	Flesh	18.35	16.00*	13.25*a	18.90	17.30*	15.00*a
	Liver	12.56	9.80*	7.00*a	13.80	12.00*	10.00*a
	Gonad	12.23	9.80*	8.15*a	14.30	13.50*	9.20*a
Lipid (g/100 g of tissue)	Flesh	0.65	0.63	0.50*	0.80	0.78	0.62*
	Liver	7.80	6.90	4.80*a	7.50	6.30	4.80*a
	Gonad	5.75	4.50*	3.00*a	7.15	6.90*	5.00*a
Pre-spawning phase							
Protein (g/100 g of tissue)	Flesh	19.20	18.00*	16.90*a	21.30	19.00*	18.62*
	Liver	16.80	14.22*	12.50*a	17.50	15.05*	11.00*a
	Gonad	10.80	8.80*	8.00*	17.20	14.54*	11.00*
Lipid (g/100 g of tissue)	Flesh	1.40	1.34	0.85*a	1.85	1.50	0.90*a
	Liver	11.50	8.22*	6.82*a	13.25	9.00*	6.92*a
	Gonad	6.52	4.93*	2.90*a	0.40	8.52*	6.40*a

*-Significant difference between control and carbaryl concentrations
a-Significant difference between carbaryl concentrations

Table 2. Gonado-somatic index and Ova diameter (mm) of C. mrigala following exposure to carbaryl

Reproductive phase	Control	Carbaryl concentration	
		0.002 mg/L	0.01 mg/L
Gonado-somatic index			
Preparatory phase	8.70	5.80*	4.90*
Pre-spawning phase	13.20	10.50*	9.25*
Ova diameter			
Preparatory phase	0.50	0.45*	0.39*[a]
Pre-spawning phase	0.62	0.59	0.52*[a]

*-Significant difference between control and cabaryl concentrations
a-significant differences between carbaryl concentrations

Table 3. Fecundity, fertilization and hatchability of C. mrigala following exposure to carbaryl

Parameters	Control	Carbaryl concentration	
		0.002 mg/L	0.01 mg/L
Absolute fecundity	14700	12680*	6500*[a]
Running fecundity	6480	3000*	1070*[a]
Percent eggs released	44	24*	16*[a]
Fertilization (%)	85	76*	72*
Hatchability	95	82*	60*[a]

*-Significant difference between control and cabaryl concentrations
a-significant differences between carbaryl concentrations

(1980) and Mohan Rao et al. (1984) considered carbaryl to be a metabolic stressor. The decrease in protein content with corresponding decrease in lipid content of liver may be due to increased utilization of protein reserve in liver during stress induced starvation. However, Saxena et al. (1989) attributed the decrease in protein content to decreased protein synthesising capacity of liver of Channa punctatus exposed to carbaryl and malathion. In present studies the concentration dependent decrease in lipid content of liver of C. mrigala may be due to decline in lipid synthesising capacity and/or due to an increase in the hydrolysis of hepatic lipids to combat the stress

conditions as reported by Saxena et al. (1989) in C. punctatus exposed to carbaryl and malathion. Singh and Singh (1980) also observed a decrease n the lipid content of liver of Heteropneustes fossilis during preparatory and post spawning phases of reproduction following exposure to malathion and hexadrin (endrin).

The effect of carbaryl on the breeding potential of C. mrigala is given in Tables 2 and 3. The ability of fish to reproduce is greatly influenced by carbaryl as reflected by significant decrease in GSI, ova diameter, absolute fecundity, running fecundity, fertilization rate, hatchability and survival of eggs. Following exposure to both concentrations of carbaryl, GSI of fish decreased significantly than control, during both preparatory and pre-spawning phases of reproductive cycle. However, no significant difference in GSI was recorded between the treated groups during both the reproductive phases. The decrease may be attributed to the arrest of follicular development/follicular atresia and impairment of vitellogenesis caused by low levels of gonadotropins in pesticide treated fish as also reported by Saxena and Garg (1978) in C. punctatus following exposure to fenitrothion and Shukla et al (1984) in Sarotherodon mossambicus following exposure to carbaryl.

In present studies, concentration dependent decrease in ova diameter, fecundity, fertilization and hatchability of C. mrigala was recorded. Carlson (1971) also observed adverse effect of 0.68 mg/L carbaryl on spawning of fathead minnow, Pimephales promelas. Since reproduction in fishes is controlled by the hypothalamo-hypophyseal-gonadal axis (Peter et al. 1986) and decrease in the level of gonadotropins caused by pesticides (Singh and Singh, 1982) possibly explain the decline in reproductive potential of pesticide exposed fish.

It may be concluded that 0.002 mg/L and 0.01 mg/L concentrations of carbaryl have an adverse effect on the protein and lipid contents of flesh, liver and gonads and maturation and breeding potential of female C. mrigala which may be due to decreased vitellogenesis either mediated through hypothalamo-hypophyseal axis or due to impaired metabolism of liver.

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