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Toxicity of Alphamethrin, Dimethoate and Carbaryl pesticides to the freshwater snails *Lymnaea acuminata* and *Indoplanorbis exustus*

Toxicidad de los pesticidas Alfametrín, Dimetoato y Carbaril sobre los caracoles dulceacuícolas *Lymnaea acuminata* y *Indoplanorbis exustus*

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ABSTRACT

To use the snails as bio-indicator of pesticidal pollution, different doses of a pyrethroid (Alphamethrin), an organophosphate (OP) (Dimethoate) and a carbamate (Carbaryl) were administrated for 24 to 96 hours to the snails *Lymnaea acuminata* and *Indoplanorbis exustus*. Both species were susceptible to the three pesticides at concentrations in the range of 0.008 mg/l to 16.92 mg/l. The order of toxicity was pyrethroid > organophosphate (OP) > and carbamate. The toxicity of all the pesticides was both time and dose dependent as expected. Variation in water temperature influenced the toxicity of pyrethroid significantly, however, OP and carbamate were not influenced significantly. At low temperature pyrethroid became 3 to 4 times more toxic. Similar results are also reported in the case of fish. Thus, the susceptibility of snails may be directed in the field of pollution monitoring.

RESUMEN

Con el fin de usar caracoles como bioindicadores de la polución por pesticidas, se administraron distintas dosis de un piretroide (Alfametrín), un organofosfato (OP) (Dimetoato) y un carbamato (Carbaril), entre 24 y 96 horas a las especies *Lymnaea acuminata* y *Indoplanorbis exustus*. Ambas respondieron a los tres a concentraciones de 0,008 mg/l hasta 16,92 mg/l. El orden de toxicidad fue piretroide > organofosfato > carbamato. La toxicidad se comporto de acuerdo con lo esperado en cuanto a dosis y periodos de exposición. La variación en la temperatura del agua afecto significativamente a la toxicidad del piretroide, pero no a las de los otros. A baja temperatura el piretroide es de 3 a 4 veces más tóxico. Se obtuvieron resultados similares en el caso de peces. Así pues, se pueden usar estas especies en el estudio la polución.

KEY WORDS: Pesticides, *Lymnaea acuminata*, *Indoplanorbis exustus*, toxicity.
PALABRAS CLAVE: Pesticidas, *Lymnaea acuminata*, *Indoplanorbis exustus*, toxicidad.

INTRODUCTION

It has been reported that both snails are susceptible to most of the synthetic pesticides entering the freshwater bodies (SINGH AND AGARWAL, 1981; 1990; 1991). SINGH AND AGARWAL (1990) reported that the pyrethroids permethrin, cypermeth-

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Table I. Experimental conditions of tap water at different temperature, determined by methods of APHA/WPCF (1985).
Tabla I. Condiciones experimentales del agua del grifo a diferentes temperaturas, determinadas según los métodos de APHA/WPCF (1985).

Water temperature, °C	18	28
pH	6.70-7.05	7.20-7.40
Dissolved oxygen, mg/L	6.5-7.2	6.8-7.40
Free carbon dioxide, mg/L	4.5-6.5	4.3-6.2
Bicarbonate alkalinity, mg/L	105-109	106-109

rin and fenvalerate are highly toxic to snail *Lymnaea acuminata*. Fishes are also very sensitive to pyrethroids (COATS AND DONNELL-JEFFERY, 1979; HAYA, 1989).

Currently most of the works concerning these snails are in the direction of their control by using synthetic pesticides, as they are the intermediate host of *Fasciola* species, causing endemic fascioliasis in the cattle and livestocks. But, considering the fact if snails are sensitive to these pesticides, their population may not remain unaffected by pesticidal pollution. We are also interested to assess the effect of the water temperature, which varies with season, on the toxicity of pesticides.

MATERIALS AND METHODS

Snails *Lymnaea acuminata* (1.8 ± 0.1 cm in shell height) and *Indoplanorbis exustus* (0.8 ± 1.1 cm in shell height) were collected locally and used as test animals. Toxicity experiments were performed using the method of SINGH AND AGARWAL (1990). Commercial grade pesticides, Stop (Synthetic pyrethroid alphamethrin), Rogohit (Organophosphate, Dimethoate) and Sevin, (Carbaryl Carbamate) were purchased from local market. Adult animals were kept in glass aquaria, containing 3 L of dechlorinated tap water. The aquaria contained 20 snails. Test animals were exposed to five different concentrations of the three pesticides for 24, 48, 72 or 96 hours. Concentrations of alphamethrin, dimethoate and Sevin used for both snails were 0.001, 0.005, 0.009, 0.03 and 0.07 mg/l; 11, 14, 17, 20 and 23 mg/l; and 12, 15, 18, 21 and 24 mg/l, respectively. Pesticides doses were given as the final concentration (w/v) of active ingredient in the test aquaria. Control groups were kept in dechlorinated tap water without any treatment. Each set of experiments was replicated six times.

Mortality was recorded every 24 hours during the observation period of 96 hours. The LC50 values, lower (LCL) and upper (UCL) confidence limit, slope values, 't' ratio and heterogeneity were calculated by the computer POLO programme (RUSSELL, ROBERTSON AND SAVIN, 1977). The product momentum correlation coefficient was determined between exposure time and different values of LC50 (SOKAL AND ROHLF, 1973).

Some toxicological experiments were performed first in the month of January (water temperature 18 °C) and then, in May (water temperature 28 °C) to assess the effects of water temperature on the toxicity of pesticides.

RESULTS

LC50 values of the three pesticides for periods ranging from 24h to 96h at 18 °C and 28 °C water temperature are shown in Tables II and III, respectively. The three pesticides had the following order of toxicity, Alphamethrin (pyrethroid) > Dimethoate (OP) > Sevin (carbamate). The toxicity was time dependent, as there was a significant negative correlation between LC50 and exposure times. Thus, with increase in exposure time, LC50 of alphamethrin for *Lymnaea acuminata* decreased from 0.008 mg/L (24h) to 0.002

Table II. Toxicity data (LC50; mg/l) for different exposure periods of the three different pesticides against the snails *Lymnaea acuminata* and *Indoplanorbis exustus* at 18°C water temperature. LCL: lower confidence limit; UCL: upper confidence limit; SF: slope function.
Tabla II. Datos de toxicidad (LC50; mg/l) de diferentes periodos de exposición a 3 pesticidas distintos de las especies Lymnaea acuminata y Indoplanorbis exustus *a 18 °C de temperatura del agua. LCL: límite inferior de confianza; UCL: límite superior de confianza; SF: función de ajuste.*

Pesticides		**Exposure period**							
		L. acuminata				***I. exustus***			
		24h	**48h**	**72h**	**96h**	**24h**	**48h**	**72h**	**96h**
Alphamethrin (Pyrethroid)	LC_{50}	0.008	0.006	0.003	0.002	0.005	0.004	0.002	0.001
	LCL	0.005	0.004	0.001	0.001	0.003	0.002	0.000	0.000
	UCL	0.018	0.010	0.008	0.004	0.012	0.009	0.005	0.004
	SF	1.48	1.39	1.37	1.32	1.73	1.49	1.45	1.24
Diamethoate (OP)	LC_{50}	14.31	12.69	11.78	11.24	13.09	11.65	11.57	10.03
	LCL	13.06	10.79	10.19	10.02	9.02	8.21	8.01	7.32
	UCL	16.07	13.88	12.71	12.01	17.42	15.91	14.81	14.06
	SF	4.35	4.15	5.46	4.72	3.78	3.21	4.59	4.78
Sevin (Carbamate)	LC_{50}	16.92	14.74	13.68	12.99	15.42	13.90	11.57	10.02
	LCL	15.16	12.65	11.47	11.12	11.16	10.23	8.43	7.51
	UCL	18.28	16.00	14.79	14.00	26.25	21.33	15.76	14.73
	SF	4.91	4.53	5.26	6.58	3.36	3.56	4.21	4.32

Table III. Toxicity data (LC50; mg/l) for different exposure periods of the three different pesticides against the snails *Lymnaea acuminata* and *Indoplanorbis exustus* at 28°C water temperature. LCL: lower confidence limit; UCL: upper confidence limit; SF: slope function.
Tabla III. Datos de toxicidad (LC50; mg/l) de diferentes periodos de exposición a 3 pesticidas distintos de las especies Lymnaea acuminata y Indoplanorbis exustus *a 28 °C de temperatura del agua. LCL: límite inferior de confianza; UCL: límite superior de confianza; SF: función de ajuste.*

Pesticides		**Exposure period**							
		L. acuminata				***I. exustus***			
		24h	**48h**	**72h**	**96h**	**24h**	**48h**	**72h**	**96h**
Alphamethrin (Pyrethroid)	LC_{50}	0.020	0.012	0.009	0.005	0.018	0.120	0.008	0.003
	LCL	0.015	0.009	0.006	0.003	0.012	0.008	0.004	0.001
	UCL	0.036	0.017	0.011	0.007	0.030	0.021	0.017	0.011
	SF	1.47	1.29	1.83	1.82	1.82	1.36	1.21	1.96
Diamethoate (OP)	LC_{50}	19.65	18.13	15.26	10.81	16.23	14.26	11.96	9.41
	LCL	17.50	15.73	13.75	7.43	13.14	11.29	9.43	6.43
	UCL	29.66	35.02	19.43	17.68	27.56	23.92	17.52	14.26
	SF	4.10	3.35	2.97	2.62	3.21	3.15	3.16	4.21
Sevin (Carbamate)	LC_{50}	20.05	17.37	15.84	14.19	18.43	15.32	13.26	12.53
	LCL	18.51	16.38	14.69	12.18	14.42	11.46	9.65	8.12
	UCL	24.50	19.07	17.08	15.30	27.51	21.51	18.39	17.91
	SF	6.57	6.56	5.61	5.11	6.21	6.26	5.41	4.53

mg/L (96h) at 18 °C and for *Indoplanorbis exustus* it decreased from 0.005 mg/L (24h) to 0.001 mg/L (96h). In case of Dimethoate, at 18 °C this decrease was 14.31 mg/L (24h) to 11.24 mg/L (96h) and 3.09 mg/L (24h) to 10.12 mg/L (96h) for *Lymnaea acuminata* and *Indoplanorbis exustus*, respectively. With Sevin, at 18 °C it decreased from 16.92 mg/L (24h) to 12.99 mg/L (96h) and 15.42 mg/L (24h) to 10.02 mg/L (96h) for *Lymnaea acuminata* and *Indoplanorbis exustus* respectively, (Table II). Same trend was also observed at 28 °C water temperature (Table III). The lower and upper limits were within 95% confidence limit and the slope values were steep (Tables II, III).

DISCUSSION

It is clear from the data given above that both the snails are highly sensitive to all the three tested pesticides. Of the three, alphamethrin (pyrethroid) was found to cause snail mortality at very low doses. The synthetic pyrethroids are mainly absorbed through the dermal, oral and respiratory routes. Their metabolic degradation occurs at numerous sites (MIYAMOTO, 1976). Due to their lipophylic nature, they undergo rapid absorption and are distributed in all the tissues of the body. Their concentrations vary according to the lipophilicity of the tissue. Higher concentrations have been reported in skin, fat, liver, kidney and brain tissue (RUZO, EUGEL AND CASIDA, 1979; RICHARD AND BRODIE, 1985). Pyrethroids are well known to change the Na+ and K+ permeability of nerve membrane resulting in repetitive discharges at the synapse and neuromuscular junction (SINGH AND AGARWAL, 1986; WILKINSON, 1976; NARAHASHI, 1983). SINGH AND AGARWAL (1986, 1991) reported that pyrethroids also cause inhibition of Acetylcholinesterase and reduction of Cytochrome oxidase and lactic dehydrogenase and increase ness in the Succinic dehydrogenase level. This multifarious mode of action rapid absorption of pyrethroid might explain its extreme toxicity to snails.

The LC50 of all the three pesticides showed a significant ($P< 0.05$) negative correlation with exposure times. It demonstrates that detoxification of pesticides in the snail body might be slow. This result also justifies the effectiveness of three pesticides up to at least 96 hours. Both the snails are very sensitive to pesticides. Thus, their mortality or decreasing population in water body result of pesticidal pollution. Finally, it may be concluded that the snails may be taken as bio indicator with bioassay spp. of water (pesticidal) pollution monitoring.

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