Bull. Environ. Contam. Toxicol. (1996) 56:796-802

Bulletin of Environmental Contamination and Toxicology

Comparative Study on the Synergistic and Individual Effects of Dimecron and Cuman L on Oxygen Uptake and Haematological Parameters of a Freshwater Edible Fish, *Sarotherodon mossambicus* (Peters)

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Received: 27 February 1995/Accepted: 10 October 1995

A survey of literature in the field of fishes and pesticide pollution clearly indicates that effects of individual pesticides on different physiological and biochemical aspects of fishes have been extensively studied by a large number of investigators. Though the studies involving the effects of individual pesticides on fishes have produced valuable information, the problem of pesticide pollution becomes magnified when the runoff waters from cultivable lands drain a wide spectrum of different pesticides into a particular freshwater body such as pond, lake or river. Besides, field application of mixtures of two or more pesticides in different proportions, recently adapted by the farmers, makes the synergistic pollution problem more pronounced in the aquatic systems. A perusal of literature indicates that the informations on the toxic effects of synergistic mixtures of pesticides on fishes are very meagre (Anderson and Weber 1975; Broderius and Smith 1979 and Hermens and Leeuwangh 1982). However, a comparative study on the synergistic and individual effects of pesticides on the physiology of fishes is totally lacking.

In view of this paucity of information, a comparative study is attempted on the synergistic and individual effects of an organophosphate pesticide (dimecron) and a carbamate fungicide (cuman L) on oxygen uptake and haematoloqical parameters of a freshwater edible fish, Sarotherodon mossambicus (Peters), as S. mossambicus, under field conditions in freshwater ponds are known to be facing the problem of pollution of different types of pesticides brought through run off water from nearby agricultura1 fields.

MATERIALS AND METHODS

A large sample of Sarotherodon mossambicus (size range: 8-12 g) was collected from the freshwater lakes in and around Coimbatore city and maintained in large cement

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tanks for 1 mon. During this period of acclimatization, the fishes were fed with cooked rice every alternate day and the water in the tank was renewed after every feeding. One wk before the commencement of the investigation, a selected batch of healthy fishes was transferred to small cement cistern and maintained under laboratory conditions (29 ± l°C), This group of fish was fed daily and water in the cistern was renewed daily. Feeding was stopped 1 d before the fishes were used in the experiment. Commercially available dimecron and cunan L (supplied as Ziram 30 per cent SC Cuman L by Hindustan CIBA-GEIGY Limited, Bombay) were used in the present study, Spraying of the organophosphate pesticide, dimecron (Phosphamidon) in combination with zinc-based carbamate fungicide, cuman L, is considered to provide a persistent effect of dimecron on different types of crop pests (Cuman L 1987). With the non-availability of recommendation (by the company) of a specific proportion of dimecron - cuman L in agricultural operations, an arbitrary ratio of 1:5 dimecron-cunan L was used in the present study to understand the synergistic toxicity of the two pollutants on S. mossambicus. The sub-lethal (96-hr LC_0) and lethal (24-hr LC_{100} concentrations of 1:5 dimecron - cuman L, assessed by repetead exposure experiments employing the static bioassay method and Probit analysis (Finney 1964) were 0.01 mL/L and 0.05 mL/L respectively.

For studying the individual effects of dimecron and cuman L, fishes were exposed to 0.002 ml/L concentration of dimecron, which formed the component composition of sub-lethal 1:5 dimecron - cuman L mixture, and to 0.008 mL/L concentration of dimecron, which formed the component composition of lethal 1:5 dimecron - cuman L mixture. Fishes were also exposed 0.008 mL/L and 0.042 mL/L concentrations of cuman L, which formed the component concentrations respectively, of the sub-lethal and lethal concentrations of 1:5 dimecron - cuman L mixture.

Fishes were exposed to 0.002 mL/L of dimecron and to 0.008 mL/L of cuman L for 5 d, 10 d and 15 d. Fishes were also exposed to 0.008 mL/L of dimecron and to 0.042 mL/L of cuman L for 3 hr, 6 hr and 12 hr. Throughout the experiment, the desired concentrations of pollutant water were prepared by using chlorine-free tap water. Control fishes were also maintained in chlorine-free tap water for a maximum period of 15 d.

Oxygen uptake of control, dimecron-exposed, cuman L -exposed and 1:5 dimecron-cuman L-exposed (of different concentrations for different periods) fishes was estimated by using a simple respiratory chamber and by measuring the loss of oxygen content (due to respiration of the fish) of water in the respiratory chamber. Oxygen content of water sample was estimated by employing Winkler's method (Welsh and Smith 1960). Oxygen consumption of control and pollutant exposed fishes were expressed in mL/kg/hr. For haematological estimations, blood samples from control and pollutant-exposed fishes were collected in separate embryo cups (already rinsed with heparin) by directly puncturing the branchial vessels in the opercular chamber. The haemoglobin content of blood of fish was estimated as described by Oser (1976) using Sahli haemometer (W-Germany) with permenant colored glass comparision standards. The haemoglobin content of the blood was expressed in g of haemoglobin per 100 mL of blood. The total erythrocyte (RBC) count of blood was made using haemocytometer (Fein-optic Blankerburg, GDR) with improved Neubauer ruling as described by Oser (1976). The erythrocyte count was given in millions of cells per mm^3 of blood.

The changes in oxygen uptake, haemoglobin content and erythrocyte count of dimecron-exposed, cuman L-exposed and 1:5 dimecron-cuman L-exposed fishes -from those of control levels were calculated as percentages. The values of oxygen uptake, haemoglobin content and erythrocyte count of control and pollutant-exposed fishes were also tested for their significance at 5 per cent level ($P<0.05$) using Analysis of Variance (ANOVA or 'F') test using one way classification (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Data on oxygen uptake, haemoglobin content and erythrocyte count of control and sub-lethal pollutant-exposed S.mossambicus are given in Table 1 and those of control and lethal pollutant-exposed fishes are given in Table 2. A perusal of Tables 1 and 2 indicates that the toxic effects of synergistic mixture of dimecron and cuman L and those of individual pollutants on the parameters studied are varied. Although, the organophosphate pesticide, dimecron is considered to be less toxic to fish (Nayar et al. 1985) and the carbamate fungicide, cuman L also reported to be less toxic compared to other carbamate pesticides (Rani et al. 1990), the synergistic mixture (1:5) of dimecron-cuman L appears to be highly toxic to fish as observed in the present study. S.mossambicus, when exposed to sub-lethal and lethal-concentrations of

Table 1. Values of oxygen uptake (mL/kg/hr), haemoglobin content (g/100mL) and erythrocyte count (milion cells/mm^3 blood) of control and pollutant-exposed (to sub-lethal concentrations) S. mossambicus. values are means of 5 observations ± S.E. Per cent changes from control levels are given in parentheses.

Pollutant	Concentration	Parameters	Control	Days of exposure			'F' Value
				5 d	10 d	15 d	
Dimecron	0.002 mL/L	Oxygen uptake	405.29±24.34	284.79±45.41 (-30)	301.06±53.95 (-27)	299.43±54.15 (-26)	0.67 NS
		Haemoglobin content	4.28± 0.11	3.12± 0.04 (-27)	2.80± 0.05 (-35)	2.40± 0.05 (-44)	81.66 *
		Erythrocyte count	1.12± 0.08	0.44± 0.03 (-61)	0.25± 0.02 (-78)	0.09± 0.01 (-92)	72.00 *
Cuman L	0.008 mL/L	Oxygen uptake	405.29±24.34	321.11±55.80 (-21)	332.07±37.39 (-18)	346.74±55.32 (-14)	0.41 NS
		Haemoglobin content	4.28± 0.11	4.04± 0.05 (-6)	3.12± 0.04 (-27)	2.94± 0.03 (-31)	82.50 *
		Erythrocyte count	1.12± 0.08	0.65± 0.03 (-42)	0.25± 0.02 (-78)	0.16± 0.01 (-86)	72.00 *
1:5 Dimecron-cuman L	0.01 mL/L	Oxygen uptake	405.29±24.34	61.28± 6.60 (-85)	217.57±19.00 (-46)	115.42±10.98 (-72)	18.09 *
		Haemoglobin content	4.28± 0.11	3.05± 0.04 (-29)	1.89± 0.07 (-56)	1.59± 0.04 (-63)	4957.00 *
		Erythrocyte count	1.12± 0.08	0.61± 0.04 (-46)	0.49± 0.01 (-56)	0.28± 0.02 (-75)	833.00 *

'- ' denotes per cent decrease from control level.

* - Statistically significant, $P < 0.05$.

NS - Not significant

Table 2. Values of of oxygen uptake (mL/kg/hr), haemoglobin content (g/100mL) and erythrocyte count (million cells/mm^3 blood) of control and pollutant-exposed (to lethal concentrations) S. mossambicus. values are means of 5 observations ± S.E. Per cent changes from control levels are given in parentheses.

Pollutant	Concentration	Parameters	Control	Hours of exposure			'F' Value
				3 hr	6 hr	12 hr	
Dimecron	0.008 mL/L	Oxygen uptake	405.29±24.34	241.60±39.61 (-40)	284.79±45.41 (-30)	511.26±65.24 (+26)	4.19*
		Haemoglobin content	4.28± 0.11	3.38± 0.06 (-21)	2.92± 0.04 (-32)	2.52± 0.04 (-41)	51.66*
		Erythrocyte count	1.12± 0.08	0.60± 0.02 (-46)	0.48± 0.02 (-57)	0.26± 0.02 (-77)	13.67*
Cuman L	0.042 mL/L	Oxygen uptake	405.29±24.34	327.52±96.17 (-19)	225.61±56.84 (-44)	191.21±37.72 (-53)	1.58 NS
		Haemoglobin content	4.28± 0.11	3.98± 0.06 (-7)	3.80± 0.06 (-11)	3.32± 0.09 (-22)	15.00*
		Erythrocyte count	1.12± 0.08	1.07± 0.01 (-4)	1.00± 0.01 (-11)	0.80± 0.03 (-28)	7.00*
1:5 Dimecron-Cuman L	0.05 mL/L	Oxygen uptake	405.29±24.34	128.92±19.40 (-68)	140.73± 3.70 (-65)	132.63±18.60 (-67)	94.73*
		Haemoglobin content	4.28± 0.11	2.45± 0.04 (-43)	2.10± 0.06 (-51)	1.74± 0.04 (-59)	6665.71*
		Erythrocyte count	1.12± 0.08	0.78± 0.01 (-31)	0.60± 0.02 (-46)	0.41± 0.02 (-63)	3040.00*

'+' denotes per cent increase from control level.

'-' denotes per cent decrease from control level.

* - Statistically significant, P < 0.05.

NS - Not significant

1:5 dimecron-cuman L, suffered severe reduction in oxygen uptake whereas individual effects of dimecron and cuman L elicited only lesser and insignificant reduction in oxygen uptake of the fish. This severe toxic effect of synergistic mixture is possible due to the persistent activity of dimecron when combined with the zinc-based carbamate fungicide, cuman L.

A comparision of magnitudes of reductions in haemoglobin content and erythrocyte count of individual dimecron-exposed and cuman L-exposed S. mossambicus with the magnitudes of reductions in the same parameters of synergistic 1:5 dimecron-cuman-exposed S. mossambicus reveals a remarkable indication about the possible mode of action of these two types of pollutants, The individual toxic effect of dimecron and cuman L appears to manifest more on the erythrocyte population than on the haemoglobin content of the blood. On the other hand, the individual toxic effect of dimecron and cuman L is found to be lesser on the haemoglobin content showing lesser reduction in the haemoglobin content of the fish compared to the reduction in haemoglobin level of the blood of fish exposed to synergistic mixture of 1:5 dimecron-cuman L.

The lesser and insignificant reduction (compared to synergistic effect) in oxygen uptake of fish inspite of significant reduction in haemoglobin content and erythrocyte count under individual effects of dimecron and cuman L exposures is hard to be explained at this juncture. However, *a* study *on* the oxygen carrying capacity and oxygen binding capacity of blood of fish under pollutant stress would provide insight.

Acknowledgments. The authors are thankful to Dr.M.D. Sundararajan, Principal and to Prof. P.S. Subbaiyan, Head of the Department of Zoology, Government Arts College (Autonomous), Coimbatore for providing the necessary laboratory facilities for this work.

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