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Differential Toxicity of Malathion, BHC, and Carbaryl to the Freshwater Fish, *Tilapia mossambica* (Peters)[1]

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The wide applicability of insecticides provide many occasions for their entry into the aquatic environment as surface run-off (ODUM, 1970) or through the direct application to inland and coastal marshes for mosquito control, thus causing considerable damage to fishes and other aquatic fauna (HOLDEN, 1972; BOYER, 1975) and ultimately posing dual threat to mankind. Our survey showed malathion (organophosphate), BHC (organochloride) and to some extent carbaryl (carbamate) are much used in this region for the control of pests and insects. Hence, we have chosen these three pesticides for the toxicity studies on the freshwater teleost, Tilapia mossambica which is a common species of freshwater ecosystem. The three pesticides selected for the present investigation belong to three different categories, each having specific properties and a particular mode of action. The use of commercial grade pesticides equate the field operations and thus helps to understand the interaction of pesticides to fish and other aquatic types.

MATERIAL AND METHODS

The fish, T.mossambica were collected from unpolluted freshwater ponds around Kavali, India and acclimatised to laboratory conditions for a week in glass aquaria with continuous aeration and regular feeding. The fish were fed with groundnut cake during acclimatisation. The commercial grade malathion, carbaryl (gift sample from Cyanamid India Limited, Bombay) and BHC (gift sample from Hindustan Insecticides Limited, New Delhi) were used for the toxicity studies.

Dosage mortality studies: These studies were conducted at 26-28°C in static waters as described by DOUDOROFF et al.,(1951) for 48 hours. The pH of the water is 7.0 ± 0.2 and the hardness is 140 ± 20 ppm. The animals were sorted in to batches separately in accordance with the biomass theory.

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Malathion and BHC were dissolved in small quantity of acetone (PICKERING et al., 1962) and carbaryl in tap water to form stock solutions which were added to the aquaria to yield the appropriate final concentrations. Acetone is non-toxic to the fish in the quantity used for each LC_{50} study (PICKERING et al., 1962). During experimentation, the aquaria containing the control and experimental animals were aerated to prevent hypoxic condition. The following are the concentration ranges of malathion, BHC and carbaryl for Tilapia mossambica: 0.2 to 0.6 ppm for malathion, 2 to 10 ppm for carbaryl and 2.5 to 4.0 ppm for BHC.

Data analysis methods: The data was subjected to probit analysis, wherein the probit mortality was obtained from percent mortality. The concentration resulting in 50% mortality, its 95% confidence limits and the slope value of the probit regression line were calculated for 48 hour period of exposure as per the statistical method outlined by FINNEY (1971).

RESULTS AND DISCUSSION

The LC_{50} values of malathion, carbaryl and BHC were found to be 0.367 ppm, 5.495 ppm and 3.199 ppm respectively, suggesting the differential toxicity of these pesticides to the fish, T.mossombica. Of the three pesticides, malathion was found to be the most toxic followed by BHC and carbaryl (Fig 1, Table 1).

TABLE 1

Malathion, carbaryl and BHC 48-h LC_{50} values and 95% confidence intervals (ppm) for Tilapia mossambica.

Pesticide	LC_{50}[a]	SE of LC_{50}	Slope[b]	95% confidence limits	
				Lower	Upper
Malathion	0.367	0.0327	6.31	0.303	0.431
Carbaryl	5.495	0.5587	5.6	4.40	6.59
BHC	3.199	0.0764	22.0	3.05	3.348

[a] expressed as mg of pesticide per liter of the test solution

[b] slope of the log probit regression line

Earlier studies on LC_{50} of malathion for 48 h on fatheads, blue gills and gold fish to be 25 ppm, 0.11 ppm and 0.79 ppm (PICKERING et al.,1962). This suggests that malathion is relatively more toxic to T.mossambica (0.367 ppm) than fatheads (25 ppm) and gold fish (0.79 ppm), but less toxic when compared to

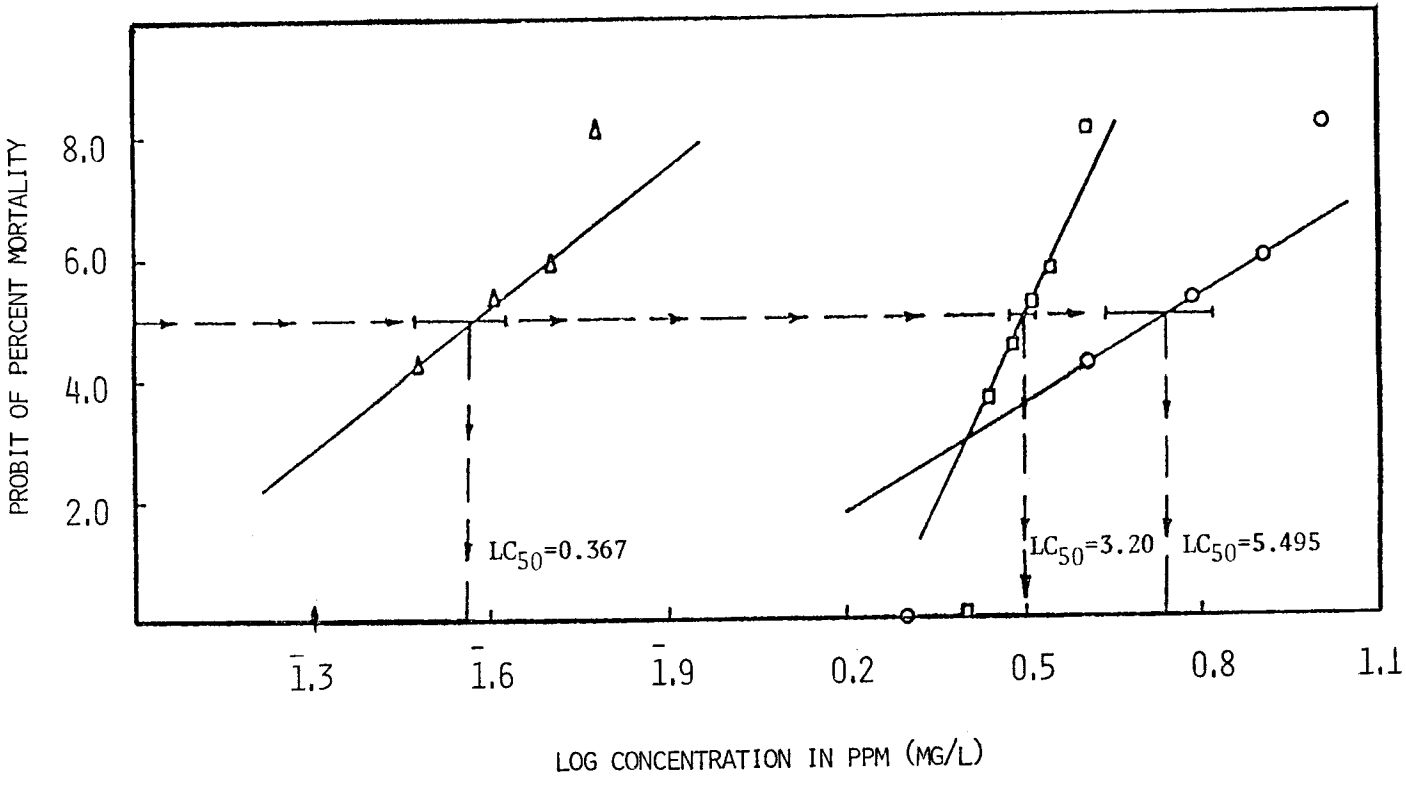

Fig 1. Log probit regression lines of malathion (Δ), BHC (□) and carbaryl (o) to the fish, Tilapia mossambica. Probit 5.0 = 50% mortality.

blue gills (0.11 ppm). These variations in the sensitivity of different species to malathion may be due to the differences in the capacity of fish to tolerate brain cholinesterase inhibition (MACEK & MC ALLISTER, 1970). The studies on carbaryl toxicity reveals the 96-h LC_{50} values for coho-salmon, brooktrout, rainbow trout as 1.3 ppm, 1.07 ppm and 1.47 ppm (KATZ, 1961) which are proved to be more toxic than to T.mossambica. The studies on BHC revealed the 96-h LC_{50} values to fatheads, blue gills, gold fish and guppies as 2.3 ppm, 0.79 ppm, 2.3 ppm and 2.17 ppm which are less than the LC_{50} value of BHC to T.mossambica (3.199 ppm) and thus proving that BHC to be less toxic to T.mossambica than fatheads, blue gills, gold fish and guppies.

From this, it is clear that the toxicity of a pesticide differs from species to species and in a single species from pesticide to pesticide (PICKERING et al., 1962). These differences could be attributed to the differences in the assay techniques, purity of the pesticide, the amount of active ingradient present and the synergistic action of the additives and emulsifiers present in the commercial samples.

The slope (regression coefficient) of the probit regression line of BHC toxicity to T.mossambica is 22.0, which is about four times greater than that of the slope values of malathion and carbaryl (Fig 1, Table 1). This greater slope value of BHC indicates that the response of T.mossambica population is homogenous to its toxicity wherein the homogenous response indicates nil mortality to 100% mortality to occur within a short range of pesticide concentration. This is further substantiated by the narrow confidence limits around the LC_{50} value (fig 1, Table 1). The slope values of malathion and carbaryl toxicity are 6.0 and 5.6 respectively, indicative of heterogenous response of this fish to their toxicity when compared to that of BHC. The higher confidence intervals around the LC_{50} values for malathion and carbaryl supports the heterogenous response of T.mossambica population to these two pesticides.

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