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Acute Toxicity of Deltamethrin and Dieldrin to *Oreochromis niloticus* (LIN)

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Synthetic pyrethroids have low toxicities, LD50's of 4592, 1260 251 and 139 mg/kg of rat, to mammals (Elliot et al 1973) and birds. They have high toxicities (LC50's of 0.037 ppm to goldfish and 0.008 ppm to bluegill for 96 hr) to fish (Coats et al 1979; Kumaraguru et al 1982). They are rapidly degraded in soil and do not leave persistent residues and have no detrimental effects on soil microflora and microfauna (Carter 1984; Elliot et al 1978). Synthetic pyrethroids are useful in controlling a variety of insect pests. They are cheap in terms of cost per hectare because they are applied at rates of about 50 g/ha. The pyrethroids are extremely versatile and very potent insecticides.

In the search for a substitute for dieldrin, a toxic and persistent organochlorine insecticide which is used in the building industry in Ghana for the control of termites, a synthetic pyrethroid looks an obvious choice. But it is only their extreme toxicity to fish which may restrict their use. The investigation reported here is the acute toxicities of dieldrin and deltamethrin, a synthetic pyrethroid to Oreochromis niloticus (LIN). This fish species is one of the commercial fish species found in many inland water bodies in Ghana. It is a delicacy in the Ghanaian dish. It can be prepared fresh, salted or smoked. Any pesticide which drastically reduces the population of this species in a body of water will have adverse effect on the national economy.

MATERIALS AND METHODS

The fingerlings of Oreochromis niloticus (LIN) with a mean fresh weight of 1.6 ± o.61 g and a mean fresh length of 2.41 ± 1.10 cm were harvested from freshwater ponds owned by the Institute of Renewable Natural Resources of the University of Science and Technology, Kumasi. They were acclimatized in the laboratory for 10 d in glass aquaria. The physical and chemical characteristics of the aquarium water were; temperature 24-30 °C, alkalinity 23-27 mg as $CaCO_3$/L, acidity 15-21 mg as $CaCO_3$/L, dissolved oxygen 6-6.7

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mg/L, calcium ions 8-10.8 mg/L, phosphate-phosphorus 0.0 mg/L, ammonium-nitrogen 0.0 mg/l, magnesium ions 5.6-7.8 mg/1, sodium ions 3.2-3.4 mg/L, potassium ions 4.2-8.4 mg/L, pH 6.26-7.60, chloride ions 6-18 mg/L and conductivity of 120-141 μmhos/cm. The weak and diseased fingerlings were identified and discarded. During this period they were fed on crumbs of bread.

Twenty percent w/v dieldrin in emulsifiable concentrate of hydrocarbon solvents, EC (Shell Chemical Products of Holland) and 2.5% w/v deltamethrin, EC (Product of Welcome Pesticide R & D Berkhamsted Herts) were obtained from the Building and Research Institute CSIR, Kumasi, Ghana. Two separate stock solutions of 100 mg/L each were prepared by dissolving 0.5 mL of 20% EC dieldrin in 1000 mL of 95% ethanol and 1 mL of 2.5 EC deltamethrin in 250 mL of 95% ethanol.

These stock solutions were used for preparing different strengths of the test solutions by diluting measured volumes with filtered aquarium water to known measured volumes. The filtered aquarium water used had the same physical and chemical properties as the one used in acclimatizing the fish. The control solutions were made up of only filtered aquarium water.

The test solutions and the controls were in triplicate in 10-L glass vessels. The test solutions and controls were prepared daily, labelled, thoroughly mixed and allowed to stand for about 15 min before use. Ten fingerlings were put in each test solution and controls. Since the weights of the fingerlings were such that ten of them required 20 L solution (Cairns et al 1976) but 20-L vessels were not available, two 10-L glass vessels were provided for each concentration and five fingerlings were put into each 10L of test solution. The control solutions were similarly treated.

Observations were made initially at 30-min intervals and then latter hourly or 2 hourly. The number of fish found dead on each observation in each solution was recorded. The dead fish were removed and their fresh weights and lengths measured and recorded. The test solutions and the controls were changed after every 24 hr for a maximum of 4 d. That is the experiments were conducted for 24, 48 and 96 hr. The percentage mortality was plotted against concentrations on logarithmic probability paper and LC50 read from the graph. After number of such analysis the 95% confidence intervals was calculated with a program from the IBM Model 55 SX computer. A series of LC50's was found and used in plotting against concentration (Figure 1) to find out whether 96 hr. was long enough for the completion of the experiment. Then the F-test and t-test were applied to the values.

RESULTS AND DISCUSSION

It was found from preliminary tests that the species of the fish was not killed in 96 hr by as much as 3000 mg/L ethanol in filtered aquarium water. This is similar to what Kpekata (1983)

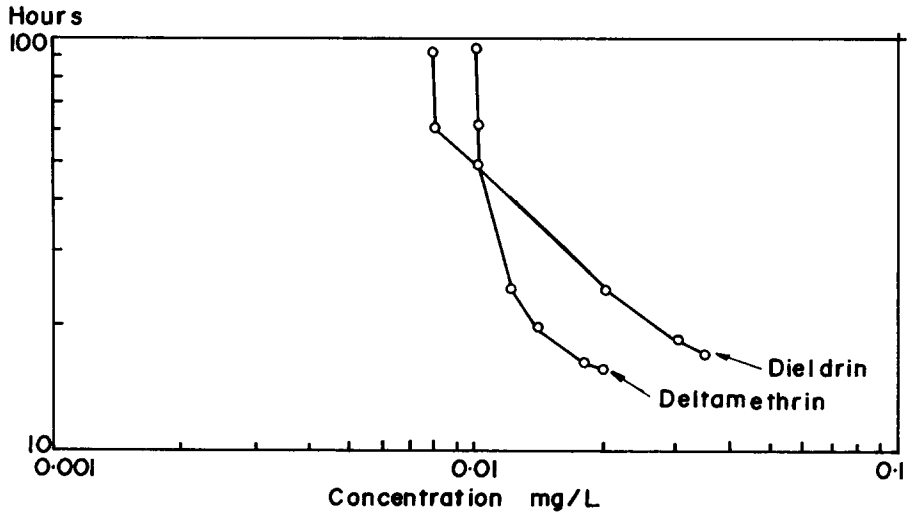

Figure 1: Toxicity of dieldrin and deltamethrin dissolved in ethanol to Oreochromis Niloticus (LIN).

Table 1. The means, lower and upper limits of LC50's for insecticides to Orecochromis niloticus (LIN) within 95% confidence limits.

Insecticide	Time hr	LC50, mg/L			
		Mean	95% Confidence Interval		
Deltamethrin	24	0.0160	0.0157	to	0.0163
	48	0.0150	0.0149	to	0.0151
	96	0.0145	0.0140	to	0.0149
Dieldrin	24	0.045	0.044	to	0.046
	48	0.40	0.038	to	0.042
	96	0.030	0.027	to	0.033

found for Sarotherodon galilaea. In the present investigation the highest concentration of ethanol in a test solution was 4 mg/L. The mortality in the control was less than 0.1%.

The 96-hr LC50 of dieldrin dissolved in ethanol for Oreochromis niloticus (LIN) was 0.030 mg/L (Table 1) and the 95% confidence limits for lower and upper values were 0.027 and 0.033 mg/L respectively. For deltamethrin dissolved in ethanol the 96-hr LC50 was 0.0145 mg/L and the lower and upper values were 0.0141 and 0.0149 mg/L within the 95% confience limits. The toxicity curves, Figure 1, indicate that 96 hr was long enough to measure the acute toxicity. The curves were asymptotic about the LC50's. When both the F and T-tests were applied to results the differences between the various times were highly significant within the 95% confidence intervals. Deltamethrin was two times more toxic to the species than dieldrin. Thus with regard to this fish species deltamethrin may not be a good substitute for dieldrin. However deltamethrin has a great deal of potential advantages over dieldrin. In that since dieldrin is more persistent and non-degradable, in the long term it will do greater damage to the

ecosystem than deltamethrin. Deltamethrin is biodegraded, strongly adsorbed on soils, sediments and organic matter in general and will not readily leach or be washed into bodies of water where it may kill fish species (Carter 1984). Deltamethrin like other synthetic pyrethroids is of low toxicity to mammals.

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