Lethal toxicity of phosphamidon on the juveniles of *Anabas testudineus* (Bloch) and *Etroplus maculatus* (Bloch)

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ABSTRACT

The present study was undertaken to delineate the lethal toxicity of phosphamidon, which is a widely used organophosphate pesticide in the paddy fields in Kuttanad, the rice bowl of Kerala, on *Anabas testudineus* and *Etroplus maculatus*. These two species of fishes have an important share to contribute to the fishery wealth of Kuttanad. The 48 h LC$_{50}$ values of phosphamidon for *Anabas* and *Etroplus* were found to be 39.34 and 2.97 ppm respectively. From the experimental results it is apparent that *Anabas* is much more resistant to phosphamidon than *Etroplus*. *Anabas* being an obligate air-breathing fish takes in only less pesticide through the gill. These LC$_{50}$ values can be utilized for sublethal toxicity studies, which will help to arrive at a maximum allowable toxicant concentration.

The freshwater ecosystem of Kuttanad, Kerala, had sustained a rich and diversified fish fauna. In recent years, human interventions have brought about major changes in these aquatic ecosystems. Reports reveal that the fishery resources of this region have dwindled considerably and some of the fish species are on the wane (Kurup et al., 1990). Though pesticides are applied to enhance agricultural production, the deleterious effects of them are often noticed in non-target organisms like the fish. Phosphamidon, monocrotophos, and malathion are the major pesticides being widely used in Kuttanad. *Anabas testudineus* and *Etroplus maculatus* are the two important species of fish contributing to the fishery wealth of Kuttanad. Reports on the toxic effect of phosphamidon on different species of fish are available (Toor and Kaur, 1974; Ritakumari and Nair, 1978; Choudhari et al., 1984; Mayer and Eller Sieck, 1986; Jacob et al., 1982; Gopalakrishnan, 1990; Govindan et al., 1994). In the present study baseline information were gathered on the lethal concentrations of phosphamidon to these fishes which could be used for making recommendations to safeguard the fishery potential of Kuttanad.

Juveniles of *Anabas testudineus* and *Etroplus maculatus* were collected from the ponds of the College of Fisheries, Panangad, Kochi, Kerala. Healthy specimens of *Anabas* and *Etroplus* with lengths 7.2±0.6 cm and 6.7±0.3 cm; weights 7.5±2.5 g and 5.0±1.0 g respectively were employed.

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Fish were acclimated to the laboratory conditions for a period of ten days prior to the experiment. During the acclimation period they were fed, ad libitum once a day on fresh clam meat. Fish were starved for 24 h prior to the experiment.

Phosphamidon (brand name Dimecron-85% Phosphamidon SL is a Hindustan Ciba Geigy Ltd, product) is a water soluble organophosphate concentrate containing 850 g of phosphamidon (0,0-dimethyl-0-(2-chloro 2-diethyl carbonyl-1-methyl vinyl) phosphate as active ingredient in a kilogram of product (m/m). This is equivalent to 1000 g of phosphamidon in a litre of product (W/v). The dilution of this concentration is made using the formula:

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\text{Volume of commercial formulation} = \frac{\text{Total wt. of active ingredient needed in the stock solution}}{\text{Strength of \% commercial formulation}} \times 100
\]

Estimated volume of commercial formulation was pipetted out and made up to the required volume of stock solution.

Seven different concentrations of phosphamidon ranging from 1.5 to 4.5 ppm for Anabas were employed to delineate corresponding 48 h LC$_{50}$ levels. Ten fishes each in triplicate were exposed in 51 of the respective toxicant concentration in glass containers, and the toxicants were replenished every 4 h. Control experiment was also run simultaneously. The physico-chemical parameters monitored during the experiment were oxygen 7.25±0.25 ppm; temperature 26±2°C and pH 6.2±0.2. Mortality during the 48 h exposure period was recorded. The 48 h LC$_{50}$ and its 95% fiducial limits were calculated by linear regression analysis after probit transformation of mean mortality and log 10 transformation of the test concentration as described by Finney (1971).

The 48 h LC$_{50}$ values and their 95% fiducial limits are given in Fig. 1A-B. The calculated 48 h LC$_{50}$ values of phosphamidon to Anabas and Erophus were 39.34 ppm (95% fiducial range 32.17-46.50 ppm) and 2.97 ppm (95% fiducial range 2.59-3.38 ppm) respectively (slope b - E. maculatus - 12.08 and Anabas - 8.09). The behavioural changes in exposed fishes were also noted. Both Anabas and Erophus exhibited excited swimming behaviour and hyperactivity soon after they were
introduced into the toxicant medium. *Anabas* were seen coming to the surface of water quite often and gulping in atmospheric air especially in the higher concentrations. However, hyperactivity of fishes decreased gradually. Prior to death the fish exhibited erratic movement and lost equilibrium. The eyes of the dead fish were protruded.

Of all the pesticide induced biochemical changes, inhibition of acetylcholine esterase, the enzyme involved in terminating the action of the neurotransmitter acetyl choline is the most often studied. This enzyme and its closely related ones are responsible for the toxicity of organophosphate compounds to vertebrates (Murty, 1986). In the present study also the death of the fish may be due to the termination of the action of this enzyme. The affected fish in the experiments exhibited initial hyperactivity followed by lethargic swimming and loss of equilibrium. Excited swimming and hyperactivity are as deleterious to the fish as lethargic swimming and loss of equilibrium (Murthy, 1986). The toxic effects of phosphamidon on different fish had been worked out by various authors. Toor and Kaur (1974) reported that the LC$_{50}$ values of phosphamidon on *Cyprinus carpio communis* for 24, 48 and 72 h were 177.7, 169.3 and 163.4 ppm respectively. Ritakumari and Nair (1978) recorded the LC$_{50}$ values of phosphamidon on *Lepidocephalus thermo*alis for 24 h and 48 h as 53.63 ppm and 44.25 ppm respectively. Choudhari et al. (1984) noted that the 96 h LC$_{50}$ values of phosphamidon for *Channa striatus* was 10.47 ppm. According to Mayer and Eller Sieck (1986) the 96 h LC$_{50}$ values of phosphamidon for bluegill, channel catfish, fathead minnows and rainbow trout were 3.4, 7.0, 100 and 7.8 ppm respectively. The 48 h LC$_{50}$ value of phosphamidon on *Gambusia* was 13.2 ppm (Govindan et al., 1994). Gopala-krishnan (1990) found that the 96 h LC$_{50}$ value of Dimecron for *Etrous maculatus* juveniles was 0.17 ppm. Jayaprakas and Nair (1993) reported the 48 h LC$_{50}$ of dimecron for adult *E. maculatus* as 25.9 ppm.

In the present study 48 h LC$_{50}$ values of phosphamidon to *Anabas* and *Etrous* were 39.34 and 2.97 ppm respectively. The result on *E. maculatus* juveniles is comparable to the findings of Gopalkrishnan (1990). It is interesting to note that the juveniles of *E. maculatus* are highly sensitive to toxicity when compared to the adults, (nearly 1/10). It is well known that different life stages of fish differ in the degree of their sensitivity to the toxicants. With the regression of the yolk sac the toxicity increases many fold to the young larva or the juvenile, but with the increase in age, the toxicity decreases. The greater tolerance by the larger size/age groups is attributable to their larger lipid pool and also a decrease in the gill surface area in relation to the body size (Murty, 1986). *Anabas* proved to be a much more resistant species than *E. maculatus*. This may probably be due to the fact that *Anabas* being an obligate air breathing fish takes in only less toxicant through the gills from the water. Jacob et al. (1982) found that *Macropodus cupanus*, an obligate air breathing fish was more resistant to the larvicides than *Apocheilus lineatus*.

Acknowledgments

The authors are grateful to the Dean, College of Fisheries, Panangad
for providing the facilities. The first two authors are thankful to the STED, Kerala State for the financial help. Thanks are also due to Ms. Alphy Korath, Asst. Prof., College of Fisheries for the statistical analysis.

References


