Risk assessment of methamidophos on non – target freshwater fish tilapia (*Oreochromis niloticus*)

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KEY WORDS : methamidophos, LC 50, histopathology, tilapia

INTRODUCTION

Aquatic ecosystems are prone to contamination of insecticides resulting from agricultural runoff. As aquatic inhabitants are directly exposed to the contaminants in water, many aquatic animal species have been examined as the bioindicators for water contamination. Methamidophos, an organophosphorus (OP) insecticide, has been extensively used in Thai agriculture although its local toxicity studies are yet to be established. In this paper, the toxicity of methamidophos to a local freshwater fish, tilapia was studied. Subcellular changes in gill and hepatic tissues of tilapia were reviewed in sublethal exposures to methamidophos. Median lethal concentrations (LC₅₀) at 24, 48, 72 and 96 h were reported in the acute toxicity testing.

MATERIALS AND METHODS

Prior to the onset of experiment, tilapia were acclimated in the 60 litre aquaria for 2 weeks. They were fed with commercial pellet diet at approximately 3% of total body wet weight/day. Aquaria were maintained daily for water quality (fully aerated, 22 – 24 °C, water hardness 200 – 240 ppm) and removal of biological waste.

Acute toxicity testing: 210 tilapia were divided to 7 groups of 30 fish. Fish were exposed to different concentrations of methamidophos (0, 15, 30, 45, 60, 75 and 90 ppm) to determine median lethal concentrations (LC₅₀) after 24, 48, 72 and 96 h static exposure. Probit analysis (SYSTAT, ver 7.0, SPSS Inc., Chicago, IL) provided a statistically – based estimate of LC₅₀ values.

Sublethal toxicity testing: 25 tilapia were exposed to a sublethal concentration of methamidophos. Gill and hepatic tissues were collected from 5 fish of each exposure (24, 48, 72 and 96 h) and fixed in 10% formalin solution for histological study. A series of subcellular alterations of gill and hepatic tissues were

studied to demonstrate parameters for sublethal toxicity in tilapia.

RESULTS

Median lethal concentrations (LC₅₀) after a 24, 48, 72 and 96 h static bath exposure of methamidophos, determined by Probit model are shown in Table 1. Data implied that fish exposed to 10 ppm methamidophos up to 96 h were apparently normal and no mortality was observed. The 10 ppm methamidophos, therefore, was applied in sublethal toxicity testing. Tilapia exposed to 10 ppm methamidophos for 24, 48, 72 or 96 h all exhibited subcellular changes in gill and hepatic tissues, although most of the exposed fish displayed ordinary behavior or appeared clinically normal. Histopathological lesions of gill filaments were markedly evident, with more pronounced effects observed in longer exposure (figure 1 – 4).

Table 1 Estimates of LC₅₀ values for exposures of methamidophos in tilapia*

Exposure (h)	LC 50 (ppm) (n=30)
24	70.72
48	55.30
72	46.13
96	43.63

*Probit analysis (SYSTAT, ver 7.0, SPSS Inc., Chicago, IL)

Figure 1 Showing the normal arrangement of gill filament, and of the secondary lamellae on the filament of tilapia (Hematoxylin & Eosin 100x).

Figure 2 Gill filament of tilapia exposed to methamidophos 10 ppm for 48 h. Note severe inflammation of epithelial cells and consequent fusion of lamella (Hematoxylin & Eosin 400x).

Figure 3 Section of the liver of tilapia indicating roundish hepatic cells with the vacuolar structure appearance. Large quantities of lipid and glycogen stored in cytoplasm become vacuolar in appearance following paraffin embedding and staining (Hematoxylin & Eosin 100x).

Figure 4 Liver of tilapia exposed to methamidophos 10 ppm for 48 h. Multifocal necrosis in hepatic parenchyma and proliferation of bile duct epithelium were observed (Hematoxylin & Eosin 100x).

DISCUSSION

Aquatic animals living in surface waters can be exposed to insecticide levels which range from acutely lethal to sublethal toxicity¹. The toxicity of OP to non-target species is commonly reported in freshwater aquatic systems by monitoring cholinesterase inhibition, changes in physiological parameters or death of the organism². Previous studies reported ranges of methamidophos LC_{50} at 96 h in different non-target fish species: 25 – 51 ppm in rainbow trout, 46 ppm in guppies, 100 ppm in carp and 100 ppm in gold fish^{3,4}. The present study indicated methamidophos' LC_{50} in tilapia at 96 h was 43.63 ppm (Table 1). Zbinder and Flurycoversi⁵ suggested that the toxicity of pesticides to aquatic animals is influenced by many factors including species, age, sex, condition of animal, water temperature and the formulation of the pesticide. As a result, several LC_{50} values can exist for the same chemical. Sublethal exposures as low as 10 ppm for 24 h caused subcellular alterations in gill and hepatic tissues, although no clinical signs were observed. Data were consistent with other toxicity studies that tilapia, as in many other freshwater fish species, were not as sensitive to methamidophos as freshwater, estuarine and marine crustaceans.

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