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Toxicity of Malathion to Nile Tilapia *Oreochromis Niloticus* (Linn.) Fingerlings

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ABSTRACT

The toxicity of a commercial grade malathion on Nile tilapia, Oreochromis niloticus,*fingerlings was determined. The 24, 48, 72, and 96-h LC50 of malathion on Nile tilapia fingerlings were 7.19, 5.43, 5.34, and 5.30 mg/l, respectively. Behavioral changes in fish included rapid opercular movement, hyperexcitability, darkening of the body, and contraction of trunk muscles. Moribund fish displayed labored opercular movement, severe contraction of the trunk muscles, erratic swimming, and total loss of equilibrium. A safe level of less than 0.53 mg/l malathion for Nile tilapia fingerlings was considered.*

INTRODUCTION

Malathion [0,0-dimethyl S-(1,2-dicarbethoxyethyl) phosphorodithioate] is a widely used organophosphorous pesticide: This pesticide seems to be more toxic to insects than to mammals due to the lack of hydrolytic enzymes in insects (1). Poisoning in animals results from accumulation of acetylcholine, a neurotransmitter substance because the active site of acetylcholinesterase (AchE) is phosphorylated by dimethyl or methyl phosphate after conversion of malathion to its oxygen analog malaoxon (2). In mammals, malaoxon is hydrolyzed rapidly, thus becoming inactive. But this hydrolysis proceeds very slowly in fish, though it does not occur in insects due to lack of hydrolytic enzymes (3).

This study was undertaken to determine the median lethal concentrations (LC50s) of a commercial grade malathion on Nile tilapia *Oreochromis niloticus* Linn. fingerlings at 24, 48, 72, and 96 h and to estimate a safe level of malathion for *O. niloticus*. The study was also designed to evaluate the histopathological response of fish tissues to malathion, which will be reported in another paper.

MATERIALS AND METHODS

Nile tilapia, *O. niloticus*, fingerlings were obtained from a commercial hatchery and conditioned for at least three weeks in outdoor concrete tanks. Fish were fed daily with a commercial diet with 30% protein. Healthy specimens (average weight of 2.9 g) were chosen and transferred to 200-L glass aquaria containing clean dechlorinated tapwater for further acclimation under laboratory conditions for one week. Water was changed daily before feeding. Fish were fed with a commercial diet at 4% body weight twice daily, but were starved 24 h prior to, and during, the experiment. Mortality during this period was either zero or less than 1% of the total population. The toxicity tests were carried out under static conditions in glass aquaria containing 40 L of gently-aerated test solutions for 96 h following standard procedures for toxicity tests (4). Twelve fish were exposed to each concentration of malathion solution (1.0, 1.8, 3.2, 5.6, and 10.0 mg/l) plus a corresponding control test. Six replicates were made for each concentration including control under a completely randomized design. Test solutions were analyzed daily for temperature, pH, and water hardness. Mortality checks were performed four times a day. The LC50 values at different exposure periods were computed by probit method (5).

RESULTS AND DISCUSSION

During the toxicity test, the addition of malathion to water did not appreciably alter temperature which remained at 27.8–29.5°C, pH at 7.4–7.7, and water hardness at 54.31–63.12 mg $CaCO_3$/l.

Behavioral changes of fish in all test concentrations were similar except for degree of severity and response time. With higher concentrations, response time was shorter and degree of response was more severe. The first noticeable changes were rapid opercular movement accompanied by a period of high excitability, followed by darkening of body, and contraction of trunk muscles especially at the midsection of the body. Some responses like severe contraction of trunk muscles,

erratic swimming, and loss of equilibrium were observed only in severe cases at the higher concentrations.

The changes in behavior of fish clearly indicate that the fish were under stress. Respiratory distress is one of the early symptoms of pesticide poisoning (6). Increased opercular rates have been documented several times as a sensitive indicator of physiological stress in fish and may be caused by decreased efficiency in oxygen uptake (7). Darkening of the body of fish has been associated with pesticide exposure (8). Malathion has caused *Cyprinodon variegatus* fry to be hyperactive but with uncoordinated twitch-like movements (9). The persistent activity of acetylcholine due to inhibition of AchE during exposure to malathion can cause continuous contraction of the trunk muscles and eventual loss of equilibrium (3). In the present study, hyperexcitability, continuous contraction of the trunk muscles, abnormal twitching movements, and loss of equilibrium could also be due to AchE inhibition.

The results of the toxicity test are shown in Figure 1. Nile tilapia fingerlings treated with 1.0, 1.8, and 3.2 mg/l malathion tolerated the chemical, with zero or very low mortality even after 96 h of exposure. On the other hand, fish treated with 10.0 mg/l malathion resulted in 100% mortality after 48 h of exposure. These results show that the toxic effects of malathion is evident in the first 48 h as indicated by only a minor increase in mortality from 48 to 96 h in the 5.6 mg/l group. Fish that survived the 48 h test were able to tolerate the chemical and recover even after 96 h of exposure. The proposed permissible concentration for malathion in this study is 0.53 mg/l.

The computed median lethal concentrations (LC50s) of malathion to Nile tilapia fingerlings at different exposure periods are presented in Table 1. The 24, 48, 72, and 96-hr LC50 of malathion were computed to be 7.19, 5.43, 5.34, and 5.30 mg/l, respectively.

The concentration of non-persistent materials, i.e. those with a half-life of less than 96 h, should not exceed 1/10 of the 96-h LC50 at any time or place (10). Malathion is considered to be non-persistent as indicated by its fast hydrolysis rate (11,12). Therefore, a safe level of malathion should not exceed 0.53 mg/l for *O. niloticus*. However, chronic tests should be conducted to demonstrate that the estimated safe level would not cause a decrease in the productivity of the test species during its life history (10).

LITERATURE CITED

1. Krueger, H.R., R.D. O'Brien, and W.C. Dauterman. 1960. Relationship between metabolism and differential toxicity in insects and mice of diazinon, dimethoate, parathion, and acethion. *Economic Entomology* 53: 25–31.
2. Cook, G.H., J.C. Moore, and D.L. Coppage. 1976. The relationship of malathion and its metabolites to fish poisoning. *Bulletin of Environmental Contamination and Toxicology* 16: 283–90.
3. Areechon, N. and J.A. Plumb. 1990. Sublethal effects of malathion on channel catfish *Ictaluru punctatus. Bulletin of Environmental Contamination and Toxicology* 44: 435–42.
4. Reish, D.J. and P.S. Oshida. 1986. Manual of methods in aquatic environment research. Part 10. Short-term static bioassays. FAO Fish. Tech. Pap. 247.
5. Finney, D.J. 1971. *Probit analysis: A statistical treatment of the sigmoid response curve.* 3rd ed. Cambridge University Press.
6. Murty, A.S., 1986. *Toxicity of pesticides to fish.* Vol. 2. CRC Press Inc., Florida.
7. Thomas, R.E. and S.D. Rice. 1975. Increased opercular rates of pink salmon *Oncorhynchus gorbuscha* fry after exposure to the water soluble fraction of Prudhoe Bay crude oil. *J. Fish. Res. Bd. Can.* 32: 2221–24.
8. Henderson, C. and Q.H. Pickering. 1957. Toxicity of organic phosphorous insecticides to fish. *Transaction of the American Fisheries Society* 87: 39–51.
9. Weis, P. and J.S. Weis. 1976. Abnormal locomotion associated with skeletal malformations in the sheepshead minnow *Cyprinodon variegatus* fry exposed to malathion. *Environ. Res.* 12: 196–200.
10. FAO. 1969. Report of the Committee on Water Quality Criteria Federal Water Pollution Control Administration. United States Department of the Interior, Washington, D.C. Facsimile of section III-Fish. FAO Fish. Tech. Pap. 94.
11. Kanazawa J. 1975. Uptake and excretion of organophosphorous and carbamate insecticides by freshwater fish, motsugo, *Pseudorasbora parva. Bulletin of Environmental Contamination and Toxicology* 14(3): 346–352.
12. Freed, V.H., D. Schmedding, R. Kohnert, and R. Hague. 1979. Physical and chemical properties of several organophosphates: Some implication in environmental and biological behavior. *Pesticid. Biochem. Physiol.* 10: 203–11.

Table 1. Computed median lethal concentrations (LC50s) of malathion to Nile tilapia fingerlings

Exposure time (h)	LC50 (mg/l)
24	7.19
48	5.43
72	5.34
96	5.30

Values represent mean of six replicates

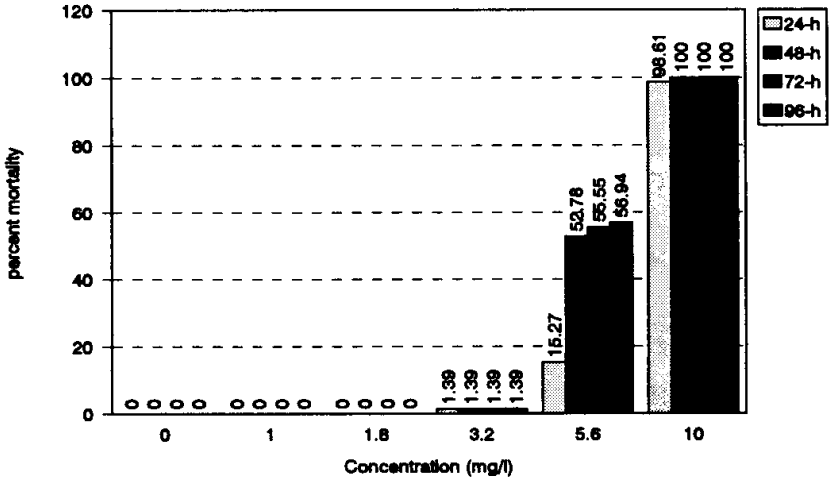

Fig. 1. Observed mean mortality rates* of Nile tilapia fingerlings untreated and treated with different concentrations of malathion

*Based on replicates