Histopathological Changes in Liver and Kidney of Common Carp Exposed to Sub-lethal Doses of Malathion

Sadia Sharmin, 1 Md. Shahjahan, 1* Md. Anwar Hossain, 1 Md. Asadul Haque 2 and Harunur Rashid 1

1Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
2Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract.- The present study was conducted to evaluate the effects of an organophosphorous pesticide malathion on histo-architecture of liver and kidney of common carp exposed to two sub-lethal concentrations (1.5 and 3.0 mg/L) for a period of 8 days. The 96 h LC50 value of malathion for common carp was 15.24 mg/L. Several morphological changes were observed in the liver after exposure to the malathion. Hypertrophy of hepatocytes, mild to severe necrosis and minor vacuolation was found in liver exposed to both concentrations. Similarly, a number of changes such as, pycknosis, necrosis, disintegrated renal tubule, vacuole, shrunk glomerulus etc were observed in the kidney exposed to both concentrations. The changes in these vital organs might have resulted in physiological and metabolic dysfunction. Therefore, the use of pesticide in the agricultural field may be a threat to fish health and their population in the aquatic environment.

Keywords: Organophosphorous, malathion, Cyprinus carpio.

Materials and methods

A total of 200 fish (14-16 cm, 50-70 g) were collected from local fish farm (Bangladesh Catfish Limited, Valuka, Mymensingh) and maintained in aquaria at 25±0.5°C under a controlled natural photo-regimen (14/10 h, light/dark) for a period of 21 days before the experiments. The fish were fed with artificial pellet feed twice a day at 8:00 am and 6:00 pm.

Malathion (Sithion 57 E/C, Siam Crop Care, Bangladesh) was purchased from local retail pesticide shop. Its 96 h LC50 value was determined against common carp. Five different concentrations (5, 10, 15, 20, and 25 mg/L) of malathion with three replicates were used. A control was also run without malathion treatment with each replicate. Malathion was directly added to the water of aquarium. Exceeding aeration was applied to the aquarium for 2 h in order to obtain a homogeneous concentration of the toxic compound, and then 10 fish were transferred into each aquarium. Mortality was assessed 24, 48, 72, and 96 h after start of exposure to malathion. Dead fishes were recorded and then immediately removed.

The major route of pesticides to water ecosystems is through rainfall runoff and atmospheric deposition. Another source of water contamination by pesticides is from municipal and industrial dischargers. Most insecticides ultimately find their way into rivers, lakes and ponds (Werimo et al., 2009; Arjmandi et al., 2010) and have been found to be highly toxic to non-target organisms that inhabit natural environments close to agricultural fields, leading to mortality of fish (Rahman et al., 2002). Malathion (O, O-dimethyl dithiophosphate of diethyl mercaptosuccinate) is an organophosphate which is used to control a wide variety of insects in agricultural field and residential area. It is toxic via skin contact, ingestion and inhalation exposure (Tomlin, 2006).

Histopathological investigations on different tissues of fish are valuable tools for toxicology studies (Thophon et al., 2003). In the present study, an effort has been made to examine the changes in liver and kidney morphology of a common carp, Cyprinus carpio after sub-lethal exposure of malathion.
To study the effect of sub-lethal doses of malathion on the liver and kidney of common carp, an experiment was set up. Nine aquaria (75 cm × 45 cm × 45 cm) were cleaned, washed thoroughly with tap water and then filled with 100 L of tap water. The experiment was conducted with three treatments, each with three replications. Two sub-lethal concentrations, viz., 1.5 and 3.0 mg/L, were added to the water of the aquaria. A control aquarium was also run without malathion. Ten fish were transferred to each aquarium and kept for a period of 8 days. Water and malathion were changed every 24 h at 10:00 am. The fish were anesthetized with 0.03% tricaine methane sulfonate (MS222, Sigma-Aldrich, Japan) before sampling. Liver and kidney were removed immediately after decapitation and preserved in 10% formalin. The fixed liver and kidney samples were processed by a routine procedure, and embedded in paraffin wax, 6-8 µm thick sections were cut using a microtome machine (KD-3358, Kedee, USA) and stained with hematoxyline and eosin.

Results and discussion

The LC$_{50}$ value of malathion calculated by probit analysis against common carp during 96 h of exposure was 15.24 mg/L (Fig. 1). This value was similar to that of another study where it was reported 16.6 mg/L for common carp (Hassan et al., 1993).

Fig. 1. Graph showing the relationship of probit of kill with log$_{10}$ concentration of malathion used to deduce the LC$_{50}$.

Histological structure of liver of fish exposed to both concentrations (1.5 and 3.0 mg/L) of malathion showed several changes such as focal necrosis (FN), loosening of hepatic tissue (LHT), pyknosis (P), haemorrhage (H), and degeneration of muscle (DM) (Fig. 2). Since liver is the site of detoxification of all types of toxins and chemicals, these changes of vacuolization, swelling and
necrosis may be attributed to the direct toxic effects of pollutants on hepatocytes. Similar observations have also been reported after exposure to other organophosphorous pesticides in various fishes (de Rodrigues and Fanta, 1998; Camargo and Martinez, 2007; Mohamed, 2009).

Kidney is another vital organ that maintains the homeostasis of a body and plays an important role in erythropoiesis (Iqbal et al., 2004). The alterations found in the kidney of fish in the present study were pyknosis (p), necrosis (N), disintegrated renal tubule (DR), vacuole (V), shrunk glomerulus (SG) etc after exposure to both concentrations (1.5 and 3.0 mg/L) of malathion (Fig. 3). Severity in alterations increased in proportion to increased dose. Similar results have been reported by Cengiz (2006) in *Cyprinus carpio* after acute exposure to deltamethrin. With severe intoxicated conditions, the degenerative process leads to tissue necrosis (Yokote, 1982). The necrosis of the tubules will affect the metabolic activities and promotes metabolic abnormalities in fish. The present results are in agreement with those observed in *C. carpio* exposed to sewage (Veiga et al., 2002; Thophon et al., 2003).

Acknowledgements

We are grateful to Mr. Sultan for his assistance in some parts of the work. This work was supported by the grant from Aqua-drugs project of Bangladesh Fisheries Research Institute.

References


(Received 6 January 2015, revised 22 June 2015)