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**EVALUATION OF SELECTED BIOMARKERS IN NILE
TILAPIA (*Oreochromis niloticus*) AS TOOLS IN MONITORING
AQUATIC POLLUTION IN SRI LANKA**



By

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ABSTRACT

The present study was aimed at evaluating selected biochemical biomarkers in Nile tilapia (*Oreochromis niloticus*), a food fish widely distributed in inland water bodies as potential tools in biological monitoring of aquatic pollution in Sri Lanka. The selected biomarkers viz. cholinesterase (ChE), (for exposure to anticholinesterase contaminants such as organophosphates and carbamates), metallothioneins (MT), (for exposure to heavy metals such as Cd), Cytochrome P4501A dependent Ethoxyresorufin O-deethylase (EROD) and Glutathione S-transferase (GST) (for exposure to carcinogenic and mutagenic planar halogenated/polycyclic aromatic hydrocarbons(PAHs)) were evaluated in the fish maintained in the laboratory controlled aquaria and in the feral fish from Bolgoda Lake and Bathalagoda reservoir using standard techniques with optimized assay conditions developed for this fish species. Levels of selected pollutants (heavy metals and PAHs) in the waterbodies were also analyzed using chemical methods. This was the first study which attempted to assess the pollution of aquatic environments in Sri Lanka using the biomarker strategy.

Influence of body length, body weight, gender, sexual maturity and tissue storage on ChE activities of brain and muscle tissues in Nile tilapia was evaluated using laboratory exposure studies. Results show that ChE activities in both tissues decreased significantly with increased total length or body weight of the fish and the relationships are curvilinear. Gender and gonadal maturity stage had no significant effect on the body size specific ChE activities. Storage of tissues at -80°C for 28 days had no significant effect on ChE activities in the control fish and the fish exposed to

carbofuran. However some reactivation of carbosulfan induced inhibition of ChE activities was observed when brain tissues were stored for 28 days. The results emphasize the importance of consideration of body size of the fish and storage time of the tissues in order to formulate accurate conclusions about the neurotoxic chemical exposure. Size specific concentration-response relationships for inhibition and recovery of ChE enzyme were obtained, following exposure of three size groups of Nile tilapia (fry, fingerlings and sub-adults) to a series of environmentally relevant concentrations of chlorpyrifos and carbosulfan. Laboratory exposure studies also showed that hepatic EROD in Nile tilapia can be utilized effectively for screening specific toxic organic xenobiotics in the environment. Administration of β -naphthoflavone or pyrene caused induction of EROD activity (2-3 fold) where as GST activity was not affected significantly. There were no significant differences in hepatic EROD induction in tilapia which could be attributable to sex or reproductive status. Hepatic metallothionein (MT) levels were studied in Nile tilapia as a response to different waterborne Cd^{2+} exposure levels in the laboratory. Hepatic MT levels in the fish exposed to Cd^{2+} increased 2-26 folds depending on the exposure level and duration, which indicates that MT is a sensitive biomarker for cadmium exposure.

The present study also reports the first analysis of water pollutants in Sri Lankan waters using a suite of biomarkers in feral Nile tilapia (*Oreochromis niloticus*) residing in Bolgoda Lake which receives urban, industrial and domestic wastes from multiple sources. The levels of biomarkers viz. EROD, GST, MT, brain and muscle ChE were compared with those of the laboratory reared control fish and the fish obtained from a less polluted water body, Bathalagoda reservoir (reference site). The induction of EROD activities in feral fish reflects the exposure of fish to aryl

hydrocarbon receptor agonists including PAHs present as pollutants in the Bolgoda Lake. Inhibition of Cholinesterase activity in the fish inhabiting Bolgoda South Lake indicated the presence of anticholinesterse pollutants in the area. Hepatic MT levels in the lake fish were higher (1.9-3.2 folds) in comparison to the controls indicating metal exposure. Chemical monitoring confirmed the occurrence of high levels of PAH and heavy metals in Bolgoda Lake.

In conclusion, responses of brain and muscle ChE, hepatic EROD and Metallothionein in Nile tilapia are promising biomarkers that could be used effectively in biomonitoring aquatic pollution in Sri Lanka. Consistency in selection of fish of certain size class will improve the degree of confidence in using a suite of biomarkers in Nile tilapia in future biomonitoring programmes.