Sri Lanka J. Aquat. Sci. ***23(1)*** *(2018): 105-117* http://doi.org/10.4038/sljas.v23i1.7551

Biomarker responses of Nile Tilapia (*Oreochromis niloticus*) exposed to polluted water from Kelani river basin, Sri Lanka: Implications for biomonitoring river pollution

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Abstract Biomarkers can be considered as early warning signals for potential adverse effects on the biota. The present study examined the feasibility of using selected biomarker responses of a model fish, *Oreochromis niloticus* under laboratory exposure approach for identification of potential biological impacts of pollution in Kelani River. Laboratory acclimated *O. niloticus* were exposed under static-renewal conditions to water samples collected from selected sites of the Kelani River basin with different anthropogenic influences and biomarker responses (brain and muscle cholinesterase activities for neurotoxicity, erythrocyte micronuclei and nuclear abnormalities for genotoxicity and liver histology for hepatic damage) were evaluated at 5 and 10 days of exposure. Exposed water was physico-chemically characterized using standard analytical methods. The results revealed that exposure of *O. niloticus* to the water from selected polluted sites which included canals and canal confluences resulted in significant increases ($p<0.05$) in total erythrocyte nuclear abnormalities, evolution of erythrocyte micronuclei and induction of liver histopathological indices in comparison to the fish exposed to the water from the upper reach of the river (reference site) in most cases and the control fish exposed to the aged tap water in all cases. Brain cholinesterase activity was significantly inhibited ($p<0.05$) in the fish exposed to the water from the most polluted site compared to the control fish exposed to the aged tap water. Biomarker responses indicated that the fish populations inhabiting the polluted sites in the river may be under stress especially due to hepatic damage and genotoxicity. Evaluation of "effect directed biomarker responses" of the model fish, *O. niloticus* following laboratory exposure to the contaminated water can be a practically feasible approach for biomonitoring potential pollution impacts associated with the riverine ecosystems.

Keywords: biomarker; biomonitoring; Kelani River; pollution; tilapia

INTRODUCTION

Contamination of riverine ecosystems with high levels of anthropogenic pollutants could deplete their resource values and create unintended irreversible damages to the biota (Pan et al. 2016). In line with the sustainable development goals, potential biological impacts of river pollution should be identified in order to implement effective strategies for management and conservation of these water resources. Conventional monitoring approach focusing on a selected set of physico-chemical factors and pollutant levels do not completely provide information on the ecological conditions under which organisms live in the ecosystems. Examining biomarkers which could reflect the interactive effects of all contaminants on impaired biological processes in exposed organisms is a promising and cost effective approach for assessing biological impacts of aquatic pollution (van der Oost et al. 2003; Colin et al. 2016). In aquatic ecosystems, use of multi-biomarkers in fish at different levels of biological organization (molecular/biochemical, cellular, tissue/organ levels etc.) may give a more reliable picture of the pollution impacts (Ballesteros et al. 2017; Vieira et al. 2017). Inhibition of acetyl cholinesterase enzyme activities in fish can affect proper neurotransmission at cholinergic synapses. Hence, cholinesterase (ChE) in fish has been recognized as a promising biomarker at molecular/biochemical level for neurotoxic contaminations in the water bodies (van der Oost et al. 2003; Pathiratne et al. 2008). Erythrocytic micronuclei and nuclear abnormalities in fish are