Abstract

Contaminant induced neurotoxicity can produce a variety of effects encompassing the altered behaviour. Changes in behaviour are among commonly used biomarkers having potential to link biochemical effects to ecological outcomes of environmental pollution. In aquatic toxicology studies, pesticide caused neurotoxicity and behavioural changes in fish have been the subject of many investigations due to the implications of pesticide triggered neurotoxicity for fish behaviour is of vital importance with eventual consequences at population level.

Keywords: Behaviour; Biomarker; Fish; Neurotoxicity; Pesticide

Introduction

The behavioural change is an integrated output of nervous system at the organismal level in response to the underlying biochemical, morphological or physiological disturbances and therefore it is considered as an ideal endpoint reflecting a series of toxic effects and compensatory responses [1]. Pesticides are widely used in agriculture and industry; however benefits of pesticides are not derived without consequences. The adverse effects of extensive pesticide use on nontarget organisms, including fish, is well known. In aquatic toxicology studies, pesticide induced neurotoxicity and behavioural changes in fish have been the subject of many investigations due to importance of nervous system in maintaining the life of an organism by enabling the monitoring of internal and external environments and response to changes appropriately [2-4].

The activity of acetylcholinesterase (AChE) which is involved in the termination of impulse transmission by rapid hydrolysis of the neurotransmitter is one of the most widely used indicator of altered neural function. Pesticide evoked inhibition, mainly by organophosphates and carbamates, leads to changes in behaviour including reduced swimming performance, hyper excitability and altered social behaviour [5].

As demonstration of this, Rafaela Leao Soares et al. (2016) observed lufenuron induced behavioural changes such as loss of equilibrium erratic swimming, motionlessness and lying down in Colossoma macropomum [6]. Similar effects were also recorded in Poecilia reticulata following rotenone application [7]. Khalil et al. (2017) researched social behavioural changes in Oryzias latipes under the effect of chlorpyrifos and reported significantly decreased schooling and shoaling behaviour varying based on the duration [8]. In Cyprinus carpio, ketoconazole exposure resulted in decreased swimming activity and enhanced shoaling behaviour. Accumulation of chemical in the brain tissue was suggested to cause recorded neurological and behavioural responses by marked correlation between determined alterations and bioconcentration parameters [9]. Observed behavioural changes can be attributed to the neurotoxic effect of tested pesticides mediated by AChE inhibition and acetylcholine (ACh) accumulation in the synapses and neuromuscular junctions, leading to...
overstimulation of cholinergic receptors which could ultimately end in death due to an overall decline in neural and muscular control [10].

Organochlorine and pyrethroid pesticides primarily act on the voltage-gated sodium channel proteins being essential for normal transmission of nerve impulses, and the interference leads to paralysis or ultimate death [11-13]. Pesticides can trigger neurotoxicity by targeting cholinergic receptors and modifying neurotransmitter levels as well. Neurotransmitters, such as ACh (motor coordination), serotonin (reproductive behaviour), dopamine (locomotor and appetitive behaviours), γ-amino butyric acid (GABA; main inhibitory neurotransmitter) and norepinephrine (cognition, attention, locomotion) function as signalling molecules depending on specific receptors in the synaptic cleft [14,15]. In Channa punctatus, carbophuran induced depletion in norepinephrine, dopamine and serotonin resulted in changed locomotor activity as evidenced by enhanced surfacing activity, distance travelled and frequent opercular movements [16]. Sledge et al. (2011) reported decrease in dopamine and norepinephrine levels in Danio rerio exposed chlorpyrifos in embryonically and stated long-lasting neurobehavioural deficits including increased startle response and hyperactivity, decreased predatory avoidance and impairment in learning [17]. Fipronil, a GABA antagonist, application resulted in anxiety-like behaviour in D. rerio larvae [18]. Therefore alterations in complex fish behaviour is received increased attention with the advantage of providing an early warning of detrimental effects of toxicants when potential impacts on fish populations are taken into account.

Conclusion

In conclusion, the nervous system has unique structural and functional characteristics providing rapid cellular communication, and maintaining both intracellular and extracellular communication is critical to proper functioning. The behavioural pattern of an organism is an integrated result of a variety of biochemical and physiological processes. Fish as a good model organism because of the central role they play in aquatic ecosystems provides an early warning of detrimental impacts caused by pesticides that may become apparent later in other species.

References


