MEDWIN PUBLISHERS
Committed to create value for Researchers

Advances in Clinical Toxicology

Pesticide Induced Neurotoxicity and Fish Behaviour

Dogan D*

Department of Plant and Animal Production, Gaziantep University, Turkey

Mini Review

Volume 2 Issue 2

Received Date: November 01, 2017

Published Date: November 22, 2017

***Corresponding author:** Demet Dogan, Vocational School of Araban, Department of Plant and Animal Production, Gaziantep University, Turkey, Tel: +90 342 611 26 66-125; E-mail: demetdogan@gantep.edu.tr

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. Inaquatictoxicologystudies, 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. Inaquatic toxicology studies, pesticide induced neurotoxicty 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 andaltered social behaviour [5].

As demonstration of this, Rafaela Leao Soareset 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 *Oryziaslatipes* under the effect of chlorpyrifos and reported significantly decreased schooling and shoaling behaviour varying based on the duration [8]. In *Cyprinuscarpio*, 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), seratonin (reproductive behaviour), dopamine (locomotor and appetitive behaviours), γ-aminobutyricacid (GABA; main inhibitory neurotransmitter) and norepinephrine(cognition, attention, locomotion)function as signalling molecules depending on specific receptors in the synaptic cleft [14,15]. In *Channapunctatus*, carbofuran 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 *Daniorerio* 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 organisms an integrated result of a variety of biochemical and physiological processes. Fish as a good model organism because of thecentral role they play in aquaticecosystems provides an early warning of detrimental impacts caused by pesticides that may become apparent later in other species.

References

1. Campbell HA, Handy RD, Sims DW (2005) Shifts in a fish's resource holding power during a contact paired interaction: the influence of a copper contaminated diet in rainbow trout. Physiological and Biochemical Zoology 78(5): 706-714.
2. Dogan D, Can C (2011) Hematological, biochemical, and behavioral responses of Oncorhynchus mykiss to dimethoate. Fish Physiology and Biochemistry 37: 951-958.
3. Renick VC, Weinersmith K, Vidal-Dorsc DE, Anderson TW (2016) Effects of a pesticide and a parasite on neurological, endocrine and behavioral responses of an estuarine fish. Aquatic Toxicology 170: 335-343.
4. Altenhofen S, Nabinger DD, Wiprich MT, Pereira TCB, Bogo MR, et al. (2017) Tebuconazole alters morphological, behavioral and neurochemical parameters in larvae and adult zebrafish (Danio rerio). Chemosphere 180: 483-490.
5. Colovic MB, Krstic DZ, Lazarevic-Pasti TD, Bondzic AM, Vasic VM (2013) Acetyl cholinesterase inhibitors: pharmacology and toxicology. Curr Neuropharmacol 11(3): 315-335.
6. Rafaela Leao Soares P, Lucas Correa de Andrade A, Pinheiro Santos T, Caroline Barros Lucas da Silva S, Freitas da Silva J, et al. (2016) Acute and chronic toxicity of the benzoylurea pesticide, lufenuron in the fish, Colossoma macropomum. Chemosphere 161: 412-421.
7. Melo KM, Oliveira R, Grisolia CK, Domingues I, Pieczarka JC, et al. (2015) Short-term exposure to low doses of rotenone induces developmental, biochemical, behavioral, and histological changes in fish. Environ Sci Pollut Res Int 22(18): 13926-13938.
8. Khalil F, Qiu X, Kang IJ, Abo-Ghanema I, Shimasaki Y, et al. (2017) Comparison of social behavior responses of Japanese medaka (Oryziaslatipes) to lethal and sublethal chlorpyrifos concentrations at different exposure times. Ecotoxicology and Environmental Safety 145: 78-82.
9. Liu, J, Cai Y, Lu G, Dan X, Wu D, et al. (2017) Interaction of erythromycin and ketoconazole on the neurological, biochemical and behavioral responses in crucian carp. Environ Toxicol Pharmacol 55: 14-19.
10. Mileson BR, Chambers JE, Chen WL, Dettbarn W, Enrich M, et al. (1998) Common mechanism of toxicity: a case study of organophosphorus pesticides. Toxicol Sci 41(1): 8-20.

11. Da Cuna RH, Rey Vazquez G, Piol MN, Guerrero NV, Maggese MC, et al. (2011) Assessment of the acute toxicity of the organochlorine pesticide endosulfan in Cichlasoma dimerus (Teleostei, Perciformes). Ecotoxicology and Environmental Safety 74(4): 1065-1073.

12. Gupta SK, Pal AK, Sahu NP, Saharan N, Mandal SC, et al. (2014) Dietary microbial levan ameliorates stress and augments immunity in Cyprinus carpio fry (Linnaeus, 1758) exposed to sublethal toxicity of fipronil. Aquaculture Research 45(5): 893-906.

13. Narra MR (2016) Single and cartel effect of pesticides on biochemical and haematological status of Clarias batrachus: A long-term monitoring. Chemosphere 144: 966-974.

14. Gomez-Gimenez B, Llansola M, Hernandez-Rabaza V, Cabrera-Pastor A, Malaguarnera M, et al. (2017) Sex-dependent effects of developmental exposure to different pesticides on spatial learning. The role of induced neuroinflammation in the hippocampus. Food Chem Toxicol 99: 135-148.

15. Sarty KI, Cowie A, Martyniuk CJ (2017) The legacy pesticide dieldrin acts as a teratogen and alters the expression of dopamine transporter and dopamine receptor 2a in zebrafish (Daniorerio) embryos. Comparative Biochemistry and Physiology Part C. Toxicology & Pharmacology 194: 37-47.

16. Gopal K, Ram M (1995) Alteration in the neurotransmitter levels in the brain of the freshwater snakehead fish (Channa punctatus) exposed to carbofuran. Ecotoxicology 4(1): 1-4.

17. Sledge D, Yen J, Morton T, Dishaw L, Petro A, et al. (2011) Critical duration of exposure for developmental chlorpyrifos-induced neurobehavior altoxicity. Neurotoxicol Teratol 33(6): 742-751.

18. Wang C, Qian Y, Zhang X, Chen F, Zhang Q, et al. (2016) A metabolomic study of fipronil for the anxiety-like behavior in zebrafish larvae at environmentally relevant levels. Environ Pollut 211: 252-258.