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Collaboration of carbaryl with acetylcholinesterase, 2,4,6-Trichlorophenol and Mercury with references to teleost, Clariasbatrachus

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Abstract:

Acetylcholinesterase (AChE, EC 3.1.1.7) of ClariasBatrachus, a fresh water teleost, was localised both in the paniculate and soluble fractions of cell free homogenate of the fish tissues. The paniculate bound enzyme could be solubilised using buffer containing Triton X100 resulting in maximum recovery of enzyme (88–92%) in the supernatant. Carbaryl at sublethal concentrations exerted an inhibitory effect on the level of AChE activity in the tissues of the fish. The inhibition was more pronounced when the fish was exposed with the subacute concentrations of the pesticide (1, 2 and 6mg/l) for 15 days than for 96 hr. There was much less difference between the inhibitory effects of carbaryl at 2 and 6 mg/1 concentrations for both treatment durations, except in gills where the inhibition was enhanced at increased concentration (6 mg/1). The interaction of carbaryl caused more inhibition of AChE activity in brain and gills than liver and muscle of C. batrachus.

Keywords: ClariasBatrachus, Solubilisation, Carbaryl, Acetylcholinesterase, Inhibition.

Introduction:

The increased discharge of various chlorophenolic compounds is a significant cause of concern for the environment (U.S.EPA 2017). One example of products included in this group is 2,4,6-trichlorophenol (2,4,6-TCP). This chlorinated phenol is widely used as antiseptic, glue, leather and wood preservative, antimildew agent, water chlorinator, organic solvent and the synthesis of various agricultural chemicals (Olaniran and Igbinosa 2011). 2,4,6-TCP has been classified as an extremely toxic, mutagenic and carcinogenic compound due to the C–CL bond position relative to the – OH group. This makes it recalcitrant to biodegradation and leads to its interference in mitochondrial oxidative phosphorylation through the inhibition of cytochrome P450-dependent mixed-function oxidases (NCBI 2021). The recalcitrant nature of 2,4,6-TCP results in high toxicity for a considerable period (Benbachir et al. 2017). This chemical enters the environment through several routes like industrial waste, insecticides

or by degradation of complex chlorinated hydrocarbons. It canbioaccumulate, for example, in fish, as observed in the studies of Igbinosa et al. (2013) and Muir and Servos (2020).

Materials and Methods:

Haematological Profiles and Indices:

The changes in different haematological parameters on chronic exposure to 2,4,6-TCP are presented in Fig. 1. A gradual increase pattern was observed for TEC, Hb and TLC for the two 2,4,6-TCP concentrations compared to the control (CTR), in opposition to MCH, where a decreasing pattern was observed. For TEC, a significant increase was observed for both concentrations after 15 and 45 days of exposure, whereas for 30 days, a significant increase was observed only for the higher concentration (1.0 mg/L). For Hb, a significant increase was observed for both concentrations after 15 and 30 days of exposure and for the higher concentration (1.0 mg/L) only after 45 days of exposure. For TLC, when compared to the control, significant increases were observed for both concentrations in all exposure times. On the other hand, when compared to the control, significant decreases for all concentrations and exposure times were observed for MCH. Due to the lack of homoscedasticity or normality, a two-way ANOVA could only be performed for TEC and MCH. On both parameters, a significant interaction was observed between time and concentration.

Discussion:

Integrated Biomarkers Response (IBR):

When looking to the different analysed parameters at the different sampling times, it is possible to observe an increasing pattern in the IBR score with the increase of 2,4,6-TCP concentrations. This increase is also reflected in the IBR scores over time. It is noteworthy that control scores are always zero or very close to it, whereas the treatments are much higher. This is even more evident for the IBR time scores, where the lower (0.5 mg/L) and higher (1 mg/L) concentration is 10×and 20×higher, respectively, than the control. The only score where the control had worse scores than the 2,4,6-TCP treatments was for the HSI parameter after 45 days of exposure.

Results:

The present study aims to determine the following: (1) the chronic toxic effects of 2,4,6-TCP on haematological parameters (haemoglobin, total erythrocyte count, total leucocyte count and mean corpuscular haemoglobin), biochemical parameters (total serum protein and total serum glucose), growth and reproductive parameters (condition factor, hepatosomatic index, maturity

index, specific growth rate, growth hormone, 17β-estradiol and testosterone) of air breathing catfish, *Clariasbatrachus*; and (2) the use of IBR as a tool to determine the deleterious effects of this chemical not always evident.

Conclusion:

The present research shows the effects of 2,4,6-TCP on the fish species *Clariasbatrachus*. 2,4,6-TCP exposure resulted in altered haematological, biochemical, growth and reproductive parameters using the IBR index to integrate all of the toxicological effects. This is the first study showing its effects on higher organisational levels, thus underlying the mechanism behind the changes in haematological, biochemical, growth and reproductive indices. Without exceptions, the results showed that 2,4,6-TCP had a deleterious impact in all of the tested parameters in the catfish *C. batrachus*. This impact occurred even at the lowest concentration (0.5 mg/L) for the shortest exposure time (15 days). These findings were further highlighted by the IBR index, which showed up to 20×worse scores than the control for all treatments and sampling times. The present data can then be used for regulatory policymakers to regulate better the industry and their illegal discharge of effluents that may be rich in 2,4,6-TCP. This becomes even more important for local populations that directly use this catfish species as food and medicinal sources. They may see their population numbers decrease or inadvertently ingest this type of pollutants. Nonetheless, future research is still needed, for example, on the fine structure of selected fish tissues to corroborate the present findings of 2,4,6-TCP toxicity and adopt specific biological methods to mitigate 2,4,6-TCP toxicity.

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