Neurobiochemical Analysis of Abnormal Fish Behavior Caused by Copper and Fluoranthene Toxicity

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The goal of this study is to develop a biomarker used in monitoring abnormal behaviors of Japanese medaka (Oryzias latipes) as a model organism caused by hazardous chemicals. Japanese medaka was treated by copper and fluoranthene of appropriate sublethal concentrations after starvation for 48 hr. In this study we investigated neural toxicity of copper and fluoranthene in Japanese medaka (Oryzias latipes) along with comparative analysis of corresponding behavioral responses. The untreated individuals showed common behavioral characteristics (i.e., smooth and linear movements). Locomotive activity of the fish was monitored using an image processing and automatic data acquisition system. When treated with copper (100 ppb), the fish showed shaking patterns more frequently. As the concentration of copper increased to 1,000 ppb, activity decreased, and the fish showed an erratic movement. The treated with fluoranthene, however, showed stopping and abrupt change of orientation (100 ppb), and severely reduced locomotive activity and enhanced surfacing activity (1,000 ppb).

Fish were exposed to copper and fluoranthene at various concentrations (0, 100 and 1,000 ppb) for 24 hrs, and acetylcholine esterase (AChE) activity was observed. When fish were exposed to 1,000 ppb of copper, the body AChE activities appeared to decrease but the head AChE activities showed little change. Treatment of the medaka fish with fluoranthene caused a significant suppression of acetylcholine esterase (AChE) activities in the body portion but not in the head portion. When fish were exposed to 1,000 ppb of fluoranthene

for 24 hr, the body AChE activities decreased from 126.±31.89 (nmoles substrate hydrolyzed per min per mg protein) to 49.51± 11.99.

Expressions of tyrosine hydroxylase (TH) protein in the different organs from both head (brain) and body (kidney) portions affected by copper and fluoranthene treatment were analyzed using immunohistochemical technique compared with control. Five organs of the fish (olfactory bulb, hyothalamus, optic lobe, pons and myelencephalon regions) showed a relatively strong TH protein expression in the control experiment. A differential expression of TH, however, was observed in the treatment (100 ppb and 1,000 ppb). The treatment (1,000 ppb) significantly suppressed TH protein production in the brain regions. In kidney, however, the same treatment caused little suppression compared with the control. Copper and fluoranthene appeared to be less effective in suppression of TH than diazinon, a known TH suppressor. This study provides molecular and neurobehavioral bases of a biomonitoring system for toxic chemicals using fish as a model organism.