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Effects of simultaneous exposure to aluminum at low pH, fluoranthene and ultraviolet radiation on antioxidant mechanisms in Japanese Medaka (*Oryzias latipes*)

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Aquatic organisms are continuously exposed to multiple stressors that originate from various anthropogenic activities. Here, we investigated the effects of multiple stressors (the photo-active polycyclic aromatic hydrocarbon: Fluoranthene (Fl), aluminum (Al), low pH and ultraviolet (UV) radiation on fish health using responses of antioxidant mechanisms and indicators of oxidative damage as biomarkers. Toxicity of Fl as well as of other PAHs is enhanced in presence of UV light by promoting production of reactive oxygen species. Furthermore, in acidified aquatic ecosystems (e.g., Orinoco and Amazon basins in South America) fish are simultaneously exposed to low pH and elevated concentrations of Al as well as to PAHs derived from oil exploitation and other sources. Juvenile Medaka (*Oryzias latipes*) were exposed to a 2×3 factorial treatment structure (0 and 100 µg L⁻¹ of total Al and 0, 1 and 5 µg L⁻¹ of Fl) at pH 5.3 in the presence of ultraviolet radiation (UVA: 360.1±18.4 µW cm⁻² and UVB: 6.3±0.5 µW cm⁻²) for 7 days. Effects on enzymatic and non-enzymatic antioxidants and the expression of oxidative stress-related genes were evaluated after 3 and 7 days of exposure. Fl inhibited the enzymatic activity of glutathione peroxidase and enhanced the glutathione reductase activity, however significant changes in gene expression were not found. Moreover, glutathione concentration decreased after exposure to either Fl or Al. The proposed hypothesis that Al at low pH enhances Fl-photo-induced oxidative stress in Japanese Medaka was not supported by this study. However, it was shown that both compounds have deleterious effects on the glutathione-related antioxidant system which may increase fish susceptibility to oxidative stress caused by adverse environmental conditions and other pollutants.

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