**Comparisons of estrogenic activities and ROS responses in rare minnow (*Gobiocypris rarus*) exposed to perfluorooctane sulfonates and perfluorononanoic acid**

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Perfluorinated compounds (PFCs) are a kind of ubiquitous environmental contaminants that have been detected in a variety of terrestrial and aquatic organisms. Perfluorooctane sulfonate (PFOS) and perfluorononanoic acid (PFNA） belong to the typical PFCs. The toxicity of these compounds has been studied recent years. However, so far the estrogenic effects and oxidative damage mechanism of single and  combined exposure have not been reported. The estrogenic activities and growth effects of perfluorooctane sulfonates (PFOS), perfluorononanoic acid (PFNA) and their mixtures were studied using recombinant yeast and rare minnow. Some endpoints of oxidative damage such as reactive oxygen species (ROS), thiobarbituric acid reactive substances (TBARS), protein carbonyl, superoxide dismutase (SOD) and glutathione (GSH), were also detected in fish liver. No estrogenic activities were found for these chemicals in vitro test. However, long exposure of PFOS, PFNA and their mixtures (>0.2μmol/L) resulted in induction of vitellogenin (Vtg) in adult male rare minnow(Fig. 1). And the growth endpoints such as body weight and condition factor were decreased. PFOS and PFNA (>0.2μmol/L) exposure could cause excess ROS formation, result in oxidative damage to lipids and proteins, and reduce antioxidant capacities in fish. There was good correlation between the content of ROS and Vtg (R2>0.99) (Fig. 2). It suggested that the induction of Vtg in male rare minnow might be due to formation of ROS in liver.



Fig. 1 Effect of PFOS, PFNA and their mixture on the Vtg synthesis in rare minnow.



Fig. 2 Linear regression between the content of Vtg and ROS