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NMR-based metabolomic study on the toxicological effects of pesticide, diazinon on adaptation to sea water by endangered Persian sturgeon, *Acipenser persicus* fingerlings

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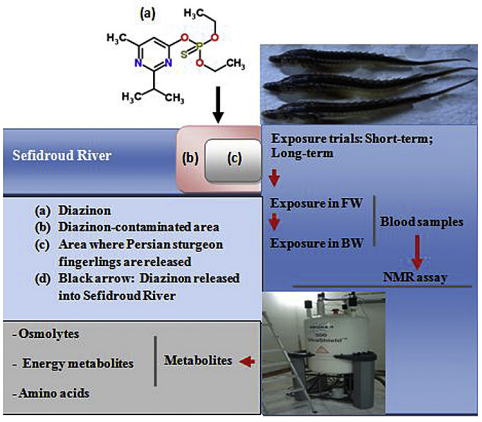
HIGHLIGHTS

- Diazinon inhibits and actives gluconeogenesis during short-term and long-term exposure in FW.
- Glucose and lipids meet energetic requirements of oxidative stress during short and long-term exposure respectively.
- Osmolytes play important role during SW adaptation.
- Osmolytes can act as antioxidant against oxidative stress.
- During short-term exposure in FW, free amino acids are probably used for synthesis of detoxification proteins.

GRAPHICAL ABSTRACT



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ABSTRACT

NMR-based metabolomics was applied to explore metabolic impacts of diazinon on sea water adaptation of Persian sturgeon fingerlings, *Acipenser persicus*. Fingerlings were exposed to sub-lethal concentrations of diazinon in freshwater (FW) for 96 h (short-term trial) and 12 days (long-term trial) and then exposed in brackish water (BW) (12 mg L^{-1} salinity) for 24 h. After 96 h and 12 days exposure in FW, identified metabolites (amino acids, osmolytes, energy metabolites) showed different change-patterns compared to control group ($P < 0.05$) as follow: (A) short-term trial: higher plasma levels of glucose, lactate (in all diazinon-exposed fish), acetate and acetoacetate (in 0.9 mg L^{-1}diazinon treatment); lower levels of creatine (in all diazinon-exposed fish), trimethylamine-N-oxide, choline, taurine, betaine, N,N-dimethylglycine and almost all amino acids in fish exposed to high concentrations of diazinon (0.54 and 0.9 mg L^{-1} diazinon). (B) Long-term trial: higher plasma levels of lipid oxidation metabolites and almost all amino acids in fish exposed to 0.54 and 0.9 mg L^{-1} diazinon; lower levels of creatine, trimethylamine-N-oxide, N,N-dimethylglycine, betaine, choline (in all diazinon-exposed fish), glucose (in 0.54 and 0.9 mg L^{-1}diazinon treatments) and taurine (in 0.9 mg L^{-1} diazinon treatment).

When fish were exposed in BW for 24 h, the plasma levels of osmolytes decreased significantly in almost all experimental groups of short-term and long-term trial ($P < 0.05$). In short-term trial, the plasma levels of glucose in all groups and lactate in 0.18 and 0.54 mg L^{-1} diazinon treatments increased

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