

Integrated biomarker analysis of chlorpyrifos metabolism and toxicity in the earthworm *Aporrectodea caliginosa*

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To increase our understanding about the mode of toxic action of organophosphorus pesticides in earthworms, a microcosm experiment was performed with *Aporrectodea caliginosa* exposed to chlorpyrifos-spiked soils (0.51 and 10mgkg⁻¹ dry soil) for 3 and 21d. Acetylcholinesterase (AChE), carboxylesterase (CbE), cytochrome P450-dependent monooxygenase (CYP450), and glutathione S-transferase (GST) activities were measured in the body wall of earthworms. With short-term exposure, chlorpyrifos inhibited CbE activity (51-89%) compared with controls in both treated groups, whereas AChE activity was depressed in the 10-mgkg⁻¹ group (87% inhibition). With long-term exposure, chlorpyrifos strongly inhibited all esterase activities (84-97%). Native electrophoresis revealed three AChE isozymes, two of which showed a decreased staining corresponding to the level of pesticide exposure. The impact of chlorpyrifos on CbE activity was also corroborated by zymography. CYP450 activity was low in unexposed ear