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Effects of aqueous soil-biochar extracts on representative aquatic organisms: a first evaluation

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Increasing considerations of biochar application to soils has raised concerns over implications to overall environmental quality, associated to some of its components. The heterogeneity of biochar composition is well documented in relation to co-existing chemical species, as a function of feedstock and pyrolysis conditions. Robust ecotoxicology studies with focus on bioavailable biochar components in soil remain scarce and have only started to emerge. This pilot study provides an insight into the potential ecotoxicological effects of aqueous extracts of biochar-amended soil on a range of aquatic organisms (Vibrio fischeri, Pseudokirchneriella subcapitata and Daphnia magna), using a battery of standard aquatic bioassays. The use of such bioassays in environmental risk assessment of soil-biochar elutriates is here suggested as a crucial tool, to bridge the gap between biochar's 'inert' fraction in soil and that bioavailable to edaphic organisms.

Aqueous extracts were obtained from LUFA 2.2 standard soil (control) and following amendment with pine biochar at common field application rates (80 ton ha-1). Acute exposure to soil-biochar extracts allowed estimating toxicity parameters and developing dose-response curves for all tested species, through well-established methodological guidelines. The bioluminescent bacteria V. fischeri showed negligible EC50 (effect concentration corresponding to 50% luminescence decline) values in the MICROTOX® basic test (independent of exposure time), suggesting low susceptibility to soil-biochar extracts. Mild toxicity was also observed in the microalgae P. subcapitata growth inhibition test, where significant deleterious effects on growth rate occurred only at the highest (100%) extract concentration ($p<0.05$). Among the tested species, toxicity was generally more marked in the primary consumer D. magna, with an EC50 (effect concentration corresponding to 50% immobilisation) of 2.95%. The pattern and extent of observed effects were species-specific, thus the use of multiple test species, as part of an integrative ecotoxicological approach, has shown relevance. Preliminary results suggest potential trophic unbalances in aquatic systems, as a result of exposure to leachates from biochar-amended soils.