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Ecotoxicity of functionalised Biochar – A case study

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Introduction

The term Biochar is used to name the charcoal obtained from the pyrolysis of biomass at temperatures generally lower than 700 °C and in environments with little or no supply of oxygen (O_2). This charcoal is produced to be applied on the soil in a deliberate manner.

In the environment, biological and chemical processes occur, altering the Biochar and generating a new compound where carboxyl groups are directly connected to the charcoal recalcitrant aromatic structures.

This final compound improves the chemical, physical and biological properties of the soil. However, this modified charcoal may take decades to be formed in nature.

Due to this, we are trying to obtain it through the chemical functionalisation of charred material. The chemical functionalisation is a process in which activated charcoal is subjected to a chemical treatment to acquire carboxylic groups linked to recalcitrant aromatic structure. However, besides the chemical and agronomic evaluation of this product, the risks that this product may present to the environment must be analysed.

The toxicological risks of a specific pollutant to the aquatic community can not only be determined through chemical analysis of water and sediment. These analyses alone will not evaluate the toxicity of the pollutant to organisms. Therefore, ecotoxicological tests have been proposed and implemented, to understand and to observe the responses of the organisms, inhabiting the areas of study, to different pollutant concentrations [1].

So, the objective of this study is to demonstrate the use of this methodology to assess the acute toxicity of a soil conditioner prototype derived from the chemical functionalisation of Biochar.

In this experiment, *Daphnia similis*, a planktonic freshwater microcrustacea (Figure 1), was used as bioindicator. The cultivation of the organisms was carried out in basic medium M4. The third generation neonates were used on susceptibility tests with potassium dichromate. The cultures of *D. similis* were kept in an incubator chamber of biochemical oxygen demand (BOD), at temperature of 20 ± 2 °C, under a light intensity of 1000 lux and a photo period of 16 hours of light. The animals were kept in glass crystallisers of 2 L with conductivity of 160 uS cm^{-1}, hardness of 180-200 mg L^{-1} $CaCO_3$ and oxygen above 80% saturation, following the method of cultivation [2, 3].

The median lethal dose with 48 h of exposure (48 h LC50) was calculated using the Probit statistical method. The experiment was conducted two times, each with three replications, using six concentrations (0; 3; 6; 12; 24; 48 and 70 mg L^{-1}) of fulvic-like fractions (the fraction that are soluble in aqueous solution at any pH) obtained from activated charcoal chemically functionalised.

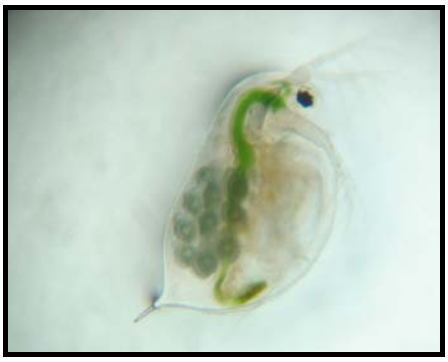

Figure 1. *Daphnia similis* in adulthood (40X magnification)

Results and Discussions

The average values for the reference tests with an aqueous solution of potassium dichromate showed 24 h LC50equals 1.47 mg L^{-1}. This result guarantees the feasibility of the study with the organism *Daphnia similis*, considering that they are within the range established as acceptable, it means, between 0.9 and 2.0 mg L^{-1}.

The value obtained with the aqueous solution of fulvic acids for the 48 h LC50 was 21 mg L^{-1}, with upper and lower limits of 32 and 20 mg L^{-1}, respectively, which classifies the material tested as moderately toxic.

In the analysis of TOC, we obtained values of 190.8 mg L^{-1} of total carbon, 1.25 mg L^{-1} of inorganic carbon and consequently, 189.5 mg L^{-1} of organic carbon.Thus values were used to convert the values oftoxicity. After converting it , 48 h LC50 values for *Daphnia similis*, turned out to be 7.28 mg L^{-1} for total carbon.

Conclusions

The results obtained, proved that *Daphnia similis* is a good bio-indicator to water pollution. It also showed that ecotoxicological tests are good to set the limits of substances in water; allowing to do appropriate corrections as well as to monitor the aquatic ecosystem.

With it this study showed the utility of toxicological tests to assess these new products, not only to meet legislation but especially to be coherent with the main objective of this research, which is environmental preservation and mitigation of anthropic activity.

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