Can biochar ameliorate triclosan impact on soil bacteria?

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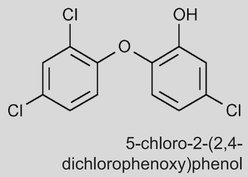
Background

What is triclosan?



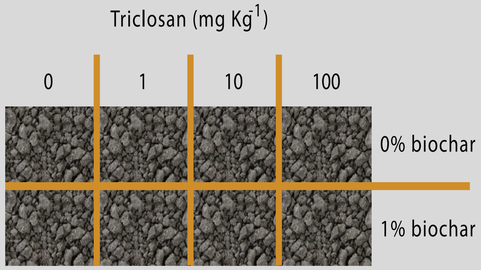
5-chloro-2-(2,4-dichlorophenoxy)phenol

- Broad-spectrum antimicrobial
- Widely used in industrial, medical and personal care products
- Persists in biosolids (0.334-133 mg Kg^{-1})[1]
- Most of the triclosan remains in the surface of biosolids-amended soils[2,3]
- It can be transformed into more toxic metabolites[4,5]
- FDA removed triclosan from over-the-counter antibacterial hand and body washes

Biochar modifies xenobiotics bioavailability

- Soil amendment[6]
- Enhance soil fertility[7]
- Carbon sequester and sorption of micropolllutants[8]

Methods

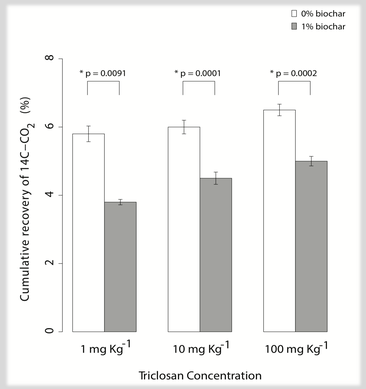


Arkport silty clay loam soil

- **Mineralization of triclosan**
- **Bacterial community analysis**
  - V6 region of 16S rRNA genes via Illumina sequencing
  - Bacterial diversity
  - Bacterial community structure
  - Dynamic OTUs

Results

1. Mineralization of triclosan



- Little triclosan was mineralized in soil samples
- Biochar decreased triclosan mineralization by 24-33%

Figure 1. Cumulative recovery of 14C-CO_2 from soil samples exposed for 42 days to different concentrations of 14C-radiolabeled triclosan. * indicates statistically significant differences (t-test, p<0.01)

2. Bacterial diversity

- Lower alpha diversity in soil samples exposed to 10 mg Kg^{-1} both in absence and presence of biochar

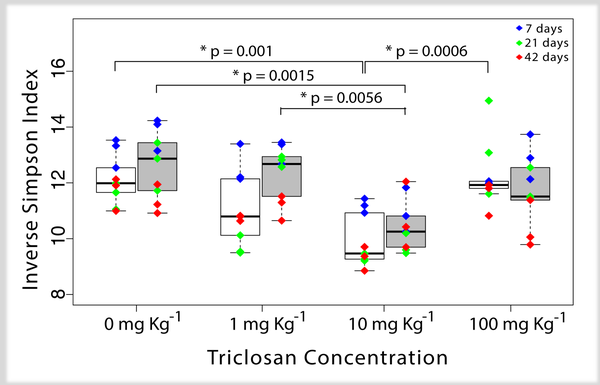


Figure 2. Bacterial alpha diversities per triclosan exposure measured by the Inverse Simpson Index in absence (white box) and presence (grey box) of biochar. * indicates statistically significant differences (Tukey HSD, p<0.01)

3. Bacterial community structure

- Bacterial communities clustered by triclosan concentration (AMOVA, p<0.01), but not by presence or absence of biochar (AMOVA, p=0.678)

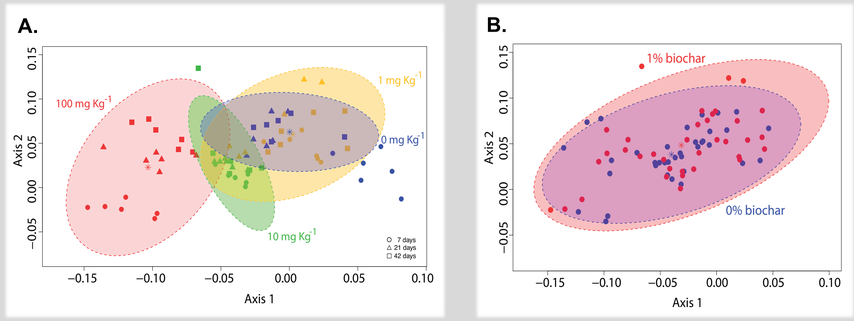


Figure 3. NMDS analysis of the bacterial community structures using θYC distances according to **A.** triclosan exposure, and **B.** presence of biochar. The 2 axes represent 95% of the variance. The lowest stress is 0.104 with and R-squared value of 0.97.

4. Bacteria taxa impacted by biochar

- Non-parametric Metastats analysis showed few OTUs impacted by biochar in a triclosan-concentration dependent manner (Control: 32 OTUs, 1mgKg^{-1}: 43 OTUs, 10mgKg^{-1}: 18 OTUs, 100mgKg^{-1}: 32 OTUs)

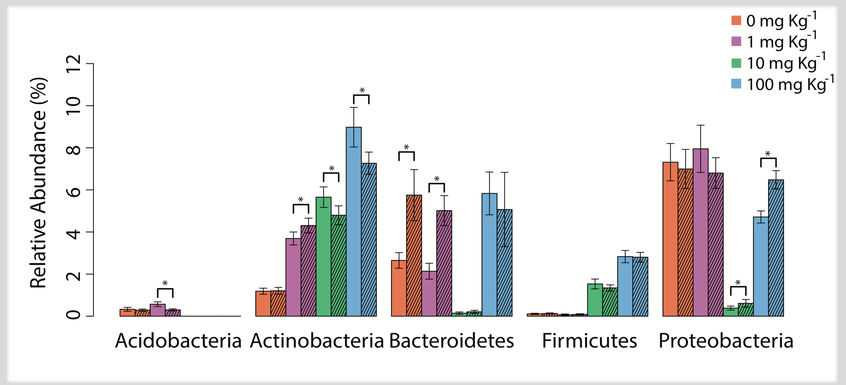


Figure 4. Relative abundance (%) of significantly impacted OTUs (NPM analysis, p<0.05) at phyla level with (☐) and without (▨) biochar for each triclosan concentration. * indicates significant difference between the relative abundances with and without biochar (Wilcoxon test, p<0.05)

Conclusions

- Even though biochar appeared to reduce triclosan bioavailability, biochar could not overcome the effect of triclosan on the soil bacterial communities
- Biochar was found to more than double the level of *Bacteroidetes* in the control (0 mg Kg^{-1}) and 1 mg Kg^{-1} of triclosan, but did not have positive effect at higher concentrations of triclosan
- *Proteobacteria* was the only phylum positively affected by biochar at higher concentrations of triclosan (10 and 10 mg Kg^{-1})
- Though known triclosan degraders were not significantly affected by biochar, other xenobiotic degraders such as *Propionivibrio* and *Variovorax* were positively affected by biochar

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