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Biochar: a green sorbent to sequester acidic organic contaminants

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Biochar is a carbon rich product of biomass pyrolysis that exhibits a high sorption potential towards a wide variety of inorganic and organic contaminants. Because it is a valuable soil additive and a potential carbon sink that can be produced from renewable resources, biochar has gained growing attention for the development of more sustainable remediation strategies. A lot of research efforts have been dedicated to the sorption of hydrophobic contaminants and metals to biochar. Conversely, the understanding of the sorption of acidic organic contaminants remains limited, and questions remain on the influence of biochar characteristics (e.g. ash content) on the sorption behaviour of acidic organic contaminants.

To address this knowledge gap, sorption batch experiments were conducted with a series of structurally similar acidic organic contaminants covering a range of dissociation constant (2,4-D, MCPA, 2,4-DB and triclosan). The sorbents selected for experimentation included a series of 10 biochars covering a range of characteristics, multiwalled carbon nanotubes as model for pure carbonaceous phases, and an activated carbon as benchmark. Overall, sorption coefficient [L/kg] covered six orders of magnitude and generally followed the order 2,4-D < MCPA < 2,4-DB < triclosan. Combining comprehensive characterization of the sorbents with the sorption dataset allowed the discussion of sorption mechanisms and driving factors of sorption. Statistical analysis suggests that (i) partitioning was the main driver for sorption to sorbents with small specific surface area (< 25 m^2/g), whereas (ii) specific mechanisms dominated sorption to sorbents with larger specific surface area. Results showed that factors usually not considered for the sorption of neutral contaminants play an important role for the sorption of organic acids. The pH dependent lipophilicity ratio (i.e. D instead of Kow), ash content and ionic strength are key factors influencing the sorption of acidic organic contaminants to biochars. Overall, the identified factors, as well as the environmental matrix, should be carefully considered when selecting the type of biochar for sequestration purposes.