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Formation of hydrothermal biochar and char stability in soils

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The use of charcoal as an artificial soil additive is suggested to beneficially modify degraded soil, reduce greenhouse gas emission and improve crop yields. So far research has been mainly done using pyrolysis chars which are produced by dry pyrolysis of biomass.

Here we used hydrothermal carbonisation (HTC). In this process wet biomass is converted to char at moderate temperatures (∼200°C). Due to the exothermal carbonisation reaction this process is almost energy neutral, i.e. the energy needed to start the carbonisation equals the energy released during carbonisation. Different process parameters have been used to modify the properties of the produced chars.

We examined the chemical and morphological properties of hydrothermally synthesized biochar. Cellulose, yeast and sucrose were used as model substances for a range of parent material types like organic and garden waste as well as residues from biogas production. By modifying the process conditions of hydrothermal carbonisation concerning temperature (180°C to 220°C) and duration (6 hours to 24 hours) we produced a variety of different biochars. Our findings suggest that the elemental composition and the thermal stability of resulting chars depend on the feedstock and production conditions. Functional group chemistry determined by NMR shows that the aromaticity of the product increases as a function of temperature whereas the amount of O-alkylic compounds declines, concurrently. Our results show that the properties of the biochar can be manipulated by the modification of process conditions. This opens the opportunity to adjust the charcoal to a given soil type.