

<https://doi.org/10.7250/CONNECT.2026.048>

MICROWAVE-ASSISTED HYDROTHERMAL CARBONIZATION OF SELECTED BIOMASSES WITH UREA

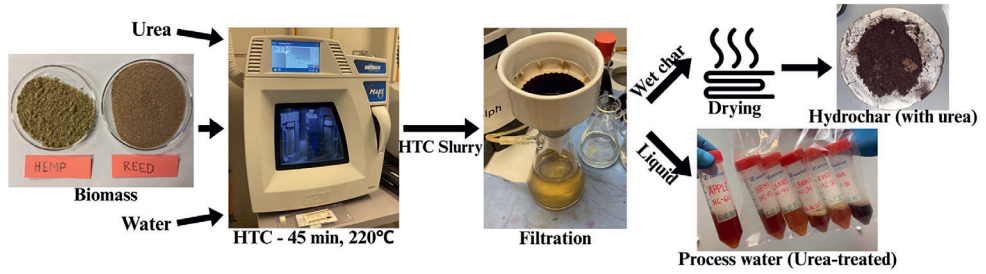
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Abstract – The condition of Latvian agricultural land has been deteriorating over the years. More than a quarter of Latvian agricultural are acidic and require liming. 35 % of the studied agricultural lands have low phosphorus reserves and 24 % have low potassium levels. A possible solution to the problem of improving soil quality is the use of hydrochar. Doping of hydrochar by nitrogen introduces specific surface functional groups. This leads to increased surface reactivity, improved cation exchange capacity and affinity for nutrients and pollutants. As a soil additive, it will contribute to slow nitrogen release and increased nutrient use efficiency. It could be a cheap, environmentally friendly material that contributes to waste reduction and carbon storage, which is consistent with the principles of a circular economy and sustainable agriculture. Biomass samples with relatively higher N, P and K content were selected for the study: reed, hemp, leaves, apple pomace, Canadian goldenrod and brewery's spent grains. Urea was chosen as a model compound (one of the main components of animal wastes). Hydrothermal carbonization (HTC) was carried out at 220 °C for 45 min in closed Teflon containers in a MARS 6 microwave digestion system. Deionized water was used, as well as 10 % (wt.) urea solutions in a liquid: biomass ratio of 10:1 for HTC. ATR-FTIR spectroscopy revealed a decreased amount of (C=O)-containing functional groups (~1730 cm⁻¹) in water-treated hydrochar up to their almost complete removal in urea-treated samples. Interaction between hydrochar and Cu²⁺ revealed no absorption at all. Absorption studies (UV-Vis spectrophotometry) of Methylene blue showed high removal efficiency (~96 %), but quiet low absorption capacity ~8 mg/g (at pH=7.4) with almost no significant differences between water- and urea-treated hydrochars. Finally, red-ox interaction between MnO₄⁻ and hydrochars shows that urea prevents oxidation of surface functional groups during HTC. As a result, final hydrochars have higher reduction properties what may significantly affect its behavior and shelf-life when used as soil amendment. Further studies are needed to understand short- and long-term effects on soil quality, as well as absorptions of pollutants in specific conditions, and evolution of C and N during its shelf life. However, obtained results show possibility of hydrochar production with regulated properties.

Keywords – *Adsorption; carbon sequestration; nitrogen doping; soil amendment; sustainability*



Hydrochar production scheme

ACKNOWLEDGEMENT

This work has been supported by The National Research Program of the Latvian Science Council “Decision-making Support System for Achieving Climate Neutrality Goals” Project no. VPP-KEM-Klimatneitralitāte-2023/1-0002.

