Activated Carbons from Organosolv Lignin for the Degradation of Organic Pollutants

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nHYBRID
Low Value Bio-based Feedstock to High Added Value Functional Nano-Materials via a Hybrid Biorefinery Concept

1 Introduction

- Biochar from lignocellulosic biomass is a promising adsorbent and catalyst for water purification.
- Organosolv fractionation of biomass enables holocellulose utilization; the lignin fraction can be converted via pyrolysis to phenolics and biochar.
- This study produced biochar from wood and lignin and evaluated its water purification performance for Bisphenol S (BPS) removal, a known pollutant and endocrine disruptor.
- Key variables investigated:
  a. Influence of feedstock type (wood, acid-washed wood, lignin)
  b. Pyrolysis temperature (600 °C vs. 900 °C)

2 Materials and Methods

Feedstocks

A. Beech wood (**Beech**)
B. Beech wood, acid-Washed (**BeechW**) with 1% HNO_3 to simulate inorganic element removal during typical organosolv treatment
C. Organosolv-derived lignin (**Lignin**)

Biochar production

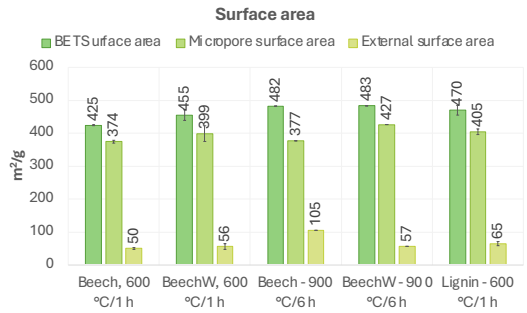
- Slow pyrolysis at 600 °C/1h or 900 °C/6h in a N_2-purged tubular reactor
- Textural properties determined via N_2 sorption-desorption

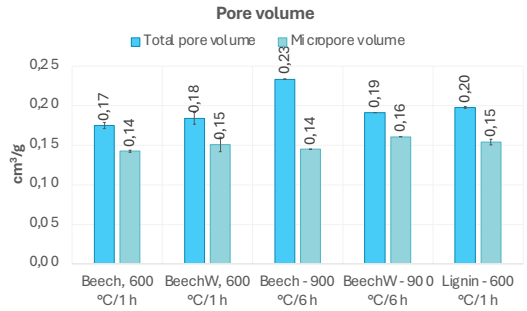
Evaluation of performance in BPS removal

- Monitored BPS (500 μg/L) removal from water solutions loaded with 500 mg/L biochar via:
  a. Adsorption (ADS) or
  b. Degradation (DEGR) in the presence of 500 mg/L sodium persulfate as oxidant
- BPS concentration measured via HPLC

3 Results

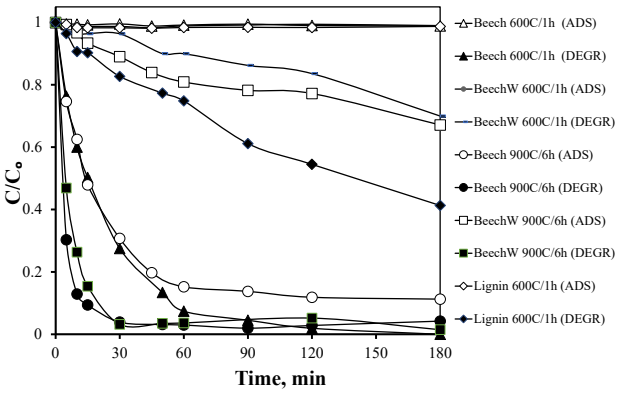
Biochar production & characterisation





- Biochar yield from beech wood: 22-29 wt.%
- Biochar yield from organosolv lignin: 40 wt.%
- High-surface-area microporous biochars obtained in all cases
- Elevated pyrolysis temperature and residence time → slightly increased surface area and pore volume
- Acid washing → increased microporous surface area
- Lignin biochar textural properties similar to those of wood-derived biochar, especially acid-washed-wood-derived biochar

Evaluation of performance in BPS removal



- Several biochars exhibited significant BPS removal, either via DEGR, or ADS, or both.
- Beech 900 °C/6h showed the highest efficiency (>98% DEGR, 85% ADS, both within 60 min)
- BeechW 900 °C/6h showed higher DEGR activity (96%) than ADS (20%) over 60 minutes
- Lignin 600 °C/1h showed negligible ADS (2% after 180 minutes), but demonstrated moderate DEGR activity (59% after 180 minutes)

4 Conclusions

- Organosolv lignin showed potential as a precursor for producing high yields of microporous biochar with high surface area
- However, despite similar textural properties, the organosolv lignin-derived biochar was less effective for the removal of BPS from water compared to beech wood-derived biochar
- The findings underscore the crucial influence of both the biomass feedstock type and the pyrolysis conditions on the biochar effectiveness in pollutant adsorption and oxidation in water purification applications
- The differences in pollutant removal efficiency between lignin-derived and wood-derived biochars are likely attributable to variations in their surface functional groups. Further research is ongoing to elucidate the specific mechanisms underlying these differences.

Acknowledgements

The work presented was conducted as part of the research project **NanoHybrid**, which is implemented in the framework of H.F.R.I's call "Basic research Financing (Horizontal support of all Sciences)" under the National Recovery and Resilience Plan "Greece 2.0" funded by the European Union – NextGenerationEU (H.F.R.I. Project Number: 015795).

H.F.R.I. Hellenic Foundation for Research & Innovation · Greece 2.0 National Recovery and Resilience Plan · Funded by the European Union NextGenerationEU