From misused feedstocks to valuable air purification materials

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Mariem Zouari
Assistant Researcher/ PhD student
Renewable Material Composites
InnoRenew CoE and University of Primorska

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**Overview**

- Olive stone
  - 10% of the fruit weight
  - In Europe, olive solid wastes are estimated at 10 million tonnes annually

- Arundo donax
  - Invasive species: 10\textsuperscript{th} among the 100 worst invasive species in the world
  - Fast growth rate: 38 tons of dry matter/ha/year

Huge amount of agricultural solid waste
Overview

Valorization by thermal conversion => Slow pyrolysis

- Sustainable approach
- Profitability
- Added-value products

Biochar is the solid residue generated during the thermal decomposition of organic matter under high temperature and inert conditions.

- Low cost
- Widely available
- Porous structure and large surface area
- Functional groups
- Frequently applied as adsorbent for organic and inorganic pollutants
- Tailorable properties

Suitable adsorbent for VOCs
Research Aim

Preparation of the biochar from under-utilized biomass and application in formaldehyde remediation

Direct effects on human health

Nausea  Headache  Skin irritation  Cancer  Lungs damage  Death
Preparation of the biochar particles

**Pre-pyrolysis treatment**

- High impurities and ash content:
  - Cleaning
  - Grinding
  - Demineralization: 1h, 60°C

**Pyrolysis**

- Optimized parameters:
  - Nitrogen, 300°C-800°C, 30min, heating rate 1500 °C/h

**Post-pyrolysis treatment**

- Wet ball milling
  - 30min
- Activation of one sample (800°C): CO₂
Characterization & Formaldehyde adsorption tests

- Physical composition
- FTIR
- Physisorption
**Effect of pyrolytic temperature on Porosity**

- Higher pyrolysis temperatures favored the thermal degradation => more volatiles were released and created cavities and pores in the biochar.
- Larger porosity and microporosity.
- The activation increased the SA by 43%.
- The activation increased the microSA by 14%.
Formaldehyde removal efficiency

- Positive correlation between FA removal and SA, Micro SA, and carbon content
- Multiple regression: only microporous SA had significant influence
- Type of biomass didn’t influence the performance of biochar in removing formaldehyde
- Occurrence of micropores in the was the key parameter for efficient formaldehyde removal

### Graph

- Arundo donax biochar
- Olive stone biochar

**Formaldehyde removal, %** (Per-1g of BC, 1 h STD)

- Pyrolysis temperature, °C
- Activated AD-BC800
Formaldehyde removal efficiency

- Small size of the formaldehyde molecule, 0.25 nm was likely favorable for filling narrow micropores
- Relation between adsorption capacity, pore size, and adsorbate size

![Graph showing formaldehyde removal efficiency](image)

0.3 nm 0.8 nm
Formaldehyde removal mechanism

- Interaction with formaldehyde molecules via polar and non-polar interactions
- FA diffused into the amorphous structure
- Physical adsorption assisted by the developed porous structure and large surface area: pores filling
Formaldehyde removal in function of time

Equilibrium was reached after 20min => saturation of the biochar
Reusability test

- Thermal regeneration in the oven for 1h at 80°C
- At the 5th cycle the adsorption capacity dropped by 13%
- Structural changes caused by several thermal regenerations
Conclusion and perspectives

- Biochar form olive stone and *Arundo donax* was successfully used for capturing formaldehyde.

- Limitation: Saturation of biochar pores

- Future research: Doping biochar with active photocatalysts to enable continuous formaldehyde removal through integrated adsorption-photocatalytic degradation technology.
Thank you for your Attention.

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