EVALUATION OF OLIVE PIT BIOCHAR AS A SUSTAINABLE ADSORBENT FOR NH_3 EMISSIONS

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BACKGROUND

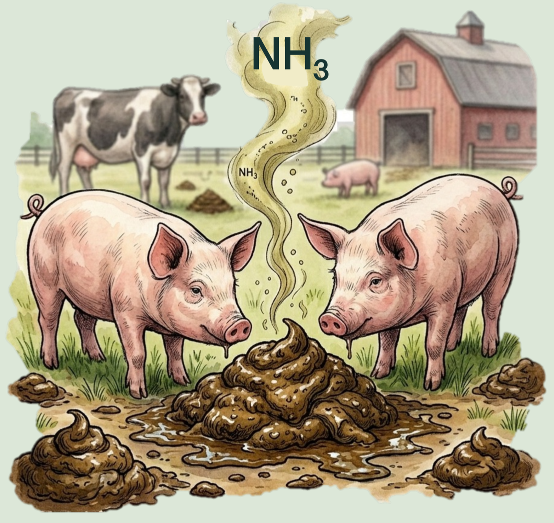
Environmental challenge: NH_3 emissions by livestock intensive farming

During storage and handling of manure, the non-protein nitrogen is enzymatically degraded to NH_3

$$CO(NH_2)_2 + H_2O \xrightarrow{\text{Urease}} 2\,NH_3 + CO_2$$

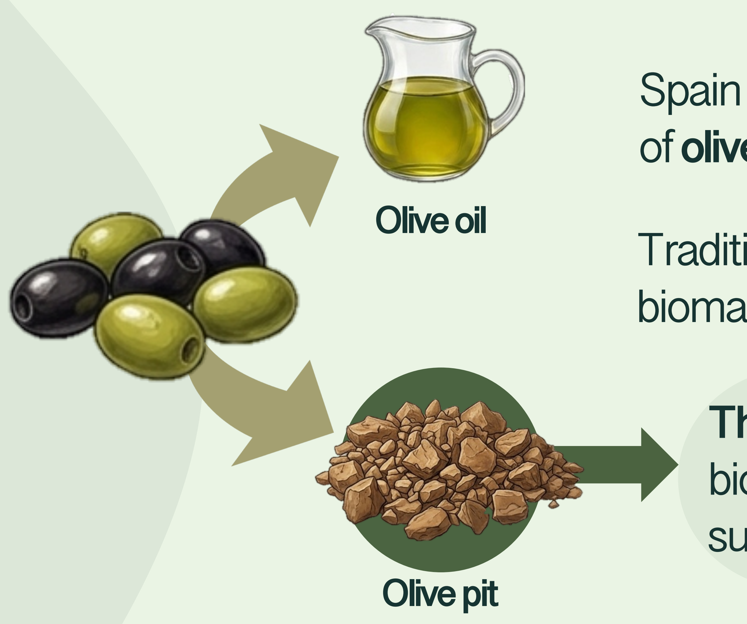
Environmental impacts of NH_3 [1]:

- Fine particulate matter ($PM_{2.5}$)
- Eutrophication
- Soil fertility loss
- Nitrate/Nitrite water pollution



OBJECTIVE

Adsorption of NH_3 using biochar from waste lignocelullosic biomass



Spain leads global olive oil production, generating **400,000 tons/year** of **olive pits** as a by-product [2]

Traditionally used for low-value combustion, this dense, low-ash biomass is an ideal precursor for thermochemical **valorization**

This study investigates how **pyrolysis temperature** affects the biochar properties and its NH_3 adsorption capacity, supporting sustainable pollutant control within a circular economy framework

MATERIALS AND METHODS

Biochar production

Pyrolysis

- Crushed olive pits
- Heating rate: 8 ºC/min
- 30 minutes
- N_2 atmosphere

Biochar particle size

0.63 – 1 mm

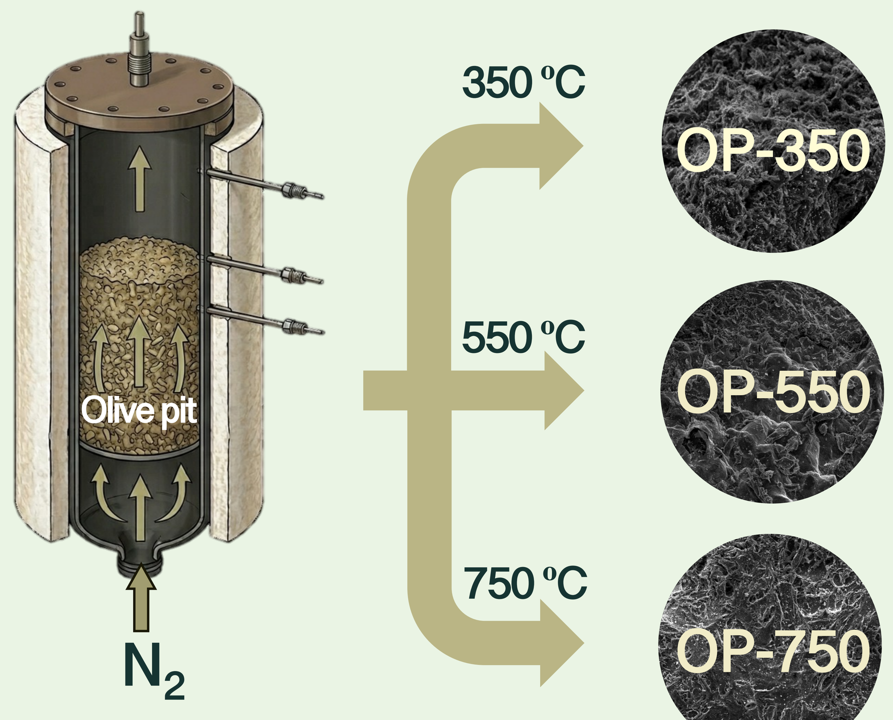
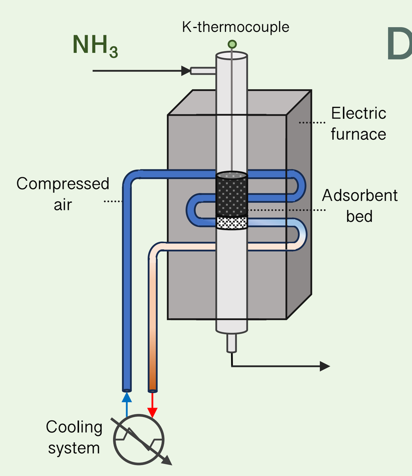


Figure 1. Pyrolysis setup for olive pit biochar production

Adsorption systems and conditions

Two experimental setups were used to assess gas-phase NH_3 capture under **dynamic** and **static** operation modes

Dynamic



- 1,000 ppm of NH_3
- 100 cm^3 STP/min
- 10 h adsorption
- 25 ºC, 1 bar
- µGC for NH_3 analysis

Figure 2. Fixed-bed experimental setup for gas-phase NH_3 dynamic adsorption

Static

- Batch process
- 30 % NH_3 solution
- 24 h adsorption
- Room temperature, 1 bar
- Elemental analysis for NH_3 quantification

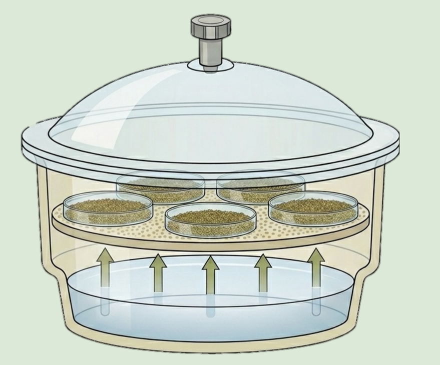


Figure 3. Experimental setup for static NH_3 adsorption

CHARACTERIZATION

Feedstock

OLIVE PIT COMPOSITION

26.0 % cellulose
24.9 % lignin
19.8 % hemicellulose
5.4 % humidity
1.3 % ashes
0.9 % protein

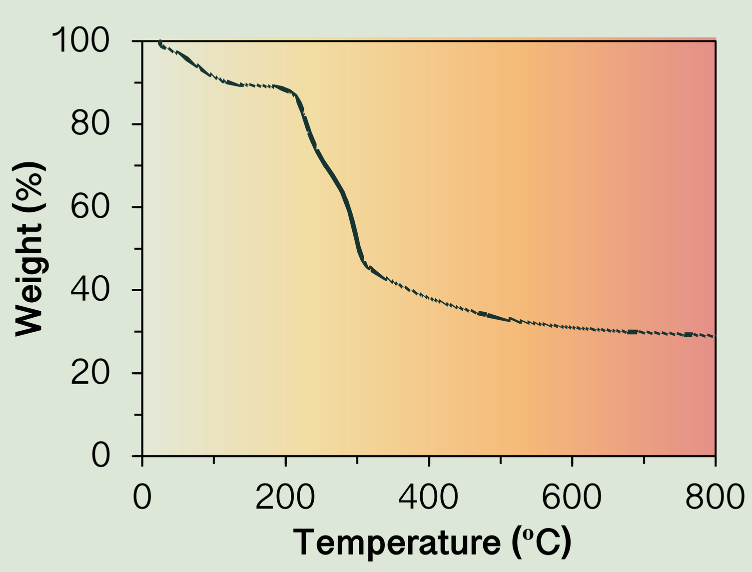


Figure 4. Thermogravimetric (TGA) analysis of olive pit

Biochar properties

Table 1. Olive pit biochar properties

Biochar	S_{BET} (m^2/g) [a]	O/C ratio [b]	pH [c]
OP-350	9	0.15	8.0
OP-550	83	0.04	8.7
OP-750	96	0.02	9.2

[a] Specific surface area from N_2 physisorption
[b] Obtained from elemental analysis
[c] Measured after stirring 1 g biochar with 20 mL of water for 1.5 h

- **Higher temperatures** enhance carbonization **increasing surface area** development
- **Higher O/C ratios** are related to higher amount of **acidic oxygenated functional groups** [3]
- **Lower pH** indicates **higher** density of **acidic functional groups**

ADSORPTION PERFORMANCE

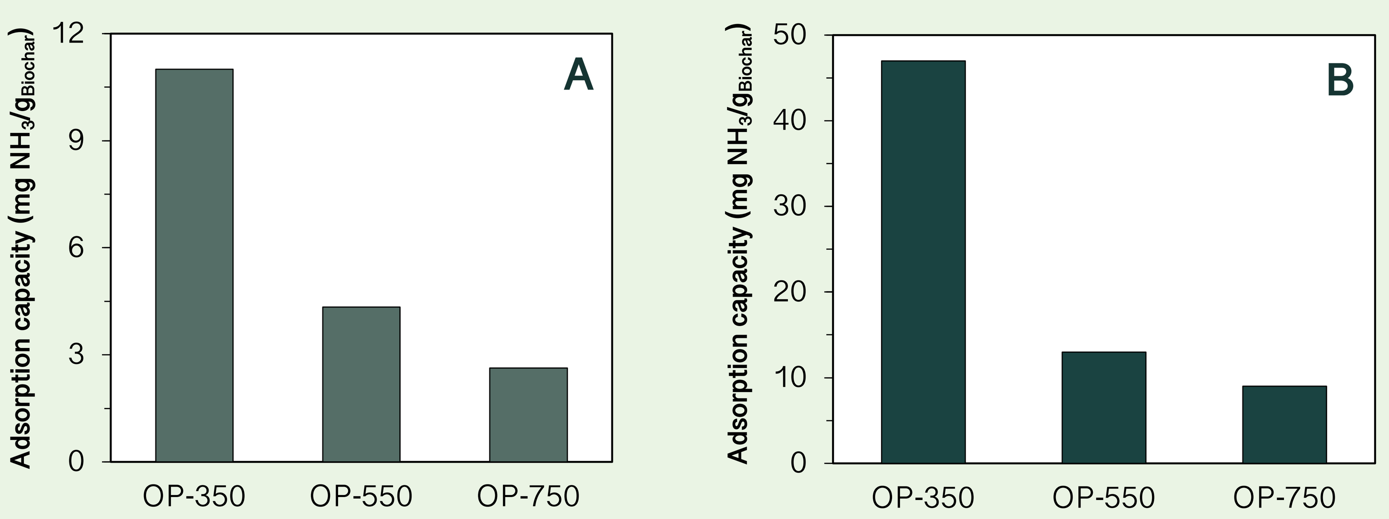


Figure 5. Adsorption capacity of biochar in dynamic (A) and static (B) experimental setups

CONCLUSIONS

NH_3 adsorption is driven by **surface chemistry** rather than porosity

Higher pyrolysis temperatures increase surface area but promote the **loss of oxygenated groups**

OP-350 is the best biochar due to its **higher density of acidic oxygenated groups**, which are responsible for NH_3 adsorption

Both batch and continuous systems show **similar performance trends**

References

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