Activated carbons derived from wasted coffee grounds and olive stones as highly porous materials for air pollutants adsorption

UNIVERSITÀ POLITECNICA DELLE MARCHE

CHANIA2023 21-24 JUNE

Natalia Czerwińska[1], Chiara Giosue[1], Ines Matos[2], Maria Bernardo[2], Maria Letizia Ruello[1]

[1]*Department of Materials, Environmental Sciences and Urban Planning (SIMAU), Università Politecnica delle Marche, Ancona, Italy*

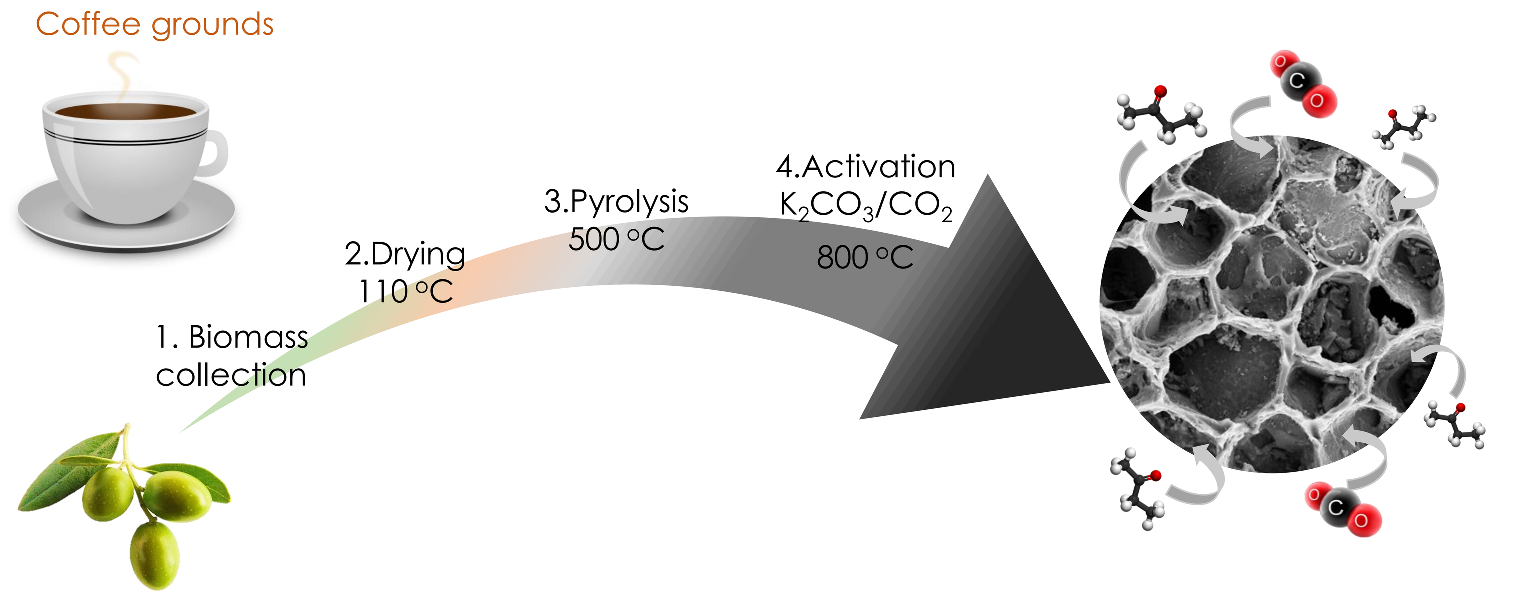
[2]*Faculdade de Ciências e Tecnologia - Universidade Nova de Lisboa, Caparica, Portugal*

n.czerwinska@pm.univpm.it

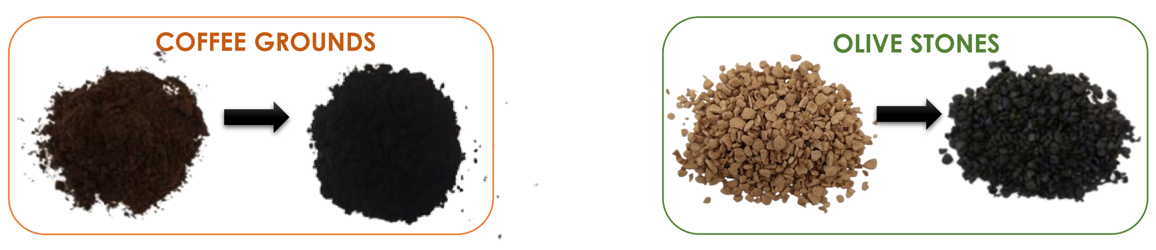
Objective

- Food waste valorization
- Biodegradable material for pollutants adsorption
- Improved air quality

Materials and Methods

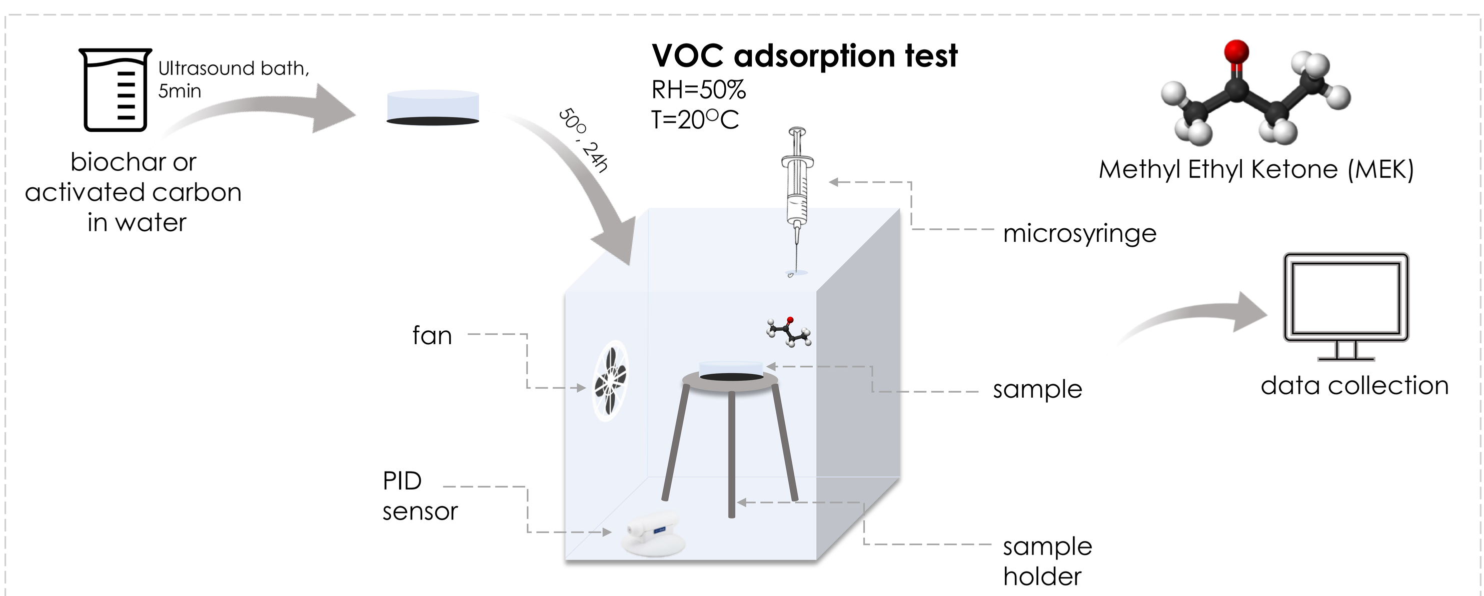


Firstly, dried biomasses samples were pyrolyzed at 500°C in N_2 and biochars were obtained, and then microporous activated carbons were produced by means of chemical (K_2CO_3) and physical (CO_2) activation. The influence of the activation process, type (physical or chemical), and time (1-3h) of activation have been also investigated.



Characterization: SEM+EDS; BET, DFT method; PID

Measurements of VOC adsorption were performed in a 17L chamber, at room temperature where 50mg of each sample was placed and Methyl Ethyl Ketone (MEK) was chosen as a model of VOC. The concentration was monitored for 90min using a photoionization detector (PID).



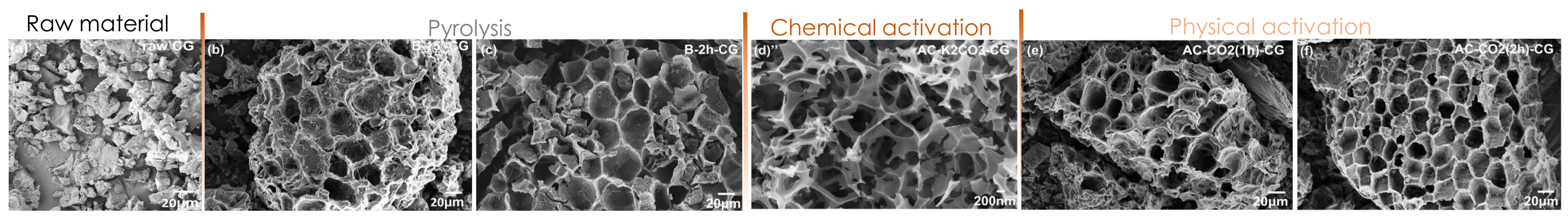
Results

Yield is one of important factors for industrial application and all the samples, showed the yield of about 17 wt% or above. These values are comparable with those of other biomass-based or waste-based activated carbons. As expected from the N_2 adsorption-desorption isotherms, BET specific surface area (SSA) and total pore volume (TPV) increased after chemical activation and as the time of activation increased.

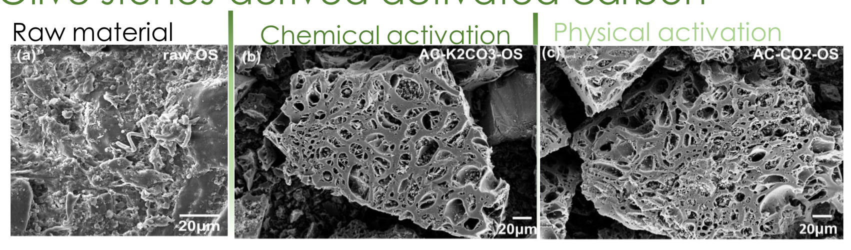
Spent coffee grounds and olive stones contained a large amount of carbon (50-60 wt%), suggesting they can be a good source for carbon materials. The carbon content increased to 80–90 wt% after the pyrolysis and activation, implying that the degree of carbonization increased as the activation time increased.

Morphology

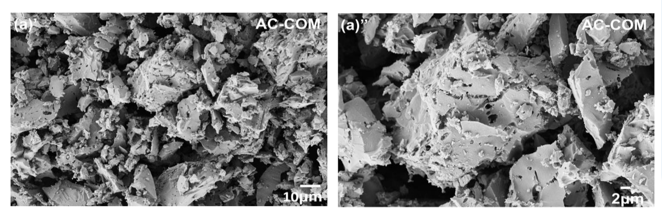
Coffee grounds-derived activated carbon



Olive stones-derived activated carbon

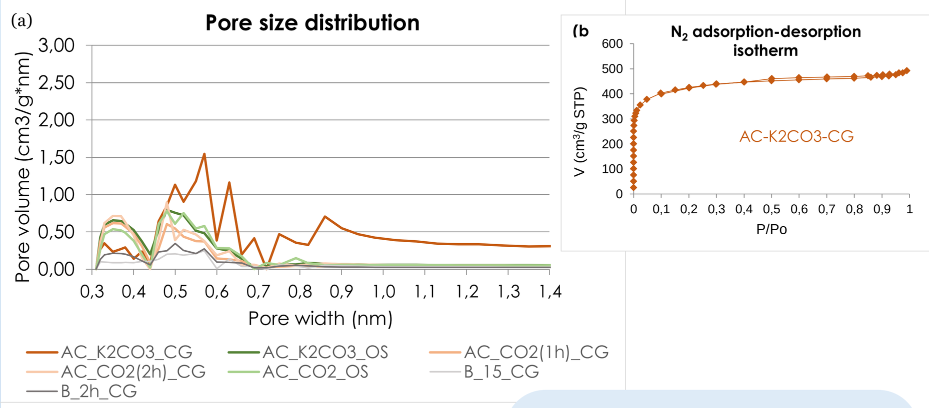


Commercial activated carbon



After the thermal treatment (biochar samples) and the activation process in all the samples there was a change in the morphology and **pores** and **cheese-like structure** was formed.

Textural properties

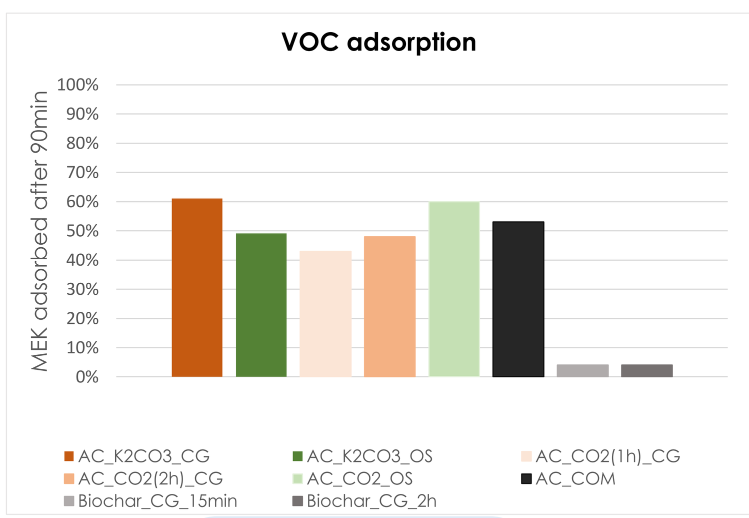


I type of isotherm confirming a predominantly **microporous structure** in the material.

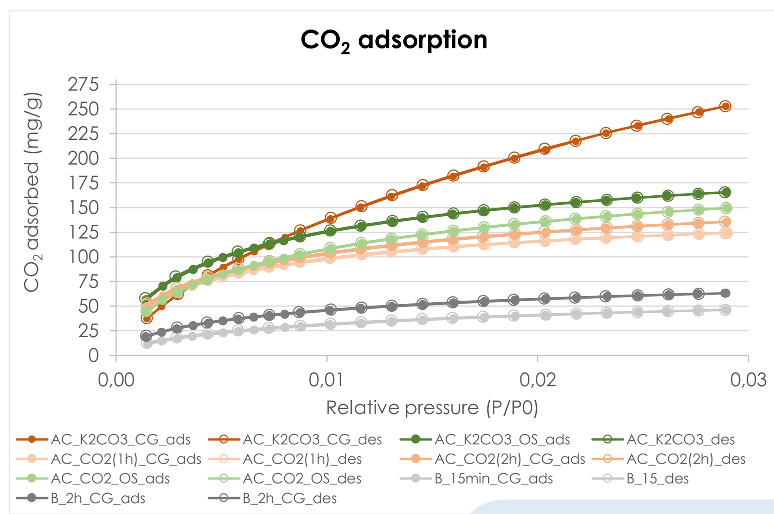
Sample	Precursor	Type and time of activation	Product yield [%]	Elemental analysis [wt%] C	O	K	Textural properties SSA [m²/g]	TPV [cm³/g]
Raw CG	-	-	-	57	41	<1	-	-
Raw OS	-	-	-	48	45	<1	-	-
AC-K2CO3-CG	Coffee grounds	Chemical 1h	17	87	12	<1	1487	0,527
AC-K2CO3-OS	Olive stones	Chemical 1h	30	89	10	<1	870	0,221
AC-CO2-OS	Olive stones	Physical 3h	21	87	10	1	778	0,205
AC-CO2-2h-CG	Coffee grounds	Physical 2h	20	84	11	3	716	0,184
AC-CO2-1h-CG	Coffee grounds	Physical 1h	20	83	11	3	649	0,159
B-2h-CG	Coffee grounds	-	24	82	13	2	331	0,088
B-15'-CG	Coffee grounds	-	28	81	14	2	251	0,074
AC-COM				79	13	0,13	1200	-

The highest **specific surface area (1487m²/g)** and **total pore volume (0,527cm³/g)** characterizes AC_K2CO3_CG.

Adsorption properties



The highest **VOC removal- 61%** after 90min was detected for AC_K2CO3_CG



The highest **CO_2 uptake (253mg/g)** was detected for AC_K2CO3_CG and the lowest for biochar

Conclusions

- Coffee grounds and olive stones are adequate precursors for preparing highly efficient adsorbents for odorous VOC and CO_2 abatement.
- Chemical activation with K_2CO_3 enhance the surface area of the adsorbent comparing to physical activation.
- The highest VOC removal and CO_2 uptake characterizes chemically activated carbon from coffee grounds and is comparable to commercially available activated carbon labelled as AC-COM.

Acknowledgement

This research was performed in the frame of STSM (Short-Terms Scientific Mission) by Cost Action Greenering, CA18224, supported by COST (European Cooperation Science And Technology).

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union