N-doped activated carbon prepared by hydrothermal carbonization of biomass waste

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1 INTRODUCTION

Hydrothermal carbonization is becoming an increasingly attractive way to valorize wet biomass waste. The main reaction product is a solid known as hydrochar (HC) which can be chemically activated by reagents as KOH, $ZnCl_2$ or H_3PO_4 to produce active carbon (AC). Recently, it has demonstrated that the N doping of the HC along HTC process alters the physical and chemical properties of the material, increasing its aromatic character, N content in the bulk, oxidation resistance and conductivity.

2 EXPERIMENTAL

Figure 1. Preparation process of the adsorbents

Activated carbons from olive stones were prepared as shown in Figure 1. The potential application of the AC as adsorbents in aqueous phase was assessed using antipyrine (APN, pKa 1.4). Samples of AC (20 mg) were contacted in stoppered glass bottles with 50 mL of APN (400-20 mg/L) solutions. Experiments were carried out in a thermostatized shaker (20 ºC, 200 rpm, 150 h). The solution pH was 5.6.

3 RESULTS

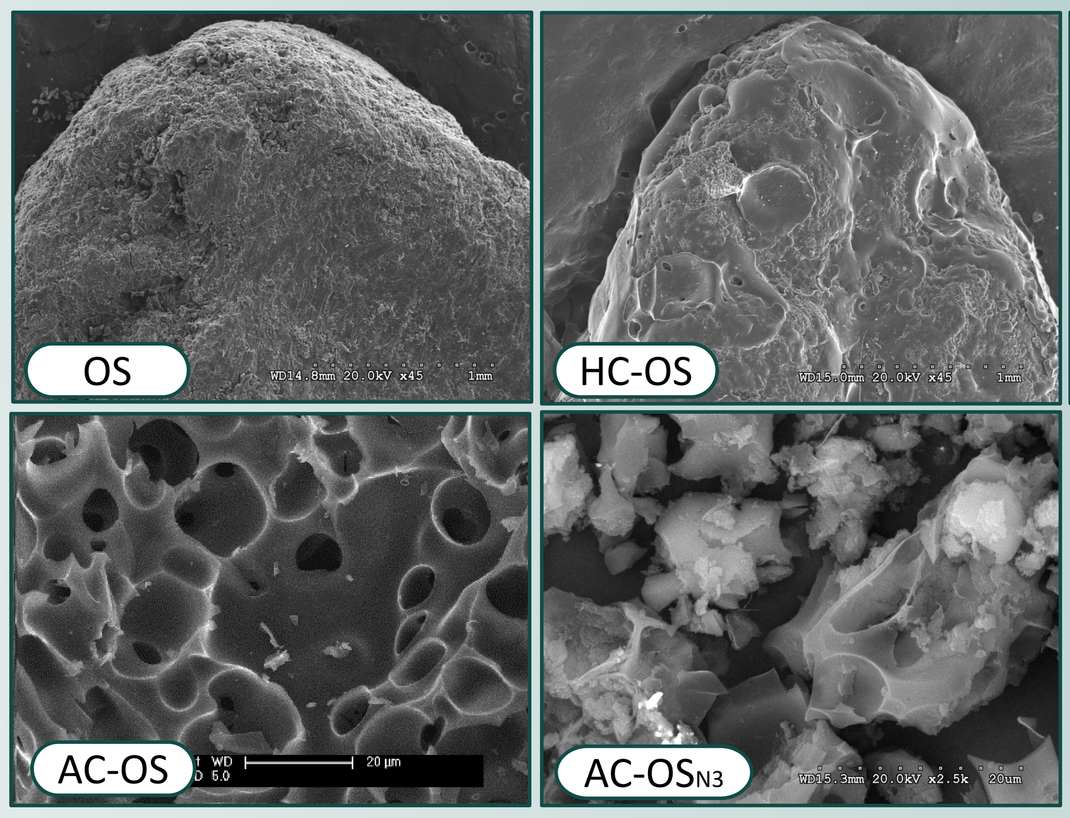

Figure 2. SEM images

CHARACTERIZATION OF ADSORBENTS

Table 1. Characterization data of OS hydrochars (HC) and activated carbons (AC)

Sample	A_{BET} (m²/g)	V_{meso} (cm³/g)	V_{micro} (cm³/g)	N (wt.%)	pH_{slurry}
AC-OS	710	0.07	0.29	0.34	6.5
AC-OS$_{N10}$	828	0.37	0.11	0.50	2.5
AC-OS$_{N3}$	1116	0.55	0.21	0.63	2.8

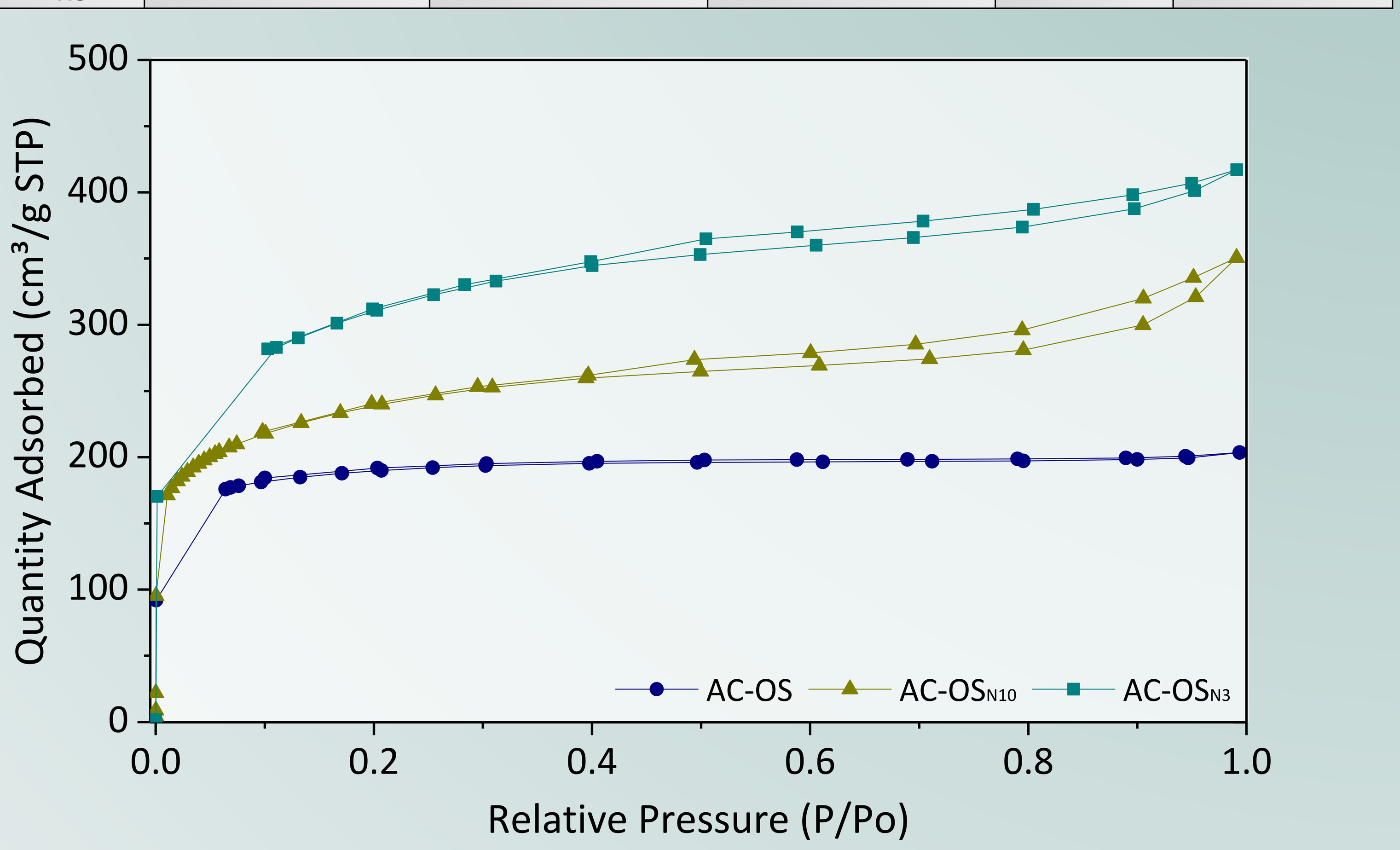

Figure 3. N_2 adsorption-desorption isotherms at 77 K of the activated carbons

ANTIPYRINE ADSORPTION

Table 2. Langmuir and Freundlich parameters for APN adsorption on the activated carbons of Figure 4

	Langmuir			Freundlich		
	qL (mg/g)	KL (L/mg)	R²	K_F [(mg/g)/(L/mg)$^{(1/n)}$]	n	R²
AC-OS	154 ± 12	93.9 ± 55.3	0.87	42 ± 5	4.3 ± 0.4	0.98
AC-OS$_{N10}$	415 ± 99	6.0 ± 3.1	0.94	14 ± 5	1.9 ± 0.3	0.97
AC-OS$_{N3}$	425 ± 80	13.5 ± 7.8	0.92	36 ± 9	2.5 ± 0.3	0.98

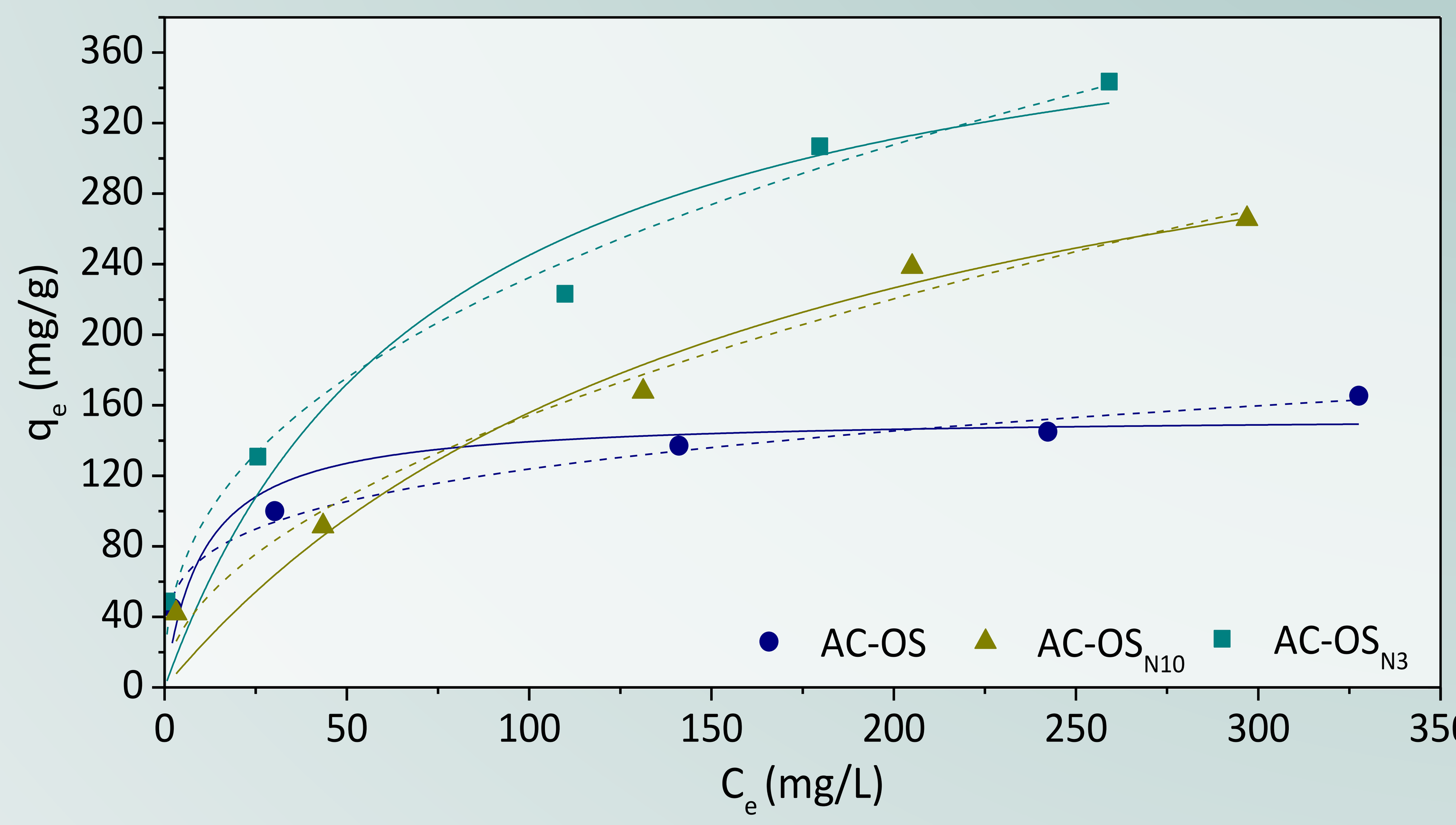

Figure 4. Adsorption isotherms of APN (symbols: experimental values; short dot lines: fitting to the Freundlich equation; solid lines: fitting to the Langmuir equation).

4 DISCUSSION

Figure 2 shows SEM images of the raw material, hydrochars and activated carbons, where it can be clearly observed the porosity originated by KOH during the activating process. As can be seen in Table 1 and Figure 3, the activated carbons prepared from N-doped hydrochar exhibited higher BET surface area values with an important contribution of mesoporosity. With respect to APN adsorption experiments (Table 2 and Figure 4), the adsorption capacity seems to be basically determined by the BET surface area of the carbons, achieving AC-OS$_{N3}$ the highest value.

5 CONCLUSION

Therefore, N-doped active carbon prepared from olive stones is a sustainable material and an excellent candidate as adsorbent in liquid phase.

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