Assessment of Argan Shell Wastes as precursors of Nanoporous Carbon Materials

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Nowadays, Argan oils are becoming widely used within the international oils market (Lakhdari and Khechairi 2011) due to its powerful functions in several areas, for instance: therapeutic medicine, cosmetic, culinary, etc. (S. Karoune *et al*. 2013). The production of argan oil leads to the generation of large amounts of biomass residues which are hard-shelled agricultural wastes.

In some countries like Algeria the argan trees are covering an important surface area. This type of tree is distributed around 96940 hectares in Tindouf city and it has also appeared on other regions (Lakhdari and Khechairi 2011). Currently, the Algerian population uses the argan seed shells as a domestic fuel because unfortunately, there aren't other types of valorization.

The main purpose of our research is to evaluate these Algerian agro wastes as a precursor for porous carbon synthesis. Several porous carbons were prepared via chemical activation using potassium hydroxide (KOH) as activating agent. Different impregnation ratios, temperatures and activation times were studied in order to determine the optimized porous carbon.

The characterization and properties of the obtained carbons were investigated by N_2 adsorption–desorption isotherms at 77K, Fourier transform infrared spectroscopy (FTIR) and elemental analyses. The porous carbon with the most developed porosity and higher surface area was further selected to be characterized by using scanning electron microscopy (SEM), thermogravimetric analysis (TGA) and pH_{PZC}.

The textural characterization indicated that the carbon obtained at 800 °C with an impregnation ratio biomass:KOH of 1:2 presents the highest surface area (S_{BET}) (1624 m^2g^{-1}), total pore volume (V_t) (0.74 cm^3g^{-1}) and highest micropore volume (V_{mic}) (0.40 cm^3g^{-1}) These textural properties are superior to the ones presented by other porous carbons derived from argan nut shells (Table 2).

This work does not only open a new way to valorize argan nut shells but also presents a simple and sustainable approach to synthesize nanoporous carbon materials. The effectiveness of the optimized porous carbon (ACK) as adsorbent is being conducted in adsorption studies.

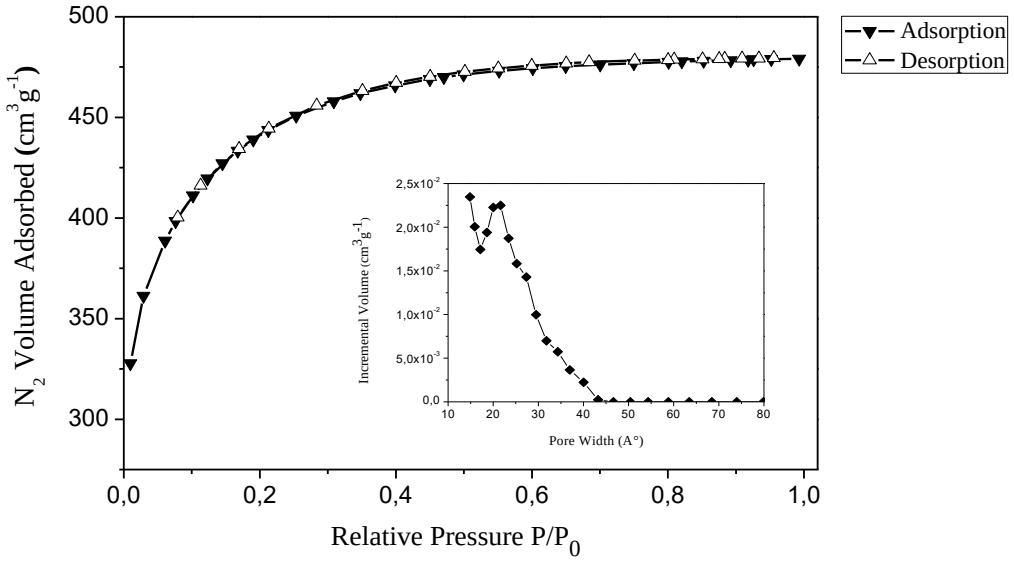

Figure 1. N_2 adsorption-desorption isotherm and pore size distribution of the optimized carbon ACK.

Table 1. Textural parameters of the optimized carbon ACK

Textural Parameters	ACK
BET surface area, S_{BET} (m^2g^{-1})	1624
Total pore volume (cm^3g^{-1})	0.74
Micropore volume (cm^3g^{-1})	0.40
Mesopore volume (cm^3g^{-1})	0.34
Average pore diameter (nm)	1.83

Table 2. Comparison between the textural properties of ACK sample and several porous carbons prepared from argan nut shells reported in the literature.

Activation agent	Activation Temperature (ºC)	BET surface area ($m^2 g^{-1}$)	References
H_2O	700	685	(Chafik 2012)
KOH	700	682	
K_2CO_3	700	527	
H_3PO_4	550	1105	(Legrouri *et al.* 2012)
H_3PO_4	700	1372	(Zbair *et al*. 2018)
NaOH	700	798	
KOH	800	**1624**	**Present study**

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References

Chafik, T.: Matériaux carbonés nano poreux préparés à partir de la coque du fruit d'Argane, patent WO 2012/050411. (19 April 2012)

Lakhdari, A., Khechairi, R.: La faune de l'arganier de Tindouf (Algérie). In: Actes du Séminaire International sur la Biodiversité Faunistique en Zones Arides et Semi-arides. pp. 207–211 (2011)

Legrouri, K., Harti, M. El, Oumam, M., Khouya, E., Wahbi, R., Hannache, H., Zarrouk, A., Sciences, F., P, U.M.I.B.: Characterization and evaluation performance of activated carbon prepared from coconut shell argan. J. Chem. Pharm. Res. 4, 5081–5088 (2012)

S.Karoune, M.Belhamra, M.S.A.Kechebar, C.Rahmoune: Characterization of the argan tree of southwestern Algeria. Int. J. Curr. Microbiol. Appl. Scieces. 2, 117–126 (2013)

Zbair, M., Ainassaari, K., Drif, A., Ojala, S.: Toward new benchmark adsorbents : preparation and characterization of activated carbon from argan nut shell for bisphenol A removal. J. Full. Nano. Carb. Nanos. 1869–1882 (2018)