Multivariate analysis of pharmaceutical pollutants adsorption in aqueous media with tailored waste-based carbonaceous adsorbent materials and commercial activated carbons

J. Lladó¹, F. López¹, J.M. Rossell¹, C. Lao-Luque¹, R.R. Gil², E. Fuente², B. Ruiz²

¹Department of Mining, Industrial and TIC Engineering (EMIT), Escola Politécnica Superior d’Enginyeria de Manresa, UPC, Manresa, Spain.
²Biocarbon, Circularity and Sustainability Group (BC&S), Instituto de Ciencia y Tecnología del Carbono (INCAR), CSIC, Spain.

Introduction

The purpose of this research is to determine the effectiveness of various biocollagenic waste-based activated carbons (BWAC) and a sludge biochar (SBC) in removing emerging pharmaceutical pollutants (phenol, salicylic acid, paracetamol, diclofenac and iodixanol) present in aqueous media and its comparison with commercial and manufactured adsorbent from different origins.

Principal component analysis is applied to develop multiple linear regression models to predict maximum adsorption capacities for future new waste-based activated carbons.

Results & Discussion

BIOCOLLAGENIC WASTE-BASED ACTIVATED CARBON (BWAC)

Chemical

Textural

Process

PCA

Adsorption PARAMETERS

Model

Qmax

Model

r²

Qphenol = 0.059 + 0.02496 C - 1.101 H - 0.3215 S + 0.0455 D + 2.55 \( V_{\text{ULTRAM}} \) + 1.51 \( V_{\text{SUPERM}} \)

86.67%

Qsalicylic = 0.087 + 0.0238 C - 0.985 H - 0.0565 O + 0.863 V

87.71%

Qiodixanol = -0.1962 + 0.00164 Ash + 0.001922 \( S_{\text{BET}} \) - 5.83 \( V_{\text{ULTRAM}} \) - 5.10 \( V_{\text{SUPERM}} \) + 0.01288 Humidity

75.12%

Conclusions

The presence of nitrogenated groups in BWACs decrease the adsorption of paracetamol due to water compete for the same sites of adsorption.

The adsorption of phenol, salicylic acid and paracetamol was on micropores. Diclofenac and IDIXL adsorption was preferably physical in the wider micropores and narrower mesopores.

Multiple linear regression models were proposed to predict maximum adsorption capacities of pharmaceutical. In the IDIXL model the textural properties predominated, while in the paracetamol model the nitrogen content had a negative influence.

Acknowledgements

The authors thank Xerollaborations collaboration, and Cabot-Norit, Kureha, and Eurocarb for supplying the adsorbents. The authors are too grateful to Miquel Farrés Rojas S.A., Igualada (Barcelona), for providing the leather wastes.