

Optimizing organosolv extraction of lignin from Rubia waste for textile industry valorization

A. ZOURIF^{1,2*}, **O. CHAJJI**¹

¹ Department of Chemical and Biochemical Sciences, Green Process Engineering CBS, Mohammed VI Polytechnic University, Morocco.

² Laboratory of Physical-Chemistry, Materials and Catalysis, Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Casablanca, Morocco.

***Email:** zourifali@gmail.com

Abstract: The composition of lignocellulosic species is complex, consisting of cellulose, hemicellulose, lignin, and various inorganic materials [1]. Separating the three primary biopolymers of lignocellulosic biomass is challenging due to factors such as lignin content, cellulose crystallinity, and water content. Lignin, which constitutes 15 to 30% of lignocellulosic biomass [2], is a crucial component in various industries, including biorefinery, textile, and water treatment, making its valorization critical. The present work aims to valorize the waste generated by the *Rubia tinctorum* L. plant used in the dyeing industry, mainly lignocellulose, that are the raw material for other industries. The composition of lignocellulosic species is complex, consisting of cellulose, hemicellulose, lignin, and various inorganic materials [2]. To achieve effective lignin extraction, environmentally friendly pre-treatment methods have been developed, which produce lignin materials with different physicochemical characteristics [3]. This study focuses on optimizing lignin extraction from the *Rubia tinctorum* L. plant waste using the Organosolv method to valorize the lignin in the textile industry [4]. The Box Behnken Design based on the response surface method was employed, varying three main parameters, organic acid concentration (OA), reaction time (TEM), and solid loading (RML) to determine the optimal conditions for extracting lignin with the highest yield and purity. The optimal conditions are (OA 75%, 0.25 RML, and 3 h TEM), with a yield of 52.23%. The extracted lignin was characterized using the analysis techniques TGA and DSC to study the thermal stability, XRD and SEM were used to study the crystal structure and morphology of lignin, NMR ¹H, ¹³C, FTIR-IR, and UV-Vis spectroscopy to elucidate the lignin structure. In order to compare the different properties of recovered *Rubia* lignin with other common plants such as sugar cane, beets, and paper pulp waste, some applications for finding lignin as a UV protection agent on textiles and a coagulant in water purification stations.

Keywords: Lignin extraction, *Rubia tinctorum* L., Organosolv method, BBD, RSM.

References

1. J. S. Kim, Y. Y. Lee, T. H. Kim, A review on alkaline pretreatment technology for bioconversion of lignocellulosic biomass, *Bioresour. Technol.*, 2016, vol. 199, p. 42-48.
2. H. J. P. L. De Souza, F. Munoz, R. T. Mendonça, K. Saez, R. Olave, C. Segura, D. P.L. De Souza, T. de Paula Protasio, R. Rodríguez-Soalleiro, Influence of lignin distribution, physicochemical characteristics and microstructure on the quality of biofuel pellets made from four different types of biomass, *Renew. Energ.*, 2021, vol. 163, p. 1802-1816.
3. T. D. M. Florian, N. Villani, M. Aguedo, N. Jacquet, H. G. Thomas, P. Gerin, D. Magali, A. Richel, Chemical composition analysis and structural features of banana rachis lignin extracted by two organosolv methods, *Ind. Crops Prod.*, 2019, vol. 132, p. 269-274.
4. O. Chajji, A. Zourif, Y. Chemchame, A. Benbiyi, Z. Azoubi, M. El Guendouzi, A. El Bouari. Nano-engineered lignin from *Rubia tinctorum* L. waste: A breakthrough in sustainable UV-protective textile coatings. *Industrial Crops and Products*, 2025, vol 227, 120843.