Optimization of cellulose recovery from banana plant pseudostem using pre-treatments

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The banana production generates great number of residues, being the main residue the pseudostem (PS) – 3 tons of PS/ ton harvested bananas. The PS can be a rich source of chemical compounds, being mainly composed of cellulose (55–65 %), hemicellulose (15–25 %) and lignin (10–15 %), which content depends on the cultivation conditions and plant species.[1]

Cellulose is the most abundant polymer, being present in the plant cell wall. It is a versatile polymer since its structure and properties vary according to the source and extraction procedure used, allowing it to be applied in many applications as packaging, coatings and biomedical devices.[2]

In this work, the banana plant pseudostem (PS) was studied to extract cellulose. For that, the PS particles were initially milled until size ≤ 180 µm, as proven in previous studies to be the most efficient size to extract cellulose.[3] Then, the particles were pre-treated with 3 different chemical methods presenting as main reagents: (1) hydrogen peroxide and sodium hydroxide; (2) acetic acid and hydrogen peroxide; (3) sodium hydroxide, hydrogen peroxide and cloridric acid.[4,5,6] The final solid obtained after each pre-treatment was analyzed according to the Sluiter *et al*. method, to determine the cellulose, hemicellulose and lignin content.[7] The obtained results are presented in the table below.

Pre-treatment	Cellulose (wt%)	Lignin (wt%)	Hemicellulose (wt%)
1	65.77	1.50	7.31
2	65.47	0.50	3.15
3	77.30	1.00	1.53

It can be observed that pre-treatment 3 resulted in the highest cellulose content (77.30 wt%) and lowest hemicellulose and lignin contents (1.53 wt% and 1 wt%, respectively). Thus, this pre-treatment proved to be promising to extract cellulose than can be applied in many applications, being a possible alternative for plastics.

References

(1) Badanayak, P.; Jose, S.; Bose, G. Banana Pseudostem Fiber: A Critical Review on Fiber Extraction, Characterization, and Surface Modification. *J. Nat. Fibers* 2023, *20* (1). https://doi.org/10.1080/15440478.2023.2168821.

(2) Cherian, R. M.; Tharayil, A.; Varghese, R. T.; Antony, T.; Kargarzadeh, H.; Chirayil, C. J.; Thomas, S. A Review on the Emerging Applications of Nano-Cellulose as Advanced Coatings. *Carbohydr. Polym.* 2022, *282* (January), 119123. https://doi.org/10.1016/j.carbpol.2022.119123.

(3) Nascimento, R. E. A.; Carvalheira, M.; Crespo, G.; Neves, A. Extraction and Characterization of Cellulose Obtained from Banana Plant Pseudostem. *Clean Technol.* 2023, *5* (3), 1028–1043. https://doi.org/10.3390/cleantechnol5030052.

(4) Prado, K. S.; Spinacé, M. A. S. Isolation and Characterization of Cellulose Nanocrystals from Pineapple Crown Waste and Their Potential Uses. *Int. J. Biol. Macromol.* 2019, *122*, 410–416. https://doi.org/10.1016/j.ijbiomac.2018.10.187.

(5) Park, C. W.; Han, S. Y.; Choi, S. K.; Lee, S. H. Preparation and Properties of Holocellulose Nanofibrils with Different Hemicellulose Content. *BioResources* 2017, *12* (3), 6298–6308. https://doi.org/10.15376/biores.12.3.6298-6308.

(6) Pereira, N. R. L.; Lopes, B.; Fagundes, I. V.; de Moraes, F. M.; Morisso, F. D. P.; Parma, G. O. C.; Zepon, K. M.; Magnago, R. F. Bio-Packaging Based on Cellulose Acetate from Banana Pseudostem and Containing Butia Catarinensis Extracts. *Int. J. Biol. Macromol.* 2022, *194* (December 2021), 32–41. https://doi.org/10.1016/j.ijbiomac.2021.11.179.

(7) Sluiter, A.; Hames, B.; Ruiz, R.; Scarlata, C.; Sluiter, J.; Templeton, D.; Crocker, D. *Determination of Structural Carbohydrates and Lignin in Biomass*; 2008.