Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026)

Editors: Elena Diaz Nieto; Francisco Heras Muñoz; Juan Antonio Melero Hernández; Manuel Gertrudix
Madrid, BIVALIA, UAM-URJC, 2026
DOI: 10.5281/zenodo.22206833 · CC BY 4.0
Full volume: https://books.ciberimaginario.cloud/libro/bivalia-w2-2026

OFFPRINT · PP. 28–29

Insights on the acetic acid pretreatment of wheat straw: changes induced in the biomass properties and benefits for the bio-oil production by pyrolysis

J. Cueto[1], M. Pagano[1], I. Moreno[1,2], D. Serrano[1,2*]

1: Thermochemical Processes Unit, IMDEA Energy Institute, Avda. Ramón de la Sagra 3, 28935 Móstoles, Madrid, Spain | 2: Group of Chemical and Environmental Engineering, Universidad Rey Juan Carlos, C/ Tulipán s/n, 28933 Móstoles, Madrid, Spain

Acetic acid washing, Selective demineralization, AAEM removal, Biomass pretreatment, Fast pyrolysis

HOW TO CITE THIS CONTRIBUTION

J. Cueto, M. Pagano, I. Moreno, D. Serrano. (2026). Insights on the acetic acid pretreatment of wheat straw: changes induced in the biomass properties and benefits for the bio-oil production by pyrolysis. In: Diaz Nieto, E., Heras Muñoz, F., Melero Hernández, J. A., Gertrudix, M. (Eds.), Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026), pp. 28–29. BIVALIA, UAM-URJC. https://doi.org/10.5281/zenodo.22206833

Oral Presentations #15

Insights on the acetic acid pretreatment of wheat straw: changes induced in the biomass properties and benefits for the bio-oil production by pyrolysis

J. Cueto[1], M. Pagano[1], I. Moreno[1,2], D. Serrano[1,2]*

[1] Thermochemical Processes Unit, IMDEA Energy Institute, Avda. Ramón de la Sagra 3, 28935 Móstoles, Madrid, Spain | [2] Group of Chemical and Environmental Engineering, Universidad Rey Juan Carlos, C/ Tulipán s/n, 28933 Móstoles, Madrid, Spain

**Correspondence: david.serrano@energia.imdea.org*

Keywords: *Acetic acid washing, Selective demineralization, AAEM removal, Biomass pretreatment, Fast pyrolysis*

Agricultural lignocellulosic residues, such as wheat straw, are abundant renewable feedstocks for biofuels and chemicals. Nevertheless, their direct pyrolysis is hindered by ash, particularly alkali and alkaline-earth metals (AAEMs), which catalyze dehydration, cracking, gas and char formation, lowering bio-oil yield. Sustainable pretreatments to remove these species are essential.

This work investigates acetic acid washing as a green pretreatment for wheat straw, benchmarking it against water and ammonia washing. Each pretreatment was assessed by combining biomass characterization, including AAEM removal, holocellulose enrichment and thermal stability, with pyrolysis under nitrogen in a downflow fixed-bed reactor with two zones at 550 and 450 °C.

Acetic acid washing selectively removed the most catalytically active species, almost eliminating potassium and sodium and reducing magnesium and calcium. Unlike ammonia, which increased demineralization through silica removal, acetic acid targeted AAEMs involved in secondary reactions. It also extracted soluble lignin, extractives and acetyl-rich compounds, increasing holocellulose content and shifting cellulose decomposition to higher temperatures. Consequently, bio-oil* yield increased from 35 wt % for raw wheat straw to 53 wt% after acetic acid pretreatment, while water, gas and char decreased.

As shown in Figure 1, bio-oil* yield increases when total AAEM content decreases and holocellulose content increases. Thus, suppressing AAEM-catalyzed fragmentation, decarboxylation and condensation, while preserving holocellulose, is crucial for maximizing liquid production. Bio-oil* quality improved, with lower acids, ketones and ethers, and higher furans and anhydrosugars. Levoglucosan became the dominant valuable compound, reaching yields close to 10 wt%, due to inhibition of cellulose ring-scission reactions. Conversely, extracted matter samples mainly promoted char and gas.

© 2026 BIVALIA-CM (TEC-2024/BIO-177) · CC BY 4.0 · DOI: 10.5281/zenodo.22206833

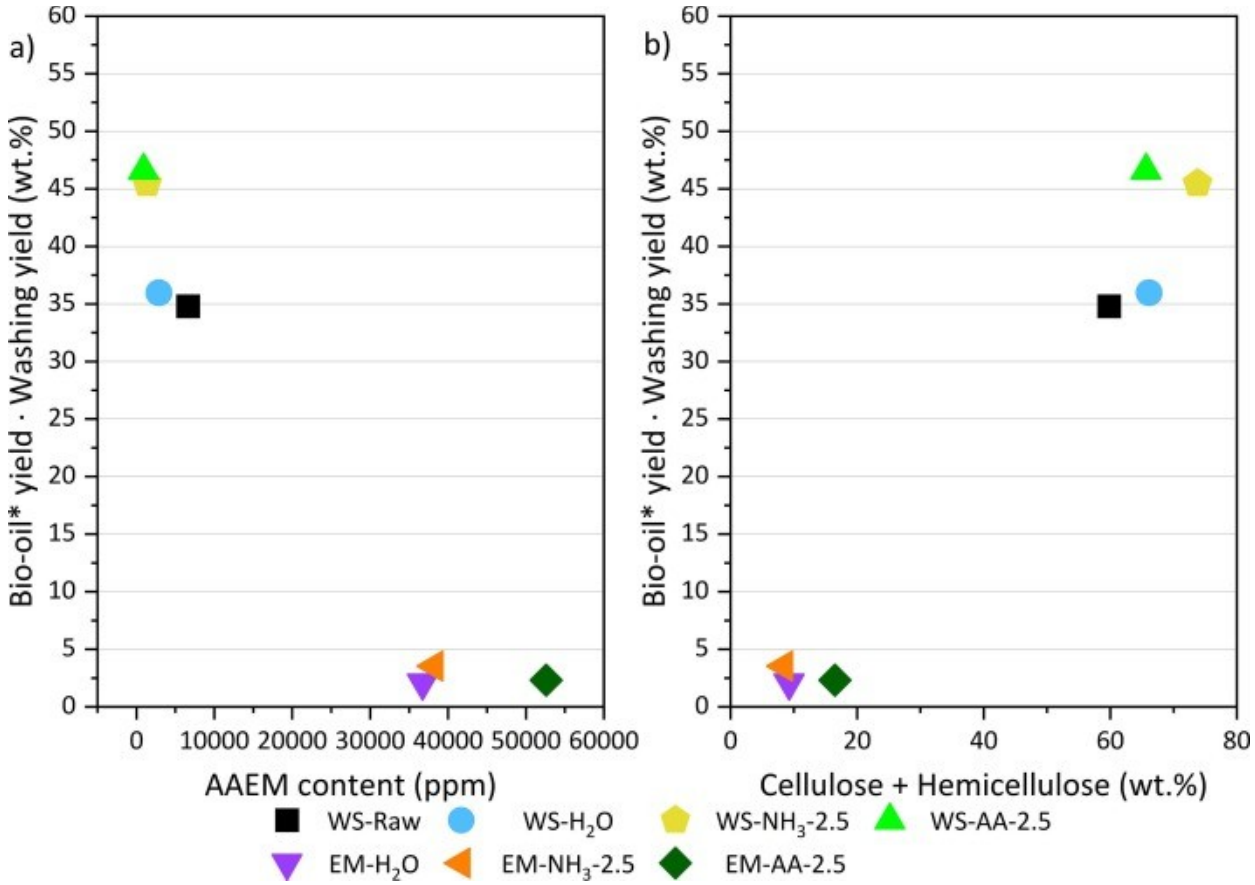


Figure 1. Bio-oil* yield versus (a) total AAEM content and (b) holocellulose content of raw WS, washed WS and EM samples. Bio-oil yields are calculated considering the washing yields of every WS and EM sample.

Acetic acid pretreatment improves wheat straw pyrolysis by separating holocellulose from catalytic inorganic species. Preliminary techno-economic analysis indicates that higher bio-oil* and levoglucosan revenues can offset acid, energy, and equipment costs, supporting its potential as a sustainable pretreatment for biorefineries.

Acknowledgements

The present work received funding from the Spanish Ministry of Science and Innovation under the grant PID2020-114740RB-C21 (ADBIOCAP Project).

© 2026 BIVALIA-CM (TEC-2024/BIO-177) · CC BY 4.0 · DOI: 10.5281/zenodo.22206833