



"Gheorghe Asachi" Technical University of Iasi, Romania



SOURCES OF SECONDARY CELLULOSE FIBERS AND THEIR PAPER-MAKING POTENTIAL IN THE CONTEXT OF CIRCULAR AND GREEN ECONOMY

Corina-Iuliana Pătrăucean-Patrașcu¹, Dan-Alexandru Gavrilăscu², Maria Gavrilăscu^{1,3,4*}

¹Department of Environmental Engineering and Management, "Cristofor Simionescu" Faculty of Chemical Engineering and Environmental Protection, "Gheorghe Asachi" Technical University of Iasi, Romania

²Department of Natural and Synthetic Polymers, "Cristofor Simionescu" Faculty of Chemical Engineering and Environmental Protection, "Gheorghe Asachi" Technical University of Iasi, Romania

³Academy of Romanian Scientists, 3 Ilfov Street, 050044 Bucharest, Romania

⁴Academy of Technical Sciences of Romania, 26 Dacia Blvd., 010413 Bucharest, Romania

Abstract

Secondary cellulose fibers have emerged as key renewable materials in advancing circular bioeconomy strategies by transforming diverse waste streams into value-added products. This review provides an integrated analysis of the sources, extraction processes, and valorization pathways of secondary cellulose fibers derived from recovered paper and cardboard, agricultural waste, industrial and textile wastes, food-processing waste, and urban biowaste. Each source exhibits distinct compositional and structural characteristics influencing its suitability for pulp production and cellulose recovery. Agricultural waste such as straw and bagasse demonstrate moderate cellulose and hemicellulose contents, offering an attractive alternative to wood-based pulps. Textile and industrial wastes, particularly cotton and viscose fibers, present nearly pure cellulose feedstocks that can be repulped or chemically regenerated into new fibers. Food-processing waste, including coffee husks, fruit peels, and cereal brans, are shown to contain significant cellulose fractions and can serve as sources for papermaking or biocomposite materials. Urban biowastes, such as municipal sludge and wastewater cellulose, expand the resource base through recovery technologies integrated into biorefineries. The environmental and economic assessment highlights substantial reductions in energy and water consumption, greenhouse gas emissions, and raw material costs associated with secondary fiber utilization. Life-cycle analysis and techno-economic data underscore the potential of these resources to substitute virgin pulp while supporting waste reduction and circularity goals. Advances in pulping, enzymatic treatment, and green solvent systems further enhance recovery efficiency and material quality. Collectively, these findings demonstrate that secondary cellulose fibers from multiple waste streams constitute a sustainable, resource-efficient feedstock for the pulp and paper industry, packaging, and emerging bio-based materials, bridging environmental responsibility with industrial competitiveness.

Keywords: agricultural waste, circular economy, recovered fibers, secondary cellulose, textile waste

Received: May, 2025; Revised final: July, 2025; Accepted: July, 2025; Published in final edited form: September, 2025

* Author to whom all correspondence should be addressed: email: maria.gavrilăscu@academic.tuiasi.ro