Supporting Information

Valorization of Consolidated Bioprocessing Residues for Bioplastics

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Table S1. LCI datasets for the CBP biorefinery. All quantities are in units of kg/kg ethanol unless otherwise noted.

	Lignin Diversion Percentage			
	0%	9.4%	78.2%	100%
Material and Energy Inputs				
Poplar, bone dry	3.5			
Glucose	0.18			
Ammonia	2.1×10^{-2}			
Boiler water chemicals	2.5×10^{-6}	2.3×10^{-6}	1.3×10^{-6}	1.4×10^{-6}
Lime	9.2×10^{-4}			
Ammonia (variable)	2.9×10^{-2}	2.7×10^{-2}	1.5×10^{-2}	1.1×10^{-2}
Natural gas (MJ/kg ethanol)	0	0	0	3.8
Electricity (kWh/kg ethanol)	0	0	0.49	0.48
Cooling tower chemicals	5.8×10^{-6}	5.2×10^{-6}	6.2×10^{-6}	6.5×10^{-6}
Cooling water (makeup)	3.5	3.1	0.16	0.18
Coproducts				
Ethanol	1	1	1	1
Lignin residuals, bone dry	0	8.5×10^{-2}	0.71	0.91
Electricity (kWh/kg ethanol)	0.72	0.58	0	0
Wastes				
Fly ash	1.9×10^{-2}	1.8×10^{-2}	6.0×10^{-3}	2.0×10^{-3}

Table S2. LCI dataset for composite production.

Material and Energy Inputs	kg/kg composite (unless otherwise noted)
Lignin residuals, bone dry	0.3
Polymer matrix	0.7
Process water	3.4×10^{-2}
Natural gas (MJ/kg composite)	0.12
Electricity (kWh/kg composite)	1.3
Cooling water (makeup)	0.23
Product	
Composite	1.0

Table S3. Tensile and impact strength test analysis of PBS and composites

Parameter \ Sample	PBS	PBS/H-CBP-R-SG	PBS/H-CBP-R-P
Youngs Modulus (GPa)	0.36 ± 0.02	0.66 ± 0.07	0.65 ± 0.04
Strain at Break (%)	236 ± 60	12.3 ± 3	12.5 ± 2
Stress at Break (MPa)	38.5 ± 6	26.4 ± 1.1	29.4 ± 0.8
Yield Strength (MPa)	17.6 ± 0.4	20.8 ± 1.2	21.6 ± 1.8
Notched Impact Strength (kJ/m^2)	22.72 ± 0.87	5.17 ± 0.04	5.44 ± 0.02
Impact resistance per unit notch length (J/m)	234.93 ± 9.52	53.16 ± 0.74	55.77 ± 0.60

Data is reported as the mean of 5 technical replicates with standard deviations. For Izod impact testing, the data is reported as the mean of 3 technical replicates with standard deviations.

Table S4: Benchmarking Mechanical Properties against Common Thermoplastics

Material	**Young's Modulus (GPa)**	**Tensile Strength (MPa)**	**Strain at Break (%)**	**Notched Impact (kJ/m²)**	**Reference**
Neat PBS	0.36 ± 0.02	38.5 ± 6.0	236 ± 60	22.72 ± 0.87	**This Study**
PBS/H-CBP-R-SG	**0.66 ± 0.07**	**26.4 ± 1.1**	**12.3 ± 3.0**	**5.17 ± 0.04**	**This Study**
Polypropylene (PP)	1.10 - 1.60	31.0 - 41.4	100 - 600	3.0 - 10.0	[1]*MatWeb Database & Callister (2020)*
PLA (Ingeo 4043D)	2.30 - 3.50	48.0 - 60.0	2.5 - 6.0	2.4 - 5.0	[2]*NatureWorks Technical Data*
Bio-PE (HDPE)	0.80 - 1.20	22.0 - 30.0	10 - 50	4.0 - 12.0	[3]*Braskem I'm green™ Data Sheet*

[1]Callister, W. D., & Rethwisch, D. G. (2020). Materials Science and Engineering: An Introduction. MatWeb Material Property Data (Polypropylene, Molded/Extruded)

[2]NatureWorks LLC. (2021). Technical Data Sheet: Ingeo™ Biopolymer 4043D for 3D Printing.

[3]Braskem. (2022). I'm green™ Polyethylene High Density (HDPE) Technical Data Sheet.

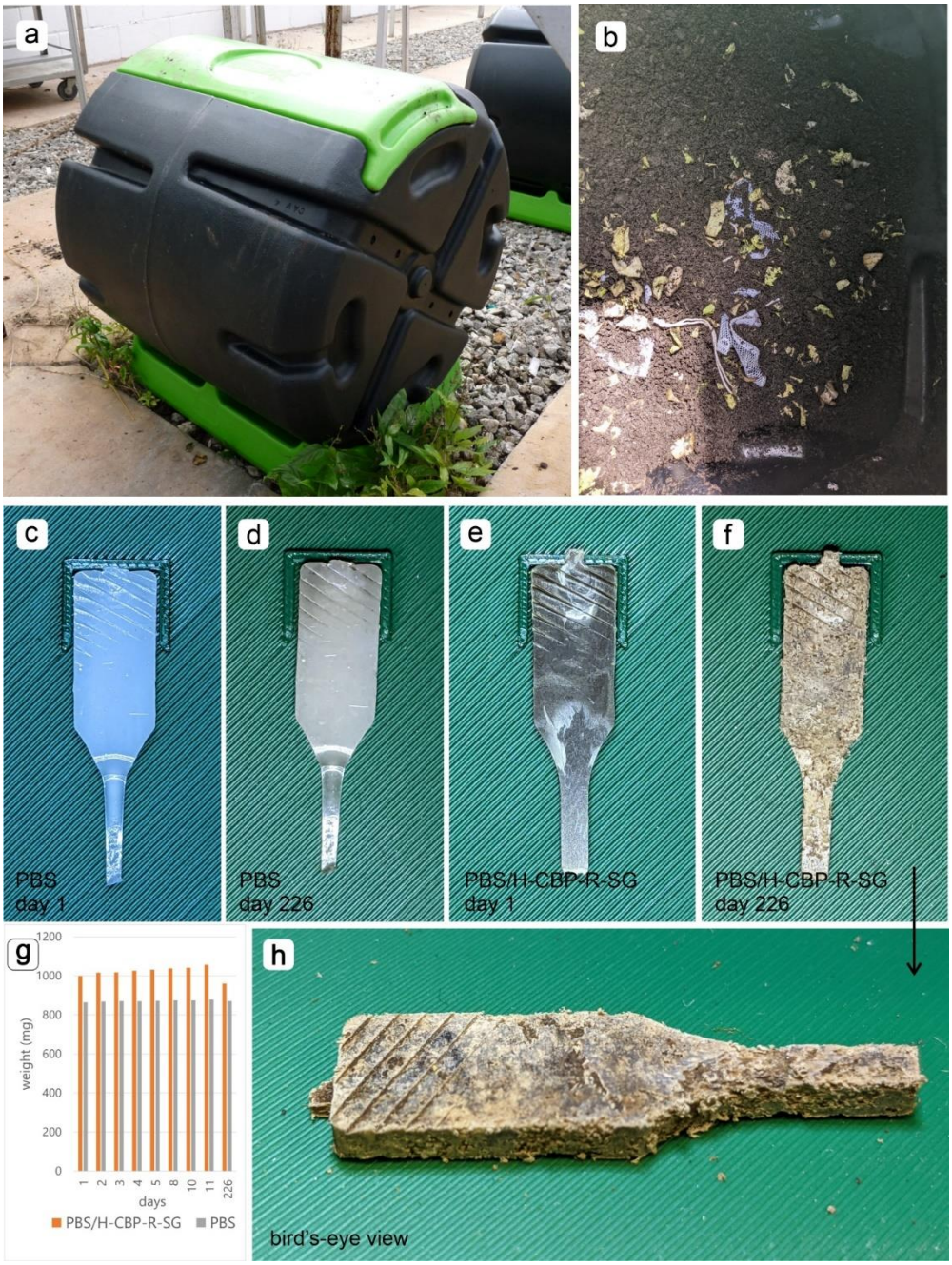

Figure S1. **Composting setup and sample placement for biodegradability assessment of PBS and PBS/H-CBP-R-SG biocomposites.** a) Composting bin setup in the greenhouse showing controlled conditions for biodegradation testing. b) Injection-molded PBS and PBS/H-CBP-R-SG samples enclosed in mesh pouches and placed in compost soil for exposure. c) to f) biocomposite specimens prior to composting, illustrating surface morphology. g) Weight gain data after humidity exposure in composter bin, highlighting differences between neat PBS and biocomposites. h) Visual changes in samples 6 months of composting (color, surface roughness).

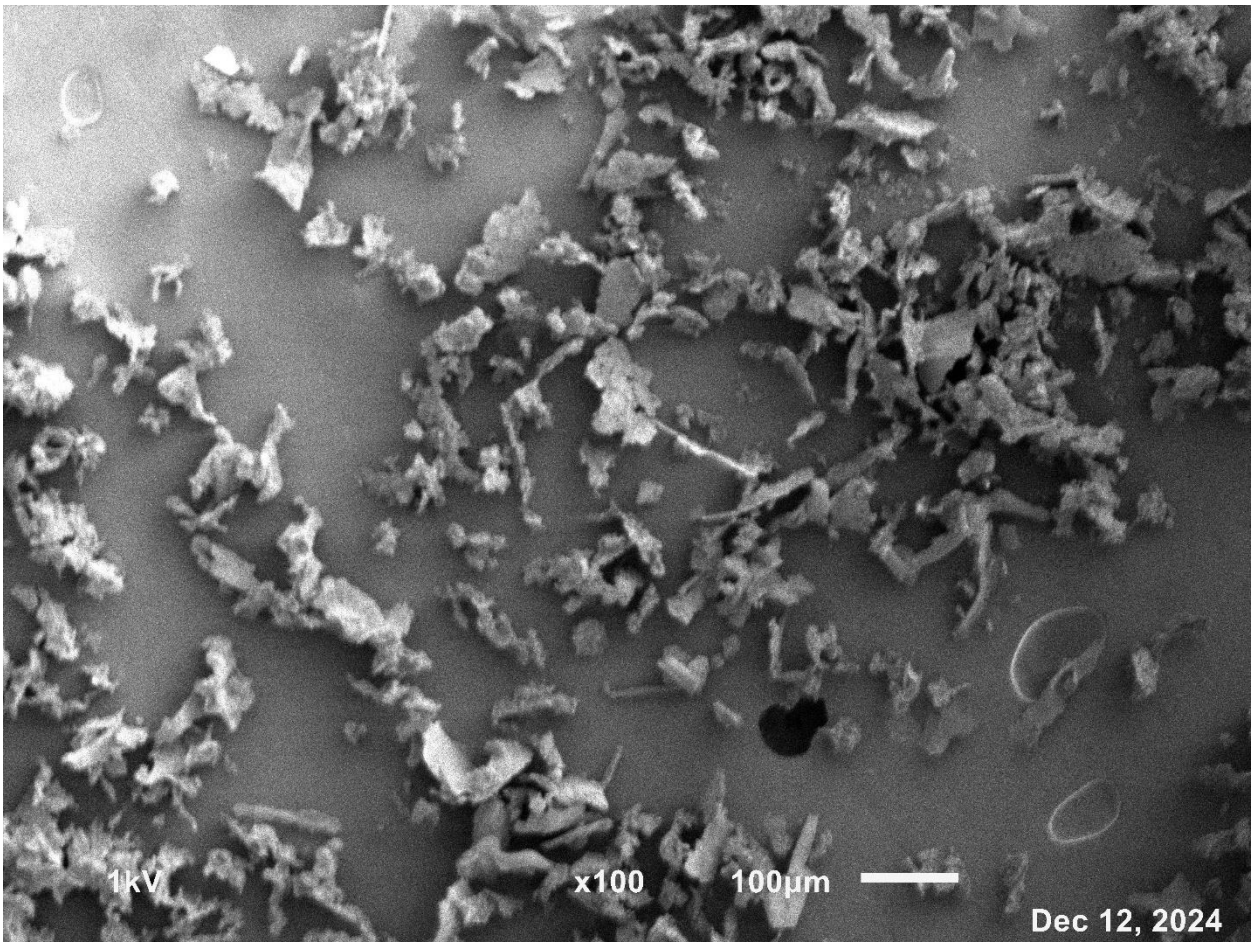

Figure S2. **HSH treated CBP-R-P sample.** Post homogenization, the morphology of fibers transformed to a reconstituted flat flakes.