

S1. Experimental Details

Fractionation of Low-Molecular-Weight Lignin (FL)

Low-molecular-weight lignin was isolated from alkaline lignin by solid-liquid extraction with absolute ethanol. Alkaline lignin (100 g) was dispersed in absolute ethanol (500 mL) and mechanically stirred for 4 h. The mixture was filtered to remove insoluble components. The filtrate was then concentrated to 100 mL at 50 °C using rotary evaporation, transferred to an evaporating dish, stored in a fume hood for 48 h, and finally vacuum-dried at 55 °C for 72 h. The resulting ethanol-soluble fraction was denoted FL and ground into powder for further use. The extraction yield was approximately 35%.

S2. Supplementary Figures

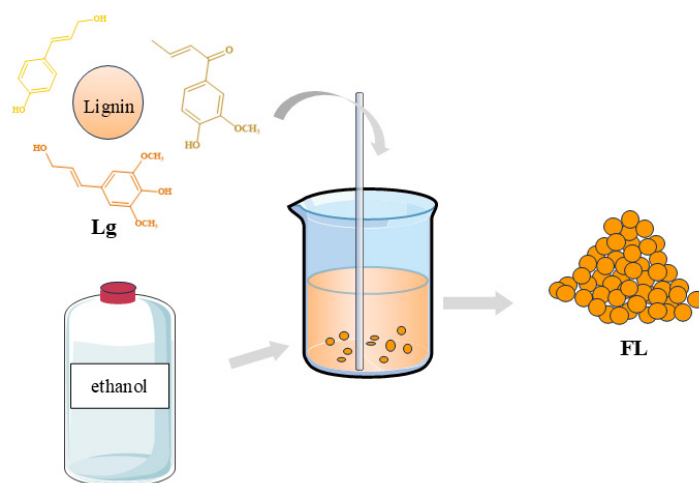


Figure S1. Extraction process for FL.

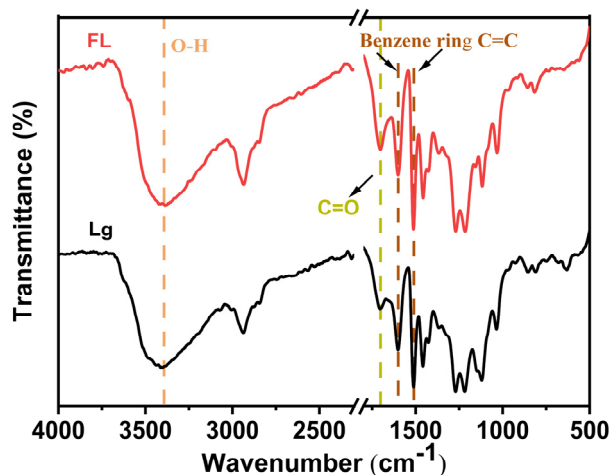


Figure S2. FTIR spectra of Lg and FL.

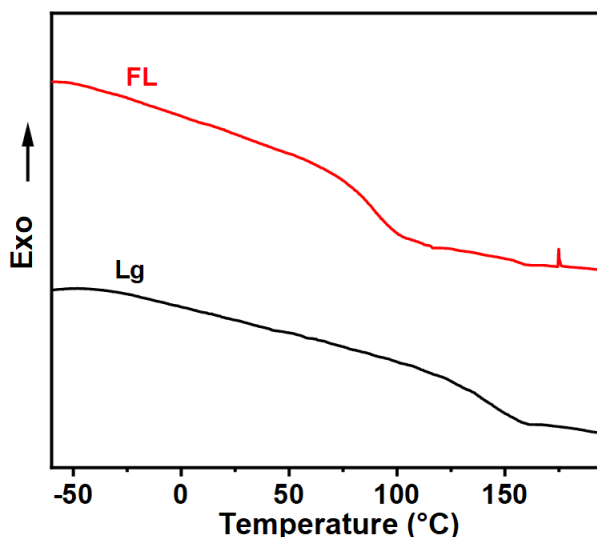


Figure S3. DSC curves of Lg and FL.

S3. Supplementary Tables

Table S1. Feed ratios of the blends and molecular-weight data of the control samples and PBAT/PLA/E-FL_x blends.

Sample	PLA (g)	PBAT (g)	E-FL (g)	Mn (g/mol)	Mw (g/mol)	PDI
PBAT				67,270	92,779	1.4
PLA				125,281	199,357	1.6
PBAT _h	50.00	/	/	22,820	52,162	2.3
PLA _h	/	50.00	/	58,485	147,670	2.5
PBAT/PLA	35.00	15.00	/	28,173	80,251	2.8
PBAT/PLA/E-FL _{0.5}	35.00	15.00	0.26	34,433	94,937	2.8
PBAT/PLA/E-FL ₁	35.00	15.00	0.51	38,606	111,638	2.9
PBAT/PLA/E-FL ₃	35.00	15.00	1.51	39,360	76,716	1.9
PBAT/PLA/E-FL ₅	35.00	15.00	2.51	29,712	87,922	2.9
PBAT/PLA/E-FL ₇	35.00	15.00	3.51	28,146	73,587	2.6

h indicates that PBAT and PLA were subjected to the same thermal history as the blend samples.

Table S2. Molecular-weight characteristics and hydroxyl-group contents of original lignin (Lg) and fractionated lignin (FL).

Sample	Mn (g/mol)	Mw (g/mol)	PDI	Alcohol -OH (mmol/g)	Phenolic -OH (mmol/g)	-COOH (mmol/g)	Total -OH (mmol/g)
Lg	2100	3000	1.41	1.08	2.92	0.40	4.00
FL	520	680	1.30	1.27	4.77	0.80	6.04

Table S3. DSC data of PBAT, PLA, PBAT/PLA, and PBAT/PLA/E-FL_x blends.

Sample	T _g			PBAT			PLA				X _c (%)
	T _{g,PBAT} (°C)	T _{g,PLA} (°C)	ΔT _g (°C)	T _m (°C)	ΔH _m (J/g)	T _c (°C)	T _m (°C)	ΔH _m (J/g)	T _{cc} (°C)	ΔH _{cc} (J/g)	
PBAT	-32.5	-	-	122.1	13.2	74.4	-	-	-	-	-
PLA	-	59.9	-	-	-	-	168.7	39.7	95.4	28.4	42.4
PBAT/PLA	-32.7	59.4	92.1	122.4	4.1	77.5	168.3	12.0	95.8	6.5	42.7
PBAT/PLA/E-FL _{0.5}	-32.2	58.8	91.0	122.5	4.9	72.7	167.0	6.7	102.4	3.8	23.8
PBAT/PLA/E-FL ₁	-31.6	58.5	90.1	121.7	4.4	71.8	167.1	2.3	102.5	0.7	8.2
PBAT/PLA/E-FL ₃	-28.7	57.7	86.4	121.5	4.3	66.9	168.2	1.2	-	-	4.3
PBAT/PLA/E-FL ₅	-27.0	56.5	83.5	120.7	4.2	67.5	-	-	-	-	-
PBAT/PLA/E-FL ₇	-26.6	55.4	82.0	120.3	3.6	69.1	-	-	-	-	-

Table S4. DMA data of PBAT, PLA, PBAT/PLA, and PBAT/PLA/E-FL_x blends.

Sample	$E'_{-50\text{ }^\circ\text{C}}$ (GPa)	$T_{g,\text{PBAT}}$ ($^\circ\text{C}$)	$T_{g,\text{PLA}}$ ($^\circ\text{C}$)	ΔT_g ($^\circ\text{C}$)
PBAT	1.0	-10.01	/	/
PLA	2.1	/	75.1	/
PBAT/PLA	1.7	-9.8	74.8	84.6
PBAT/PLA/E-FL _{0.5}	1.4	-8.5	71.3	79.8
PBAT/PLA/E-FL ₁	1.7	-6.2	76.7	82.9
PBAT/PLA/E-FL ₃	1.8	-3.5	75.2	78.7
PBAT/PLA/E-FL ₅	1.7	-1.4	74.5	75.9
PBAT/PLA/E-FL ₇	1.7	0	73.9	73.9

Table S5. Mechanical properties of PBAT, PLA, PBAT/PLA, and PBAT/PLA/E-FL_x blends.

Sample	Tensile Strength (MPa)	Elongation at Break (%)	Fracture Toughness (MJ/m ³)
PBAT	21.8 ± 0.8	1036 ± 57	156.8 ± 11.1
PLA	61.2 ± 1.9	21 ± 2	9.3 ± 1.8
PBAT/PLA	15.3 ± 2.9	586 ± 98	85.6 ± 26.5
PBAT/PLA/E-FL _{0.5}	29.9 ± 0.9	894 ± 21	181.5 ± 6.5
PBAT/PLA/E-FL ₁	33.4 ± 0.4	986 ± 16	209.8 ± 4.8
PBAT/PLA/E-FL ₃	36.1 ± 0.1	1035 ± 17	238.3 ± 5.4
PBAT/PLA/E-FL ₅	28.6 ± 1.5	870 ± 27	175.9 ± 2.4
PBAT/PLA/E-FL ₇	17.5 ± 0.7	764 ± 62	109.9 ± 18.5