Supporting information for

Deep Eutectic Solvent Engineering: A Novel Ternary System for Efficient Lignocellulose Extraction

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Table S1 The details of different DESs and treatment conditions.

Biomass	DESs				Treatment Conditions		Treatment effect
	Name	HBA:HBD	Molar ratio	PEG (ml)	Temperature (°C)	Time (h)	
Wheat straw	D	K_2CO_3:Gly	1:5	/	160	24	□Satisfactory ✪General □Poor
	D-5			5			✪Satisfactory □General □Poor
	D-10			10			✪Satisfactory □General □Poor
	D-20			20			✪Satisfactory □General □Poor

Note: Alkaline DESs (PH value:12.5-13)

Table S2 Parameters of Arrhenius equation fitting curves.

Name	Parameters		R^2
	η_1	E_η ($kJ \cdot mol^{-1}$)	
D	1.71×10^{-11}	72.21	0.99
D-5	8.40×10^{-11}	65.63	0.99
D-10	2.93×10^{-10}	60.16	0.99
D-20	2.62×10^{-9}	51.54	0.99

Note: E_η is the viscous flow activation energy, which is not only the energy needed to overcome the action of the surrounding molecules when the macromolecule transitions to the hole, but also a measure of the melt viscosity-temperature sensitivity. That is, the larger the E_η, the fluidity is also worse, and the viscosity-temperature change is more sensitive.

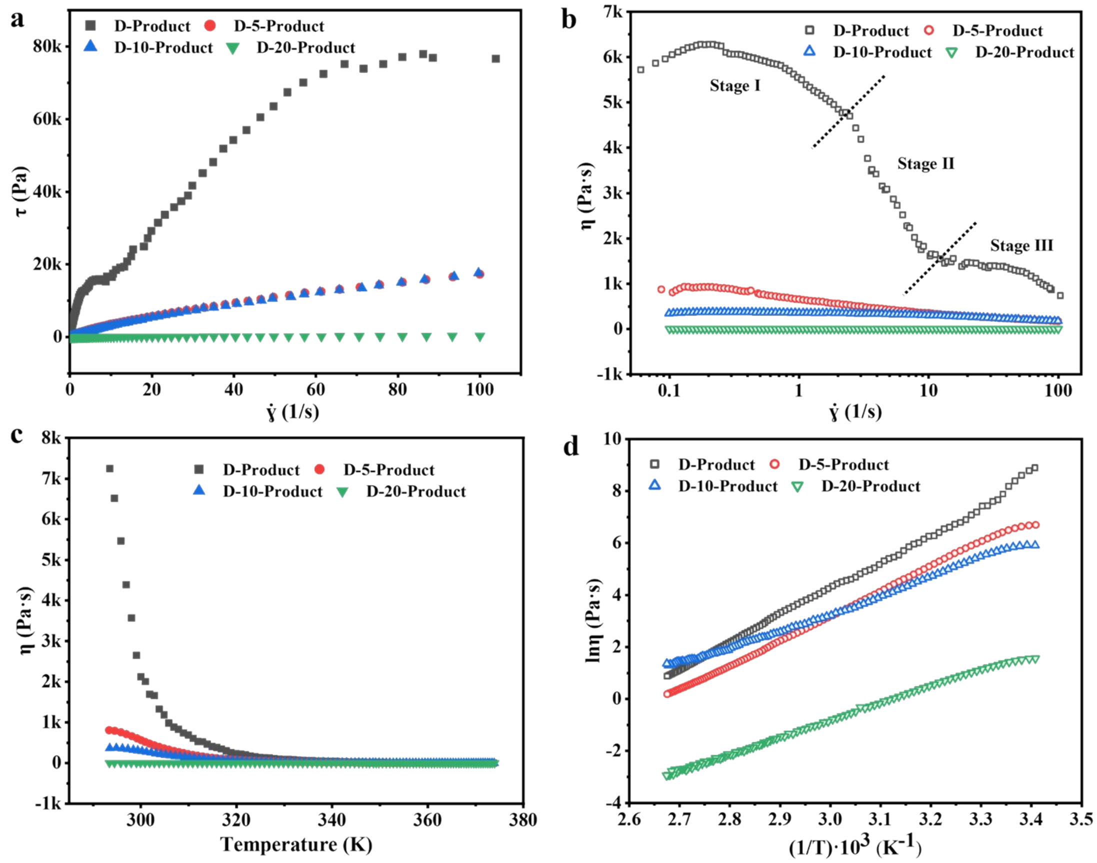

Fig. S1 Rheological properties test of D-product, D-5-product, D-10-product and D-20-product: (a) Rheological curve (shear stress-shear rate); (b) Viscosity-shear rate dependence curve; (c) Viscosity-temperature dependence curve; (d) Viscosity-temperature sensitivity fitting curve.

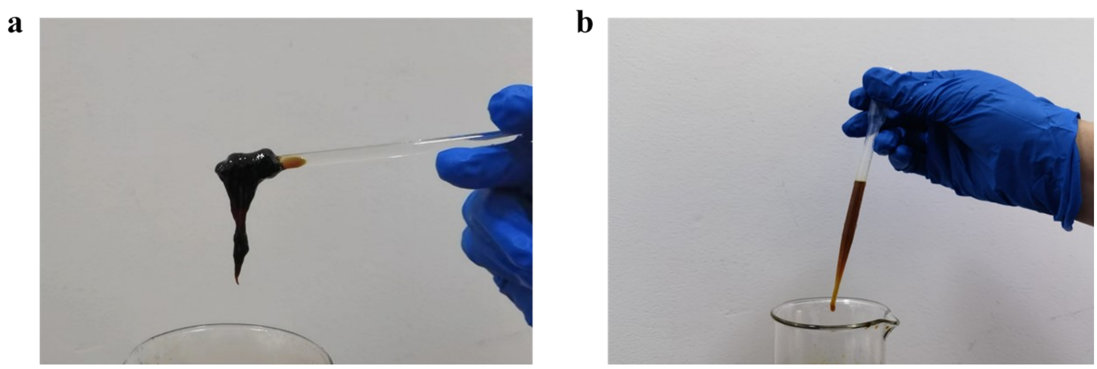

Fig. S2 Fluidity of (a) D-product and (b) D-10-product.

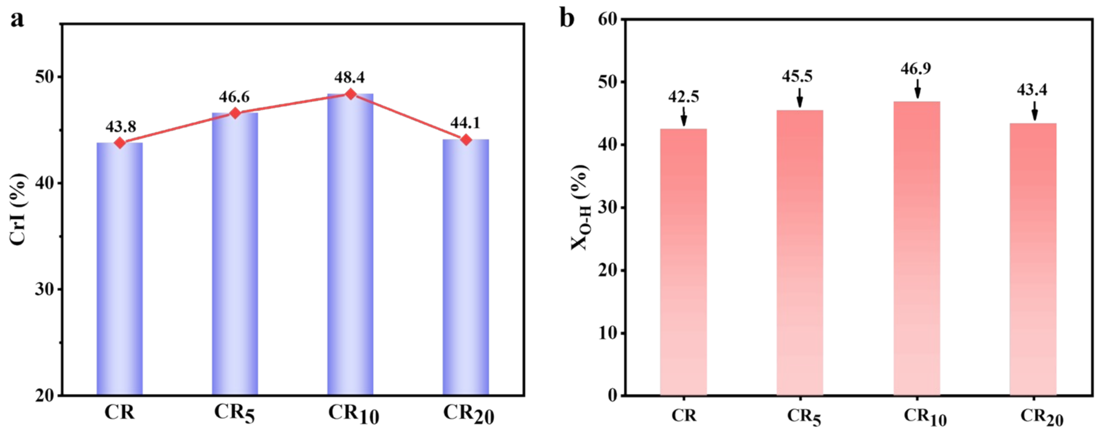

Fig. S3 Calculation results of CR, CR_5, CR_{10} and CR_{20}: (a) CrI values; (b) X_{O-H} values.

For potassium carbonate, the main functional group is the vibration absorption peak of carbonate ion. The peaks at 1456 and 1377 cm^{-1} correspond to the out-of-plane asymmetric stretching vibration of CO_3^{2-}. The peaks at 879 and 707 cm^{-1} correspond to the out-of-plane asymmetric and in-plane symmetric bending vibration of CO_3^{2-}, respectively.[1] For glycerol, the peak at 3288 cm^{-1} corresponds to the stretching vibration of O-H. The peaks at 2929 and 2875 cm^{-1} correspond to the asymmetric and symmetric stretching vibrations of $-CH_2$, respectively. After forming a binary DES system with K_2CO_3, the absorption frequency of the O-H stretching vibration shifts to the low wave number direction and the peak shape is broadened. This indicates the formation of intermolecular associative hydrogen bonding, where the oxygen atom of the CO_3^{2-} attracts the hydrogen proton in glycerol.[2] The same phenomenon can also be observed in the ternary system formed by introducing PEG-200. In addition, the relative intensity of the asymmetric stretching vibrational peak of $-CH_2$ is weakened, while the relative intensity of the symmetric stretching vibrational peak is enhanced. This may also be attributed to the presence of hydrogen bonding, which in turn affects the stretching vibration of $-CH_2$.

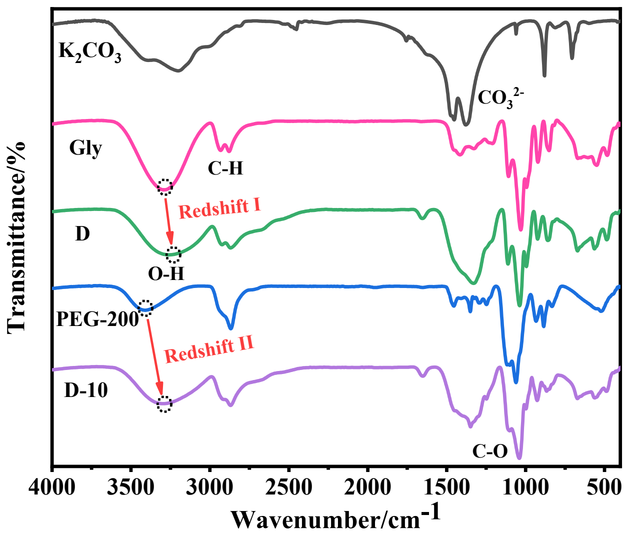

Fig.S4 FT-IR spectrum of individual components and different DESs.

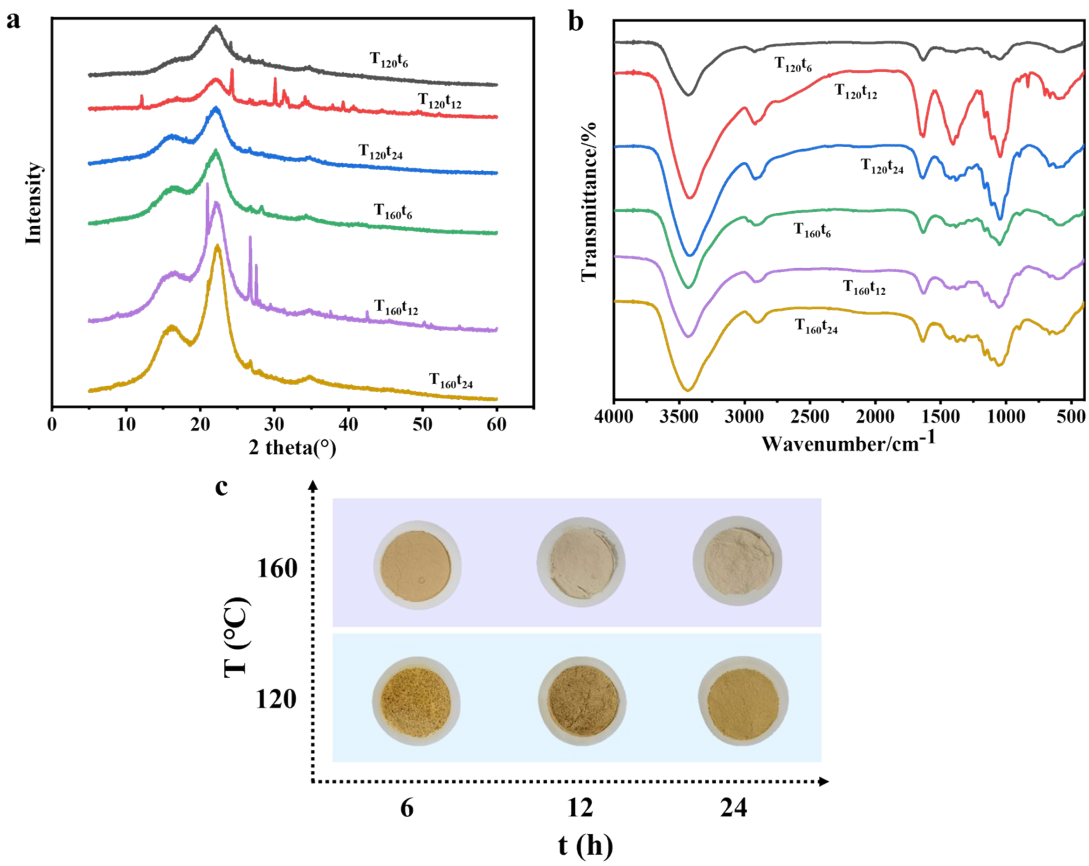

Fig. S5 Comparing tests: (a) XRD characterization; (b) FT-IR characterization; (c) Treatment effects of D-10 at different reaction temperatures and times.

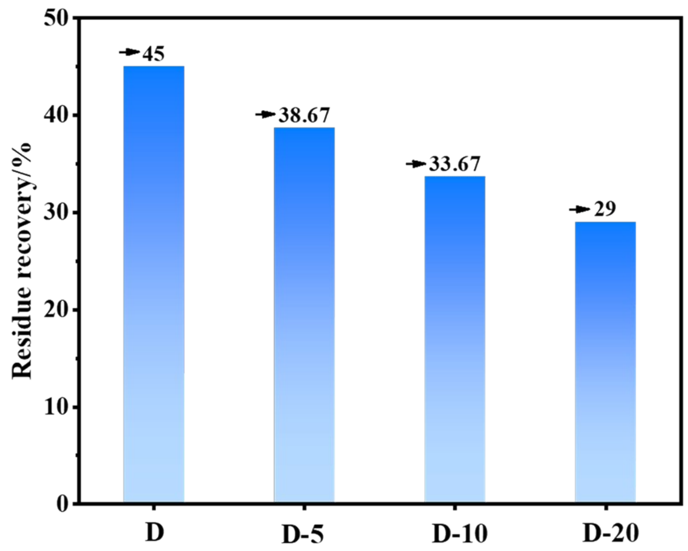

Fig. S6 Residue recovery of D, D-5, D-10 and D-20.

Table S3 Performances of traditional and our designed ternary DESs treatment on LCB.

Biomass	DESs (HBA/HBD)	Treatment Conditions: Temperature (°C)	Time (h)	Other	Removal (%): Xylan	Lignin	Residue recovery (%)	Cellulose yield (%)	References
Wheat straw	K_2CO_3/Gly/PEG-200	160	24	/	81.93	96.37	33.67	73.65	This work
Wheat straw	ChCl/LC	120	6	/	/	60.1	/	64.9	34
Wheat straw	ChCl/LC	100	16	/	/	/	44.9	/	19
Corn stalk	ChCl/LC	100	16	/	/	/	32.2	/	19
Corn stover	ChCl/OA/EG	130	1	High pressure	/	75.27	/	/	20
Bamboo	ChCl/Xylitol	120	3	1 wt% H_2SO_4	92.79	80.75	41.5	/	22
Bamboo	ChCl/LC	120	3	Dewaxing	74.81	94.39	49.18	91.06	24
Eucommia ulmoides seed shells	ChCl/OA/EG	100	3	/	79.7	65.6	/	84.0	37

1 Hosein. Ghaedi, Payam. Kalhor, M. Zhao, *Frontiers of Environmental Science & Engineering*, 2022, 16, 7, 92.
2 P. C. Meng, J. Li, W. Liu, G. L. Yang, *LWT - Food Science and Technology*, 2023, 186, 115232.