Supplementary Information (SI) for Green Chemistry.
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Supporting Information

Full conversion of Grass Biomass into Sustainable Functional Antimicrobial Bioplastics

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Table S1. Material and energy inventory for "*GPL20*" processing. Energy is highlighted in yellow. Wastes are highlighted in light orange. Outputs are highlighted in blue.

Comment	Item	Amount (g)	Source/provider
Step 1: washing			
Biomass source	Grass	0.8888	*Burden free according to cut-off*
10 km to the processing site	Transport	0.0089 kg×km	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 5 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 5 | Cutoff, U - RER
For washing	Water	10.0000	market for water, deionised | water, deionised | Cutoff, U - Europe without Switzerland
-	Wastewater	9.0000	treatment of wastewater, unpolluted, wastewater treatment | wastewater, unpolluted | Cutoff, U - CH
Step 2: drying			
At 60 ºC for 24h	Energy [a]	37.60 Wh	market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U - CH
	Evaporated H_2O	1.0000	Emission to air / unspecified
Step 3: grinding			
5 min blender	Energy [b]	0.12 Wh	market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U - CH
Step 4: sieving			
2 h sieving	Energy [c]	1.12 Wh	market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U - CH
10 wt% is lost during sieving	Waste	0.0888	treatment of biowaste, industrial composting | biowaste | Cutoff, U - CH
Step 5: hydrolysis			
1 M NH_3	Ammonia	0.3406	ammonia production, steam reforming, liquid | ammonia, anhydrous, liquid | Cutoff, U - Europe without Russia

(20 mL)	Water	19.3000	water production, deionised | water, deionised | Cutoff, U - Europe without Switzerland
Plasticizer	ε-polylysine	0.2000	*From Agrybalise v3.1.1*
For stirring, 24 h at 40 ºC	Energy [d]	50.82 Wh	market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U - CH
Step 6: casting			
48 h at the fume hood	Energy [e]	82.20 Wh	market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U - CH
	Evaporated NH_3	0.3406	Emission to air / unspecified
	Evaporated H_2O	19.3000	Emission to air / unspecified
	Bioplastic	**1.0000**	**Process output**

[a]: An oven with a power of 1400 W with capacity to dry 0.5 kg (ONH 60). Estimated workload of 70%.
[b]: AMZCHEF blender with a power of 2000 W with capacity of 2 L. Estimated workload of 70%.
[c]: sieve shaker with 350 W (https://www.mrclab.com/sieve-shaker-for-200mm-sieves). It can hold approximately 0.350 kg of grass at a time. Estimated workload of 70%.
[d]: Instrument power: 605 W (Fisherbrand™ Isotemp™ Hot Plate Stirrer). 4 L capacity. Estimated workload of 70%..
[e]: considering that a conventional laboratory fume hood consumes 30000 kWh anualy (https://fumehoodcalculator.lbl.gov/). It has room to dry 2 kg of material in 2 days.

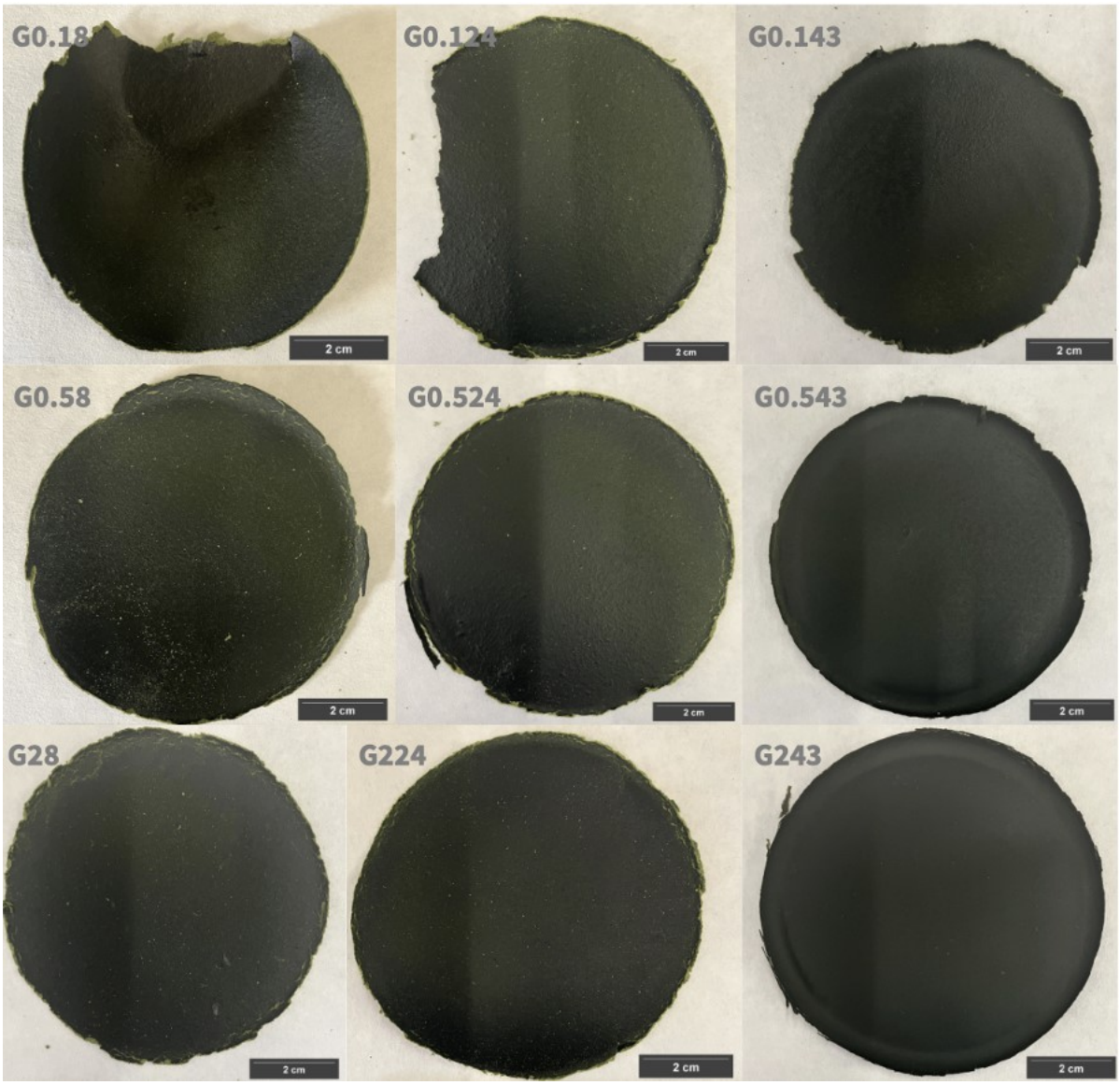

Figure S1. Grass-derived bioplastic films obtained at different hydrolysis time and NH_3 concentration.

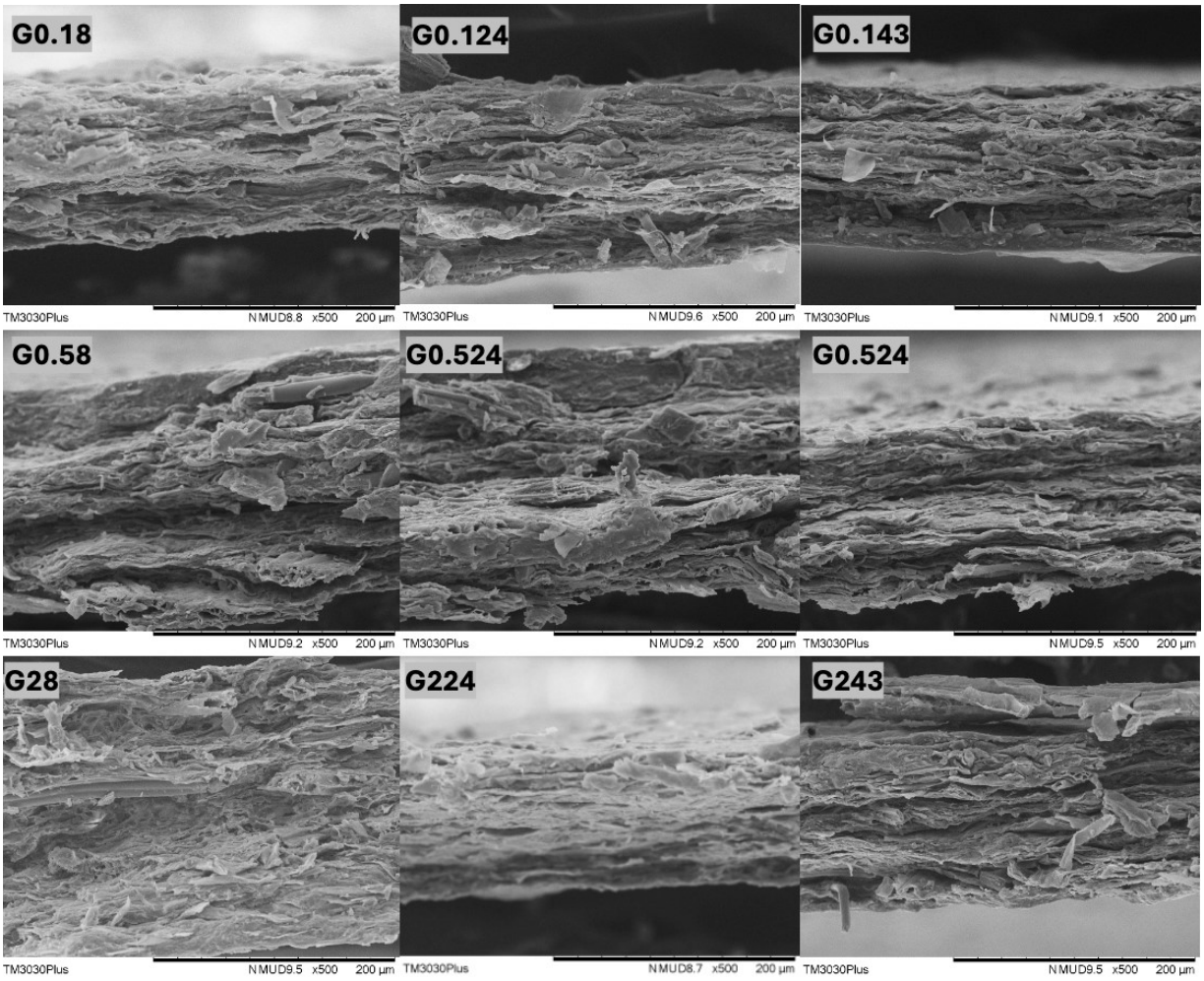

Figure S2. Cross section of grass biofilms obtained after alkaline hydrolysis and cryofracture.

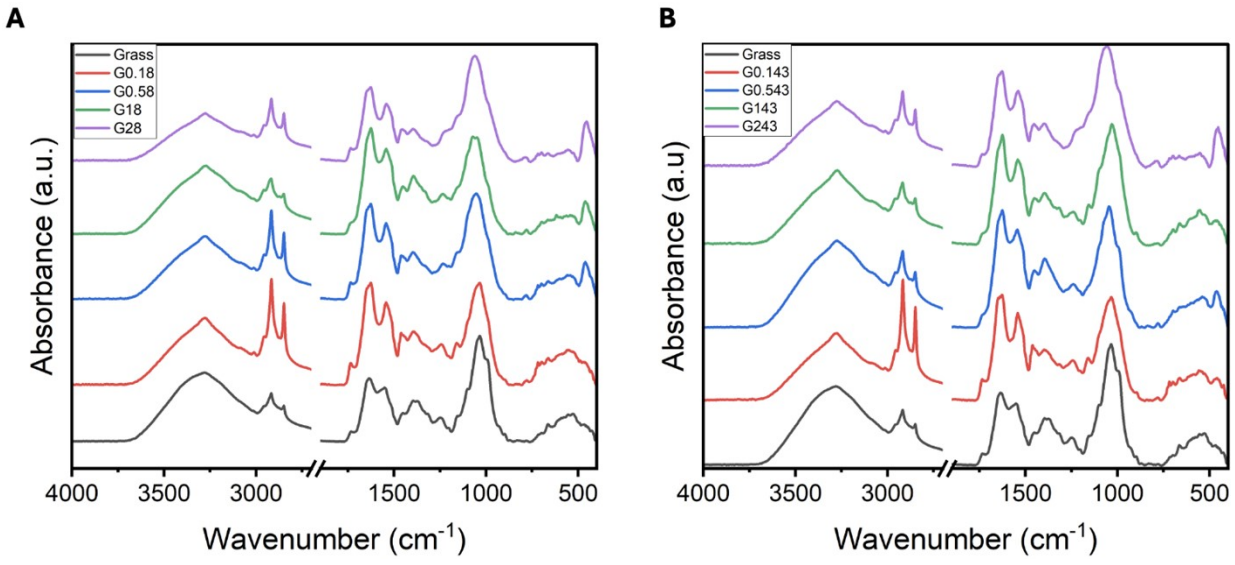

Figure S3. FTIR spectra of the grass biofilms obtained at different hydrolysis times. A) 8h of hydrolysis; **B)** 43 h of hydrolysis.

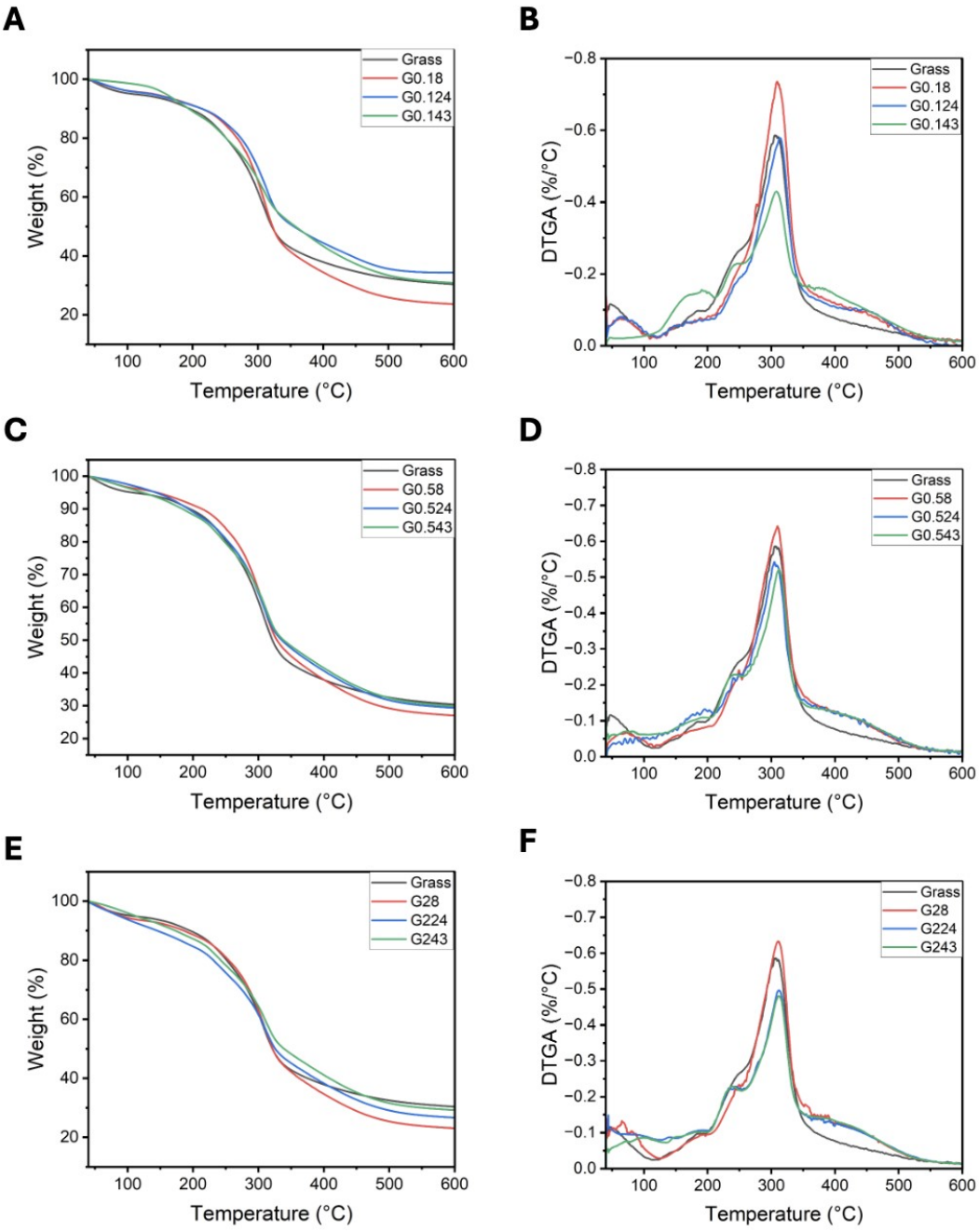

Figure S4. **TGA and DTGA of grass-derived bioplastic films obtained at different concentration of NH_3 (0.1, 0.5, 2 M) and different hydrolytic times (8, 24, and 43 h). A)** TGA of films obtained

with 0.1M NH_3, **B)** DTGA of films obtained with 0.1M NH_3; **C)** TGA of films obtained with 0.5M NH_3, **D)** DTGA of films obtained with 0.5M NH_3; **E)** TGA of films obtained at 2M NH_3; F) DTGA of films obtained at 2M NH_3.

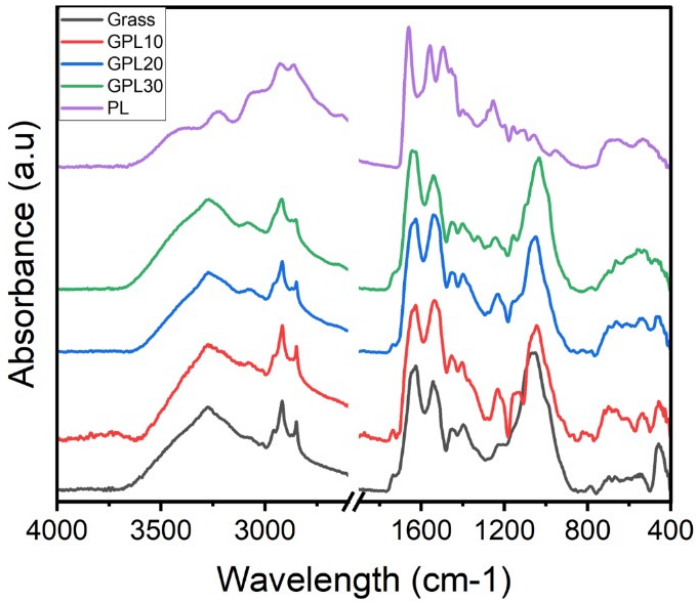

Figure S5. FTIR spectra of PL-grass bioplastics containing different PL content.

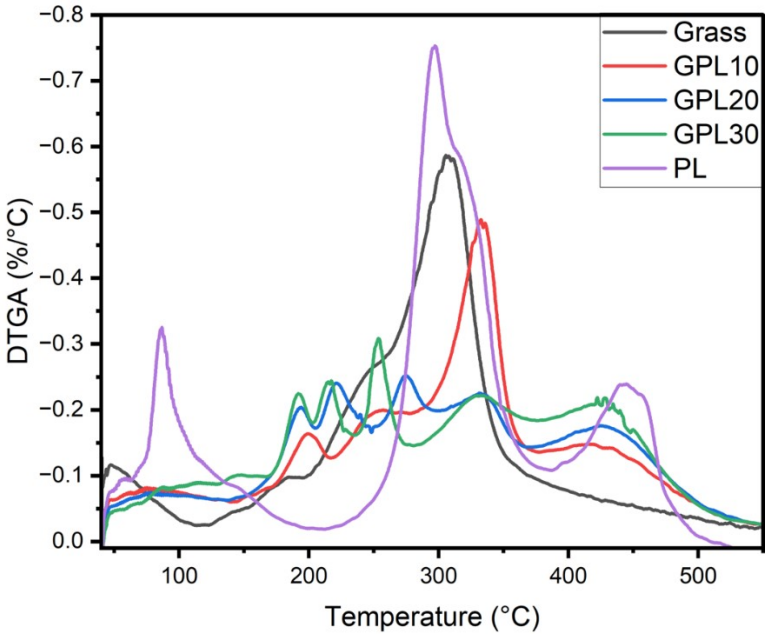

Figure S6. DTGA curves of PL-grass bioplastics containing different PL content.

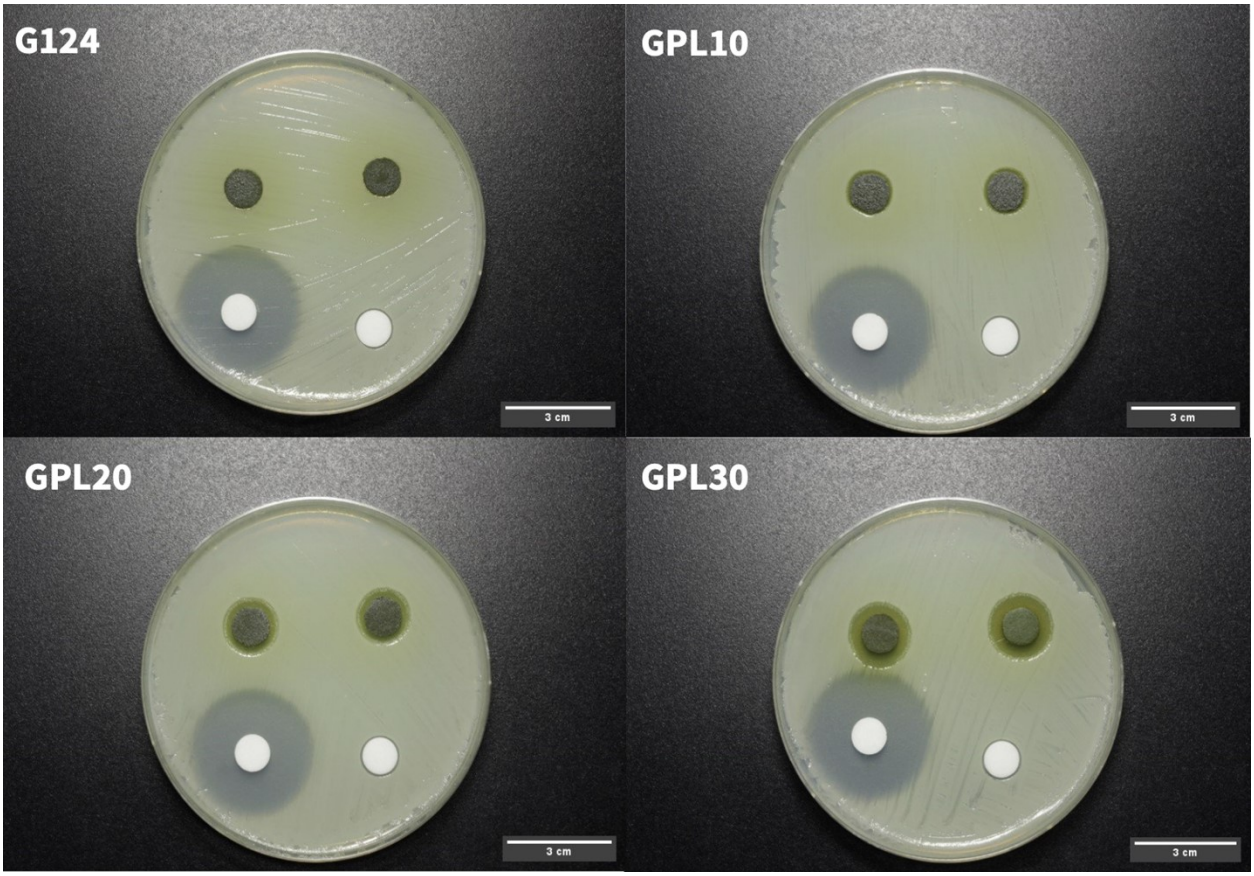

Figure S7. Antimicrobial assay of PL-grass bioplastics against gram positive *Staphylococcus aureus.* Agar diffusion test using 2 replicates (top right and top left in disc), antibiotic control (bottom left) and positive control (bottom right).

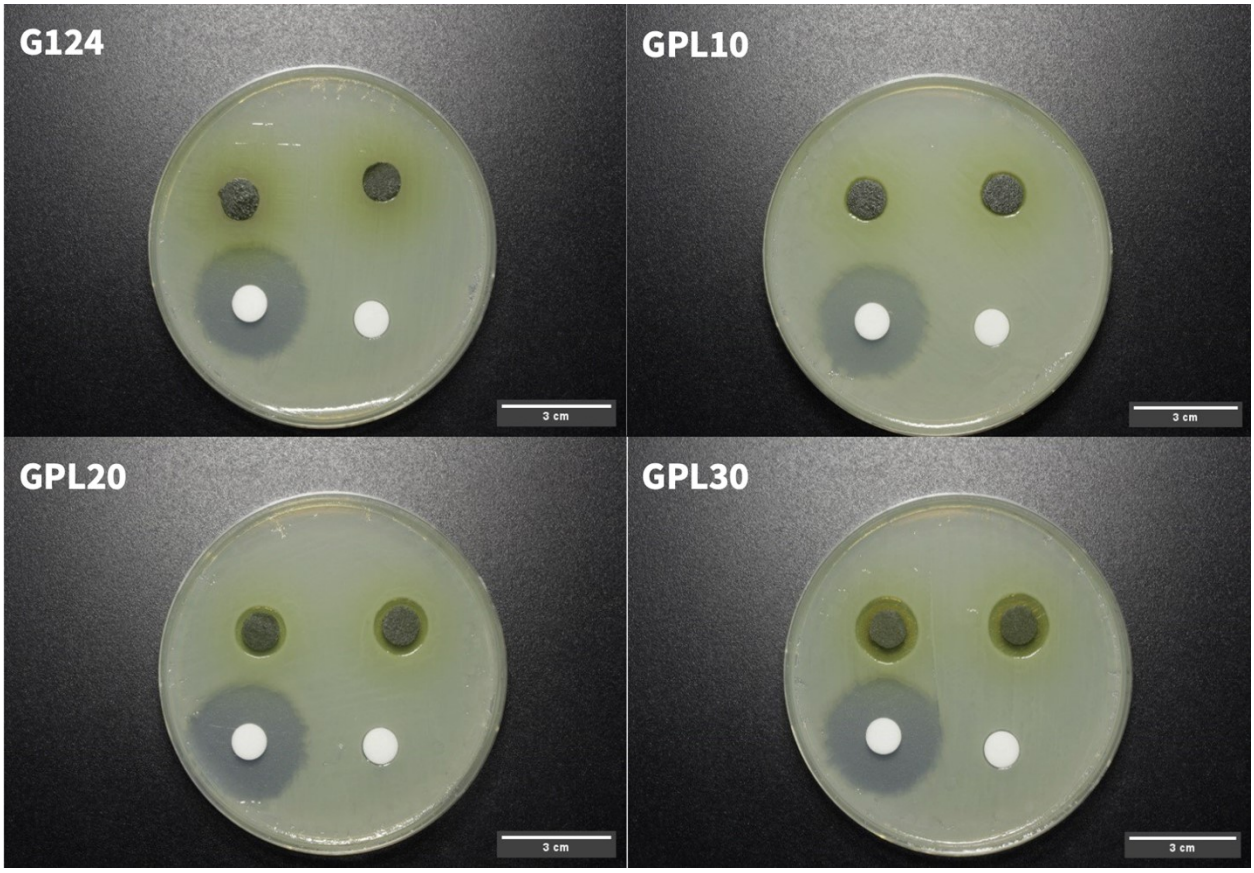

Figure S8. Antimicrobial assay of PL-grass bioplastics against gram negative *Escherichia coli*. Agar diffusion test using 2 replicates of each sample (top right and top left in disc), antibiotic control (bottom left) and positive control (bottom right).

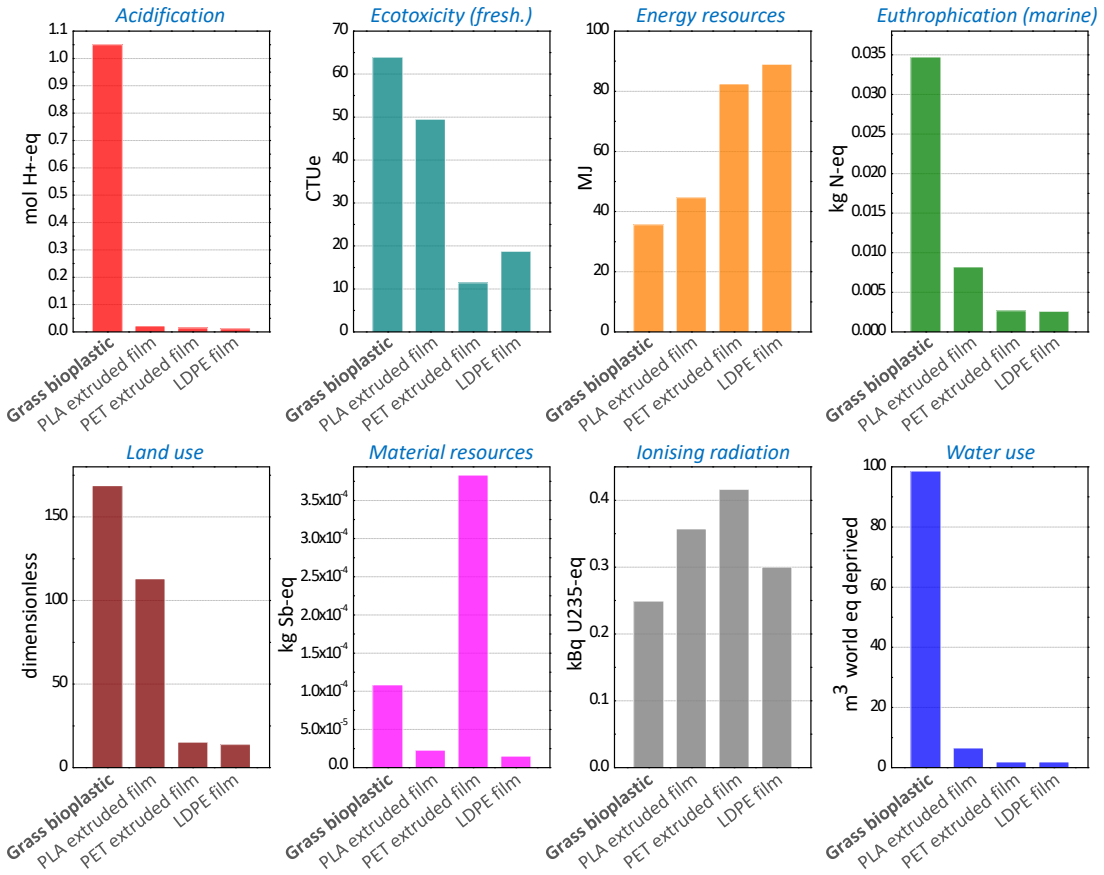

Figure S9. *Cradle-to-gate* environmental impacts of *"Grass bioplastic"* and its packaging plastic films competitors.