Compatibilization of immiscible PLA/PBS biodegradable blends using poly(lactide-*co*-butylene succinate) copolymers

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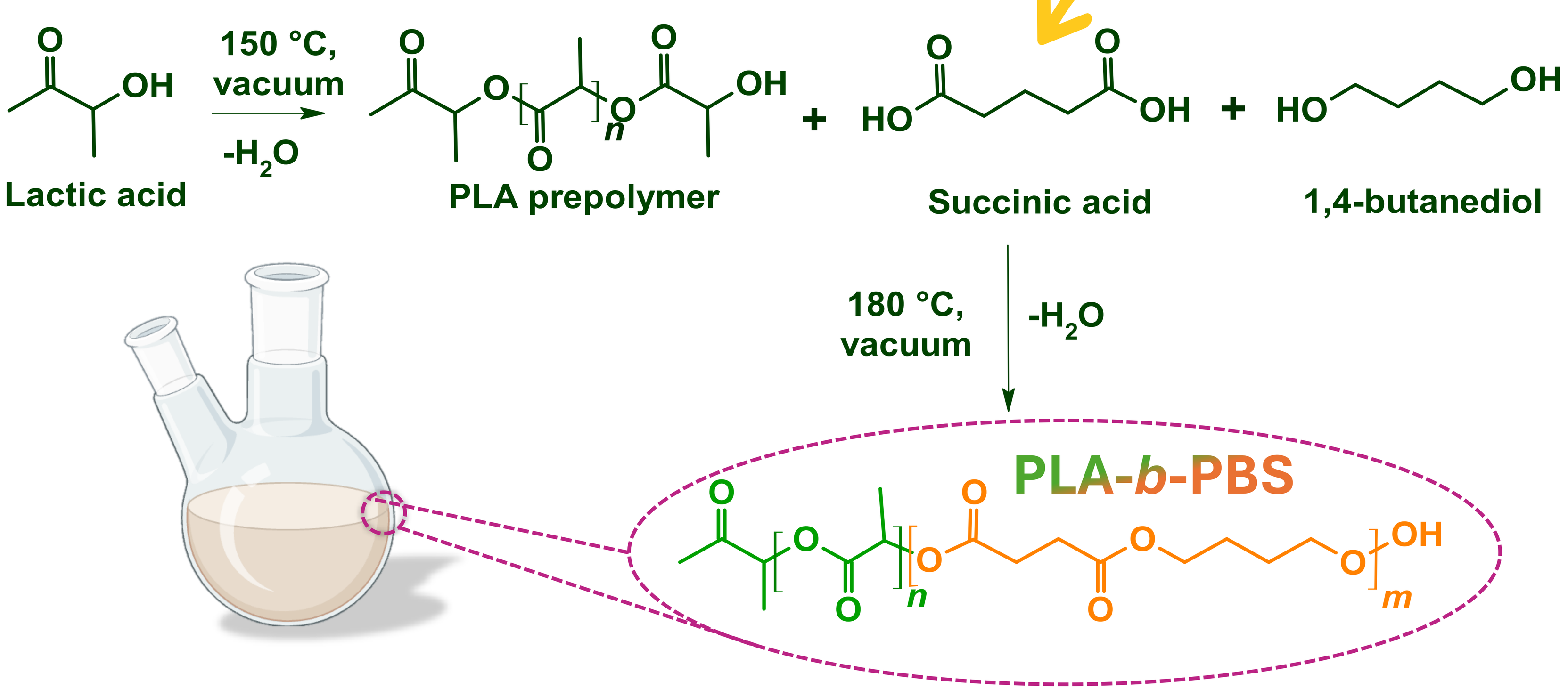
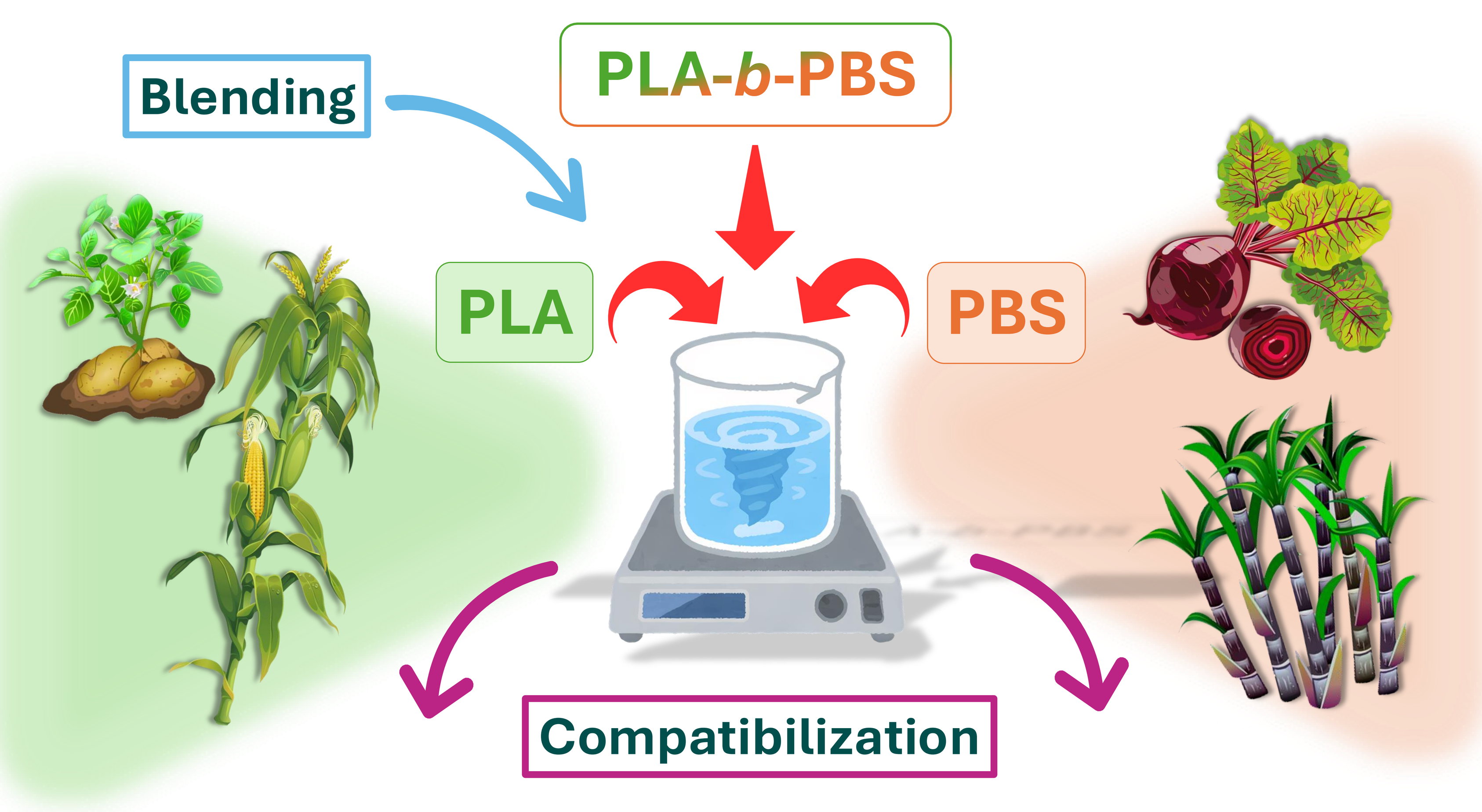
Introduction

Biodegradable polymers, also known as bioplastics, have become a potential replacement for traditional petroleum-based plastics and work as a promising strategy for achieving environmental stability and increasing the demand for eco-friendly materials. Among the most promising bio-based polymers are brittle PLA and ductile PBS, which are obtained from renewable sources and offer several properties for different applications. Blending brittle PLA with ductile PBS is a practical and cost-effective strategy to tailor the properties of each component and extend their application scope. However, the immiscibility between PLA and PBS polymers leads to their performance impairment and application limitations. **Compatibilization strategies**, **using copolymers** with segments chemically identical or similar to the polymer blends, are usually used to **enhance the interfacial interaction** and **overall material performance**.

Materials & Methods

Synthesis





Abbreviation	PLA	PBS	A	B
L25/S75	25.0	75.0	–	–
L25/S75-A	22.5	75.0	2.5	–
L25/S75-B	22.5	75.0	–	2.5
L50/S50	50.0	50.0	–	–
L50/S50-A	47.5	50.0	2.5	–
L50/S50-B	47.5	50.0	–	2.5
L75/S25	75.0	25.0	–	–
L75/S25-A	72.5	25.0	2.5	–
L75/S25-B	72.5	25.0	–	2.5

A – PLA-*co*-PBS 75-25
B – PLA-*co*-PBS 25-75
L – poly(lactic acid) (PLA)
S – poly(butylene succinate) (PBS)

Abbreviation

We present a synthesing method using tunable PLA-*co*-PBS block copolymers as multifunctional compatibilizers to enhance miscibility, interface compatibility, and overall performance of PLA/PBS blends, surpassing traditional approaches and offering promise for eco-friendly packaging and agricultural materials.

Results

Blends morphology

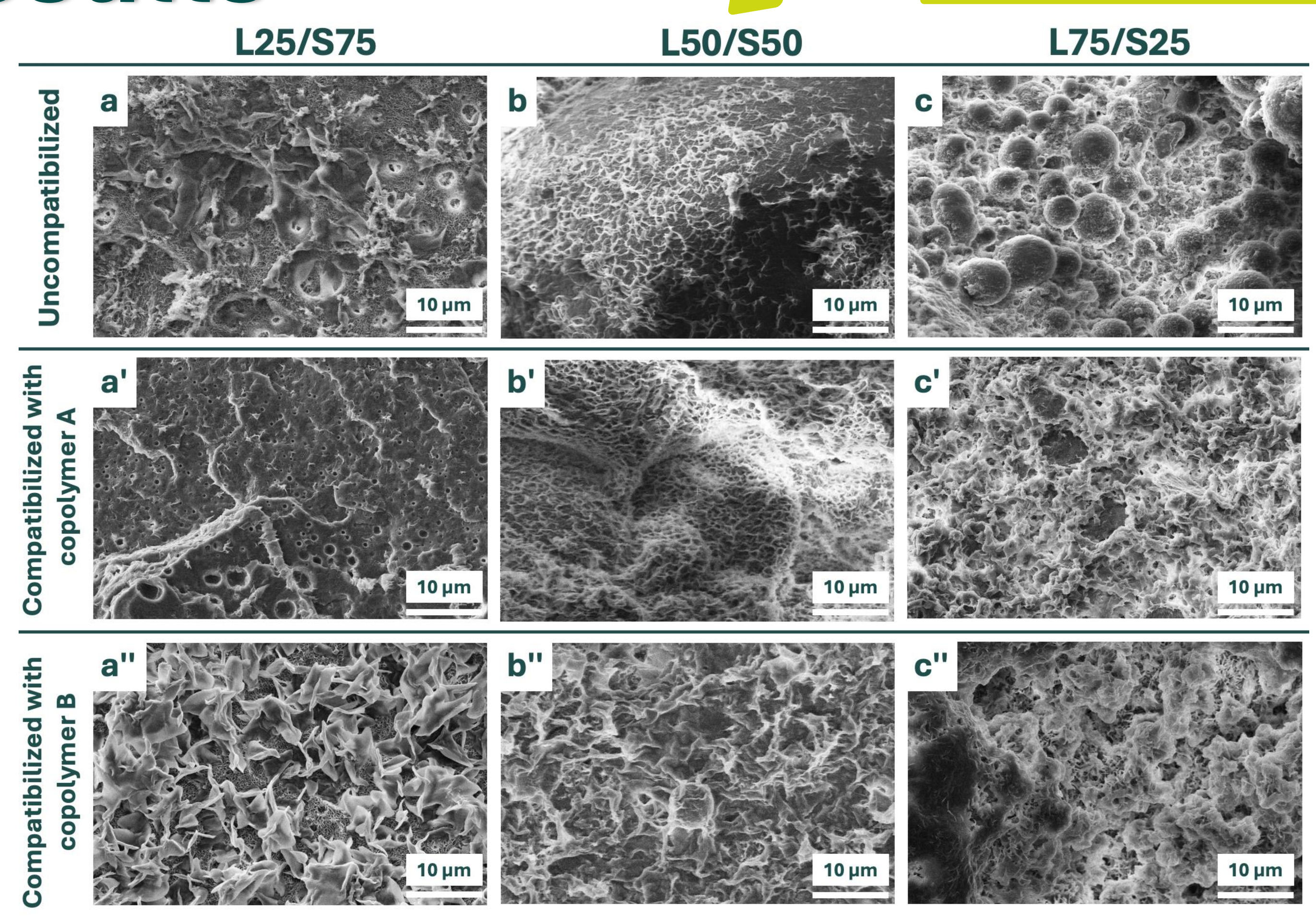


Fig. 1. SEM micrographs presenting etched cryo-fructure of the neat and compatibilized PLA/PBS (25/75, 50/50, and 75/25 wt%) samples.

Thermal properties

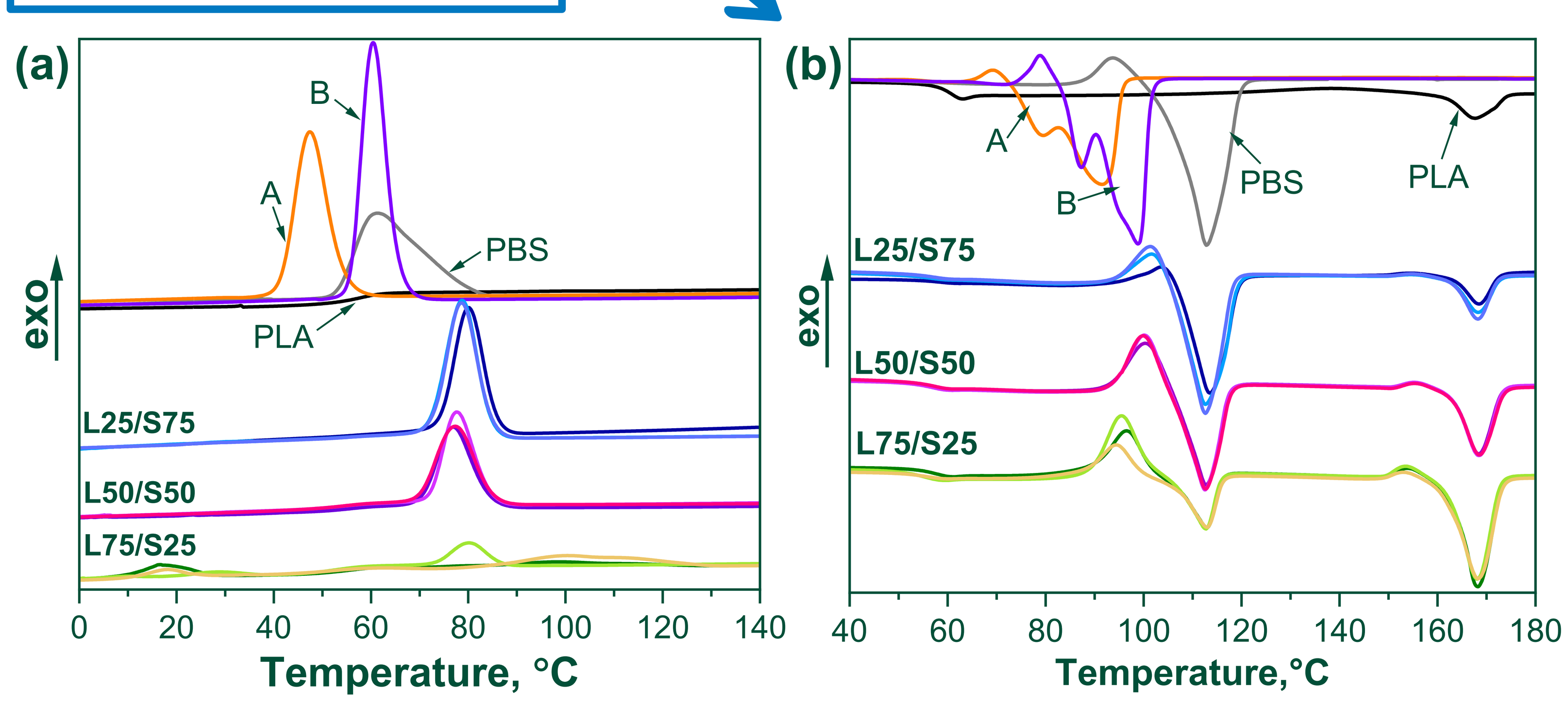


Fig. 2. DSC (a) cooling and (b) second heating scans for neat and compatibilized PLA/PBS (25/75, 50/50, and 75/25 wt%) blends.

Tensile properties

PLA-*co*-PBS 75-25 (A):
↑E and ↑σ for all L/S blends
↑ε_U for L/S 25/75 and 50/50

PLA-*co*-PBS 25-75 (B):
↓E for L/S 25/75 and 50/50, but ↑E 75/25
↑σ for all L/S blends
↑ εU L/S 25/75

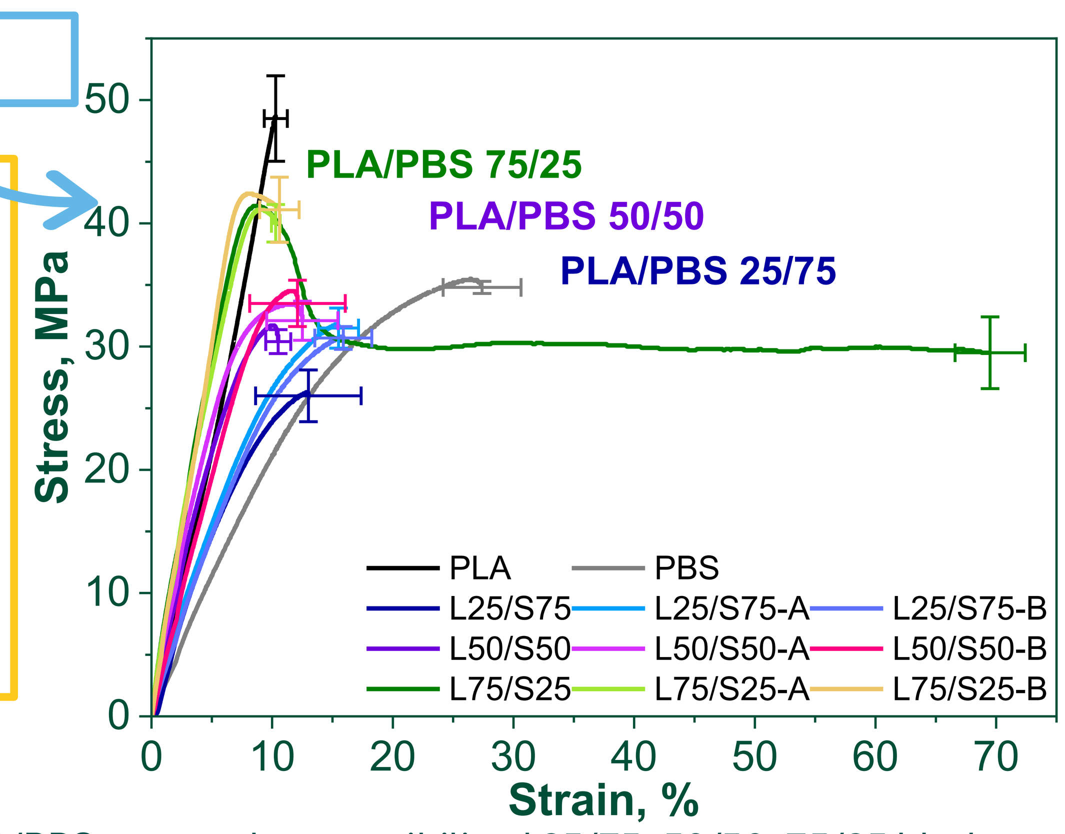
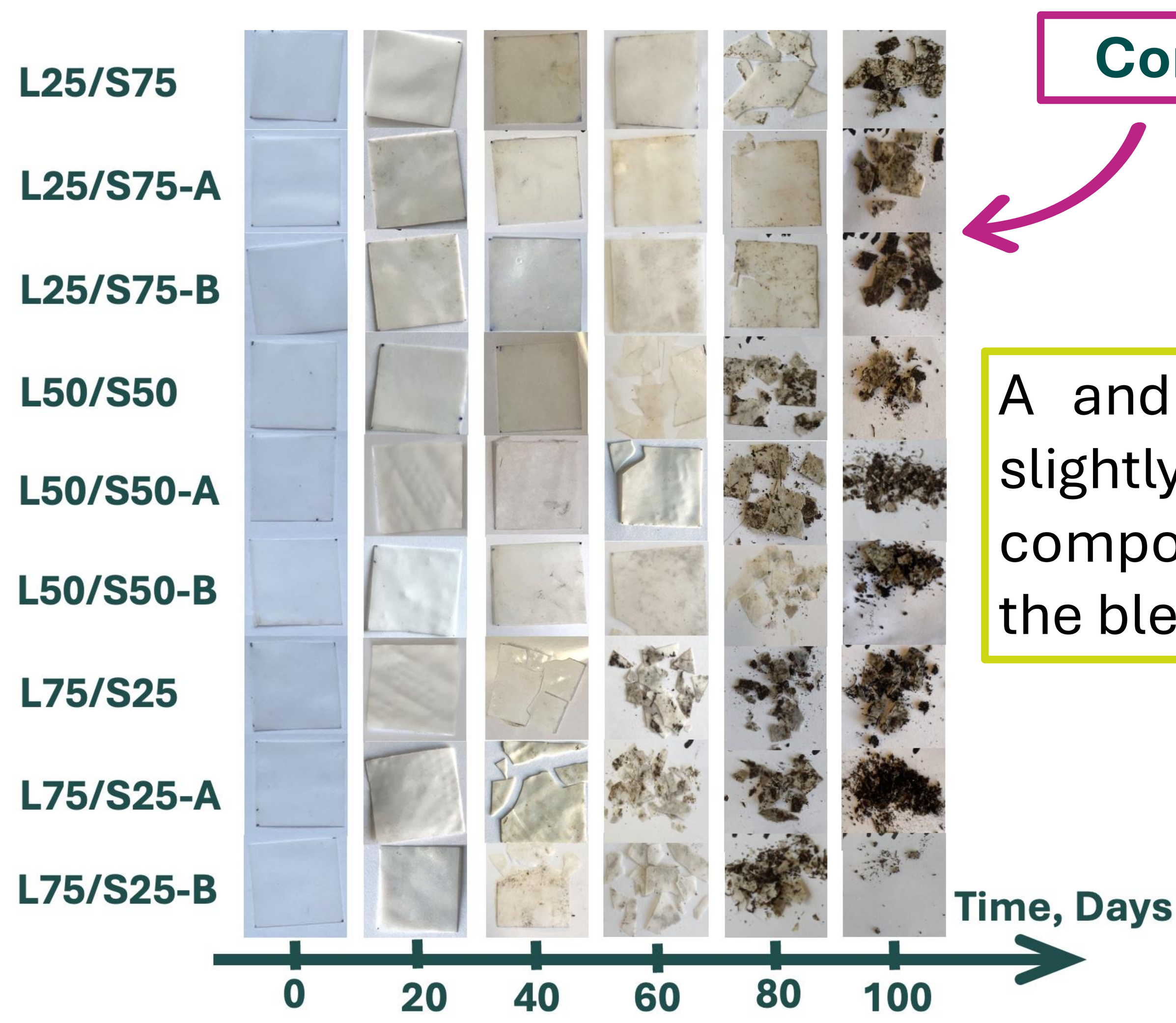


Fig. 3. Stress-strain curve for PLA/PBS neat and compatibilized 25/75, 50/50, 75/25 bleds.

Composting



A and B copolymers slightly increase the composting time of the blend.

Fig. 4. Visual changes of PLA/PBS neat and compatibilized (25/75, 50/50, 75/25 wt%) blends during biodegradation prosecc under composting conditions

Conclusion

PLA-*co*-PBS copolymers were used as multi-functional additive for different PLA/PBS (25/75, 50/50, 75/25 wt%) blends. Both PLA-*co*-PBS 75-25 (A) and PLA-*co*-PBS 25-75 (B) copolymers almost equally enhance miscibility and toughness for the blends of PLA and PBS, reducing interfacial adhesion and stabilizing the formed morphology.

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