Evaluation of mechanical recycling of poly(lactic acid): Effect on the physical ageing and migration

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Poly(lactic acid) (PLA)

- Is a bioplastic coming from renewable resources.
- Is mainly used in packaging applications.
- Its production will grow 10%/year between 2016 and 2021.
Mechanical recycling: An alternative for waste valorization

- Increased production:
  - Moral and social conflicts

- Mechanical recycling

- Increased consumption:
  - Environmental issues

Performance of recycled materials
Objectives

• Previous studies revealed that mechanical recycling causes a decrease on molecular weight and on some properties of PLA.

• Our main objective is to continue the study the effect of the mechanical recycling of PLA on:
  
  ✓ Physical ageing
  
  ✓ Degradation and migration in food simulants
**Methods**

**PLA: Ingeo™ 2003D**

- **Extrusion**
- **Compression molding**

**Recycled and Washed PLA (PLARW)**

- **NaOH Surfactant**
- **85 °C**
- **468 h**
- **50 °C**
- **40 h UV light**

**Virgin PLA (PLAV)**
Test conditions

Physical ageing
- Differential Scanning calorimetry
- Ageing temperature: 40 °C

Migration tests
- Water and acetic acid (3%)
- Temperature: 40 °C
Mechanical recycling and physical ageing

- Physical ageing is the densification of the amorphous zones of PLA.
- It can affect the mechanical and gas barrier properties of PLA.
- It can quantified by the relaxation enthalpy.

DSC heating scan of PLA
Mechanical recycling and physical ageing

- Results show that recycled PLA present lower values of the relaxation enthalpy ($\Delta H_\infty$).
- This means that recycled PLA is less prone to physical ageing than PLAV.
Mechanical recycling and migration

- Degradation of PLA in contact with food is crucial in packaging applications.
- Mechanical recycling caused a severe degradation on PLA.
- Degradation rate in water is similar for both materials.
Migration of degradation products after 6 days of immersion in water

- Migration of degradation products is relevant in food packaging applications.

- UV-Vis spectra of the immersion media shows that PLARW liberates more degradation products than PLAV after 6 days of immersion.
Conclusions

- Mechanical recycling poses an alternative for the valorization of PLA wastes.
- Recycled PLA seems to be less prone to physical ageing, which might affect mechanical and gas barrier properties.
- Mechanical recycling did not affect the stability of PLA against water.
- Migration of degradation products into food simulants is higher in mechanically recycled PLA.
Conclusions

Mechanical recycling causes some small changes in PLA. However, recycled PLA could be reused in packaging applications.
Thank you for your attention

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Questions

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