



Evaluation of the parameters of poly(butylene succinate) enzymatic polymerization

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Introduction

Poly(butylene succinate) (PBS) is a **bio-based** and **biodegradable** polyester, that can be used in numerous applications, especially in the biomedical sector [1,2]. Even though green polymerization routes such as **biocatalysis** are being developed [3,4], there is a very limited literature on the enzymatic synthesis of PBS and in most of the works where high-molecular-weight PBS is produced, several drawbacks may impede the process scaling up. On that basis, an **eco-friendly, solvent-free, enzyme-based process for the production of PBS** was applied and the most important process parameters were evaluated.

Experimental part

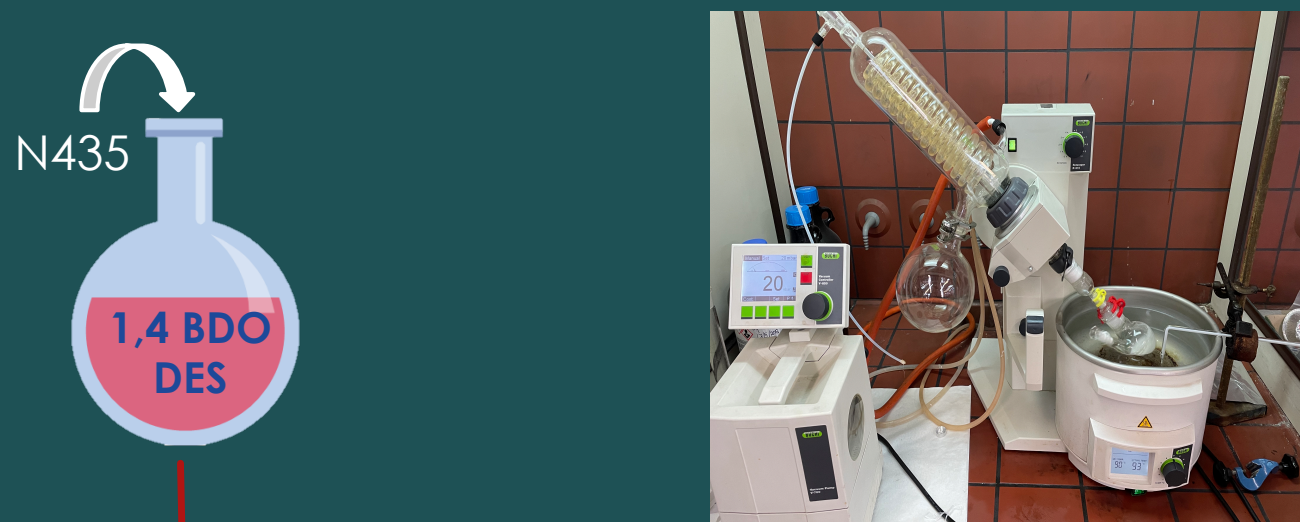


Figure S1. Apparatus for the production of PBS oligomers

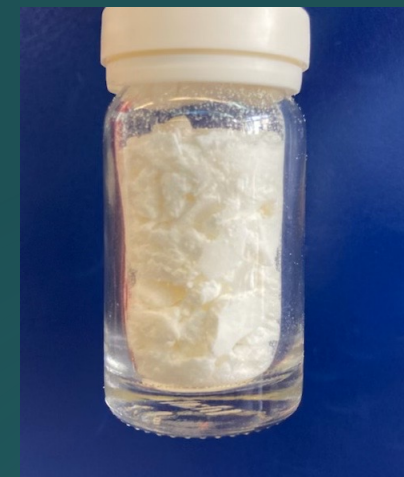
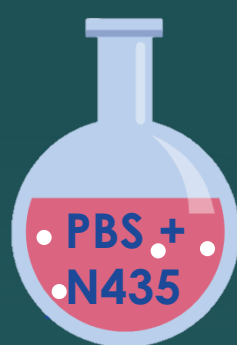
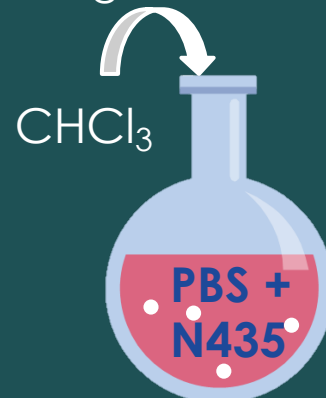


Figure S2. Enzymatically synthesized PBS oligomer (scaled up, 10 g)

Reaction:
40°C, 24h
(1st stage)



Reaction:
 T, P, t_2
(2nd stage)



Filtration, Drying

PBS oligomer

Results and Discussion

- Evaluated process parameters:

Reaction temperature	→ 90 and 95°C
Pressure	↑ \overline{M}_w at 90°C, ↓ \overline{M}_w at 95°C
Reaction time	↓ \overline{M}_w at 90°C and 95°C

Optimum conditions: 90°C, 20 mbar, 2h

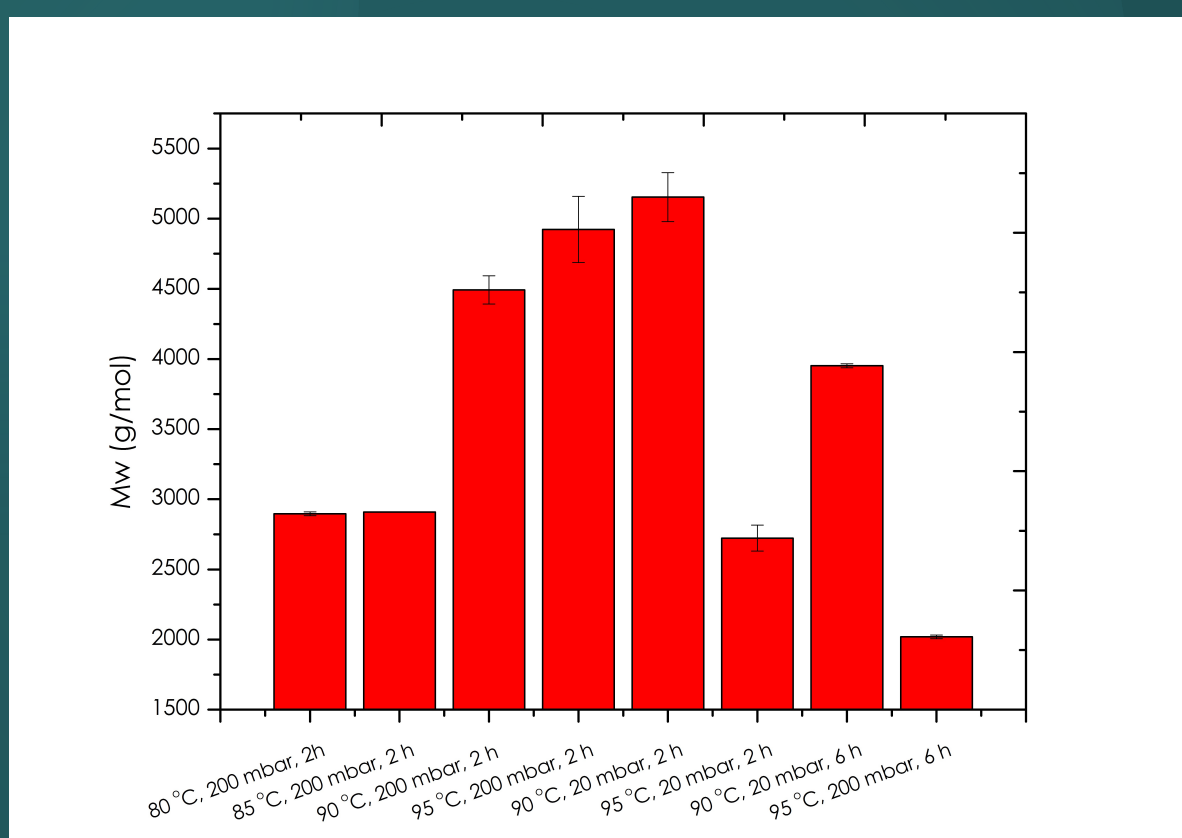


Figure S3. \overline{M}_w of the enzymatically synthesized oligomers

- The synthesized at 90 °C, 20 mbar, 2h product was successfully **scaled up** (ca. 10 g of product).

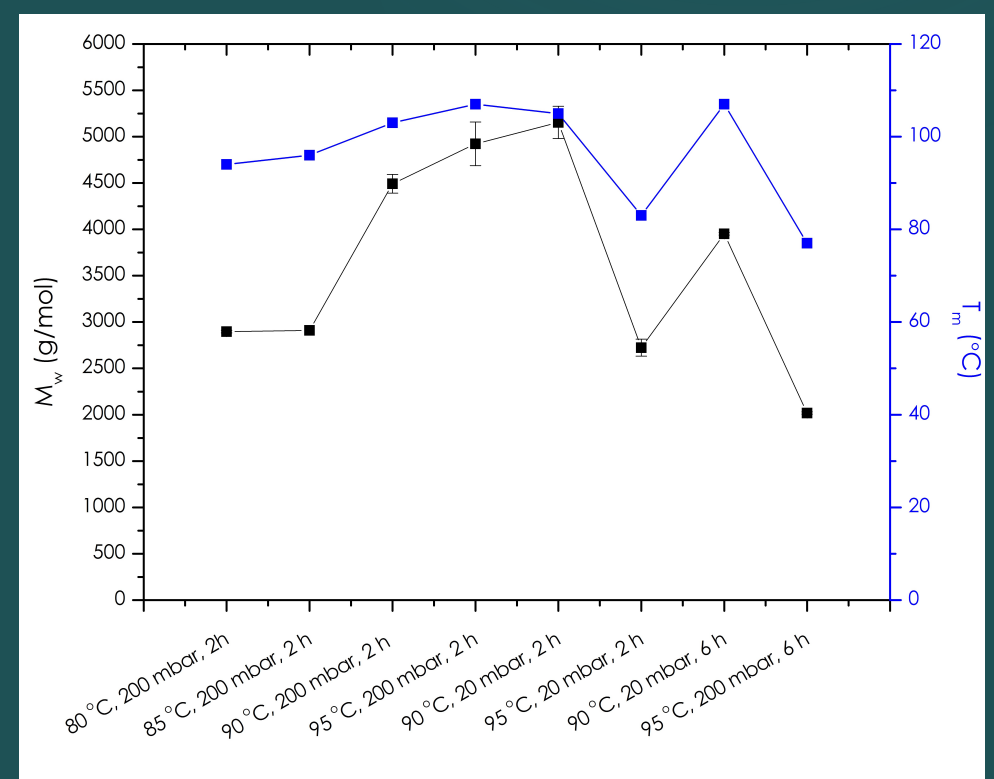


Figure S4. \overline{M}_w and T_m of the enzymatically synthesized oligomers

Table 1. Scaled-up PBS oligomer's properties

\overline{M}_n (g/mol)	\overline{M}_w (g/mol)	T_{m1} (°C)	T_c (°C)	T_{m2} (°C)	$T_{d,5\%}$ (°C)	T_d (°C)	Residue (%)
1000	4700	104	57	103	258	387	1,44

Conclusions

The bulk enzymatic polymerization route resulted in a PBS grade of \overline{M}_w 4700 g/mol, crystallinity ca. 61% and melting points at ca. 104°C. This free of thermal degradation and metal catalyst residues grade is appropriate to be used in biomedicine applications where low controlled molecular weight is usually needed.

References

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- [2] Gigli M, Fabbri M, Lotti N, Gamberini R, Rimini B, Munari A. European Polymer Journal. 2016; 75: 431–460.
- [3] Douka A, Vouyiouka S, Papaspyridi L.M, Papaspyrides C.D. Progress in Polymer Science. 2018; 79: 1–25.
- [4] Gkountela C, Rigopoulou M, Barampouti E.M, Vouyiouka S. European Polymer Journal. 2021; 143: 110197