

Supplementary material

Biodegradability of novel high T_g poly(isosorbide-co-1,6-hexanediol) oxalate polyester in soil and marine environments

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Table S.1. Studies of polyoxalate degradation. Phosphate-buffered saline (PBS).

Type of polyoxalate	Shape	Matrix	Parameters	Results	Ref.
Poly(isomannide-co-dodecanediol)oxalate	Pellets	pH7 solution, room temperature	Weight loss	39%, 15 days	(Rajput et al., 2018)
Poly-(decylene-co-resorcinol bis(hydroxyethyl)ether) oxalate (50% aromatic)	Powders	Air	Molecular weight	63,700→4,200 g mol ⁻¹ , 13 months	(Garcia and Miller, 2014)
Poly1,4-cyclohexanedimethanol oxalate	Nanoparticles	Buffered pH7&5.4, 37°C	Molecular weight	Half-life 6.5 days	(Kim et al., 2010)
Poly(vanillin oxalate)	Nanoparticles	PBS, 37°C, pH7.4 & 5.4	Monomer release (vanillin)	40% & 80%, 36 hours	(Kwon et al., 2013)
Poly(amino oxalate)	Fine powders	PBS, 37°C, stirring, pH7.4 & 5.5	Molecular weight	Half-life ~40 hours & ~20 hours	(Seong et al., 2011)
Poly(ethylene oxalate) (blend with PLA)	Films (2*2 cm)	PBS, Lipase solution, 45°C, 100 rpm	Weight loss	>60%, 7 days	(Yoshikawa et al., 2011)

Table S.2. Properties of soil.

Properties	Values
Sand/Silt/Clay (%)	90/5/1*
Organic carbon (mg g ⁻¹)	18.29*
Nitrogen (mg g ⁻¹)	0.97*
C:N (g C g ⁻¹ N)	22*
Phosphate (µg g ⁻¹)	4.6*
pH (0.01 M CaCl ₂)	5.9
Cation exchange capacity (mmol ⁺ kg ⁻¹)	60*
Field capacity (g water 100 g ⁻¹ dry soil)	33.3

* Values taken from Schlemper et al. (2017).

Table S.3. Constituents of mineral salts solution used to adjust soil moisture (OECD, 2014).

Salts	mg l ⁻¹
Potassium dihydrogen phosphate (KH ₂ PO ₄)	85.0
Dipotassium hydrogen phosphate (K ₂ HPO ₄)	217.5
Disodium hydrogen phosphate dihydrate (Na ₂ HPO ₄ ·2H ₂ O)	334.0
Ammonium chloride (NH ₄ Cl)	50.0
Calcium chloride dihydrate (CaCl ₂ ·2H ₂ O)	36.40
Magnesium sulphate heptahydrate (MgSO ₄ ·7H ₂ O)	22.50
Iron (III) chloride hexahydrate (FeCl ₃ ·6H ₂ O)	0.25

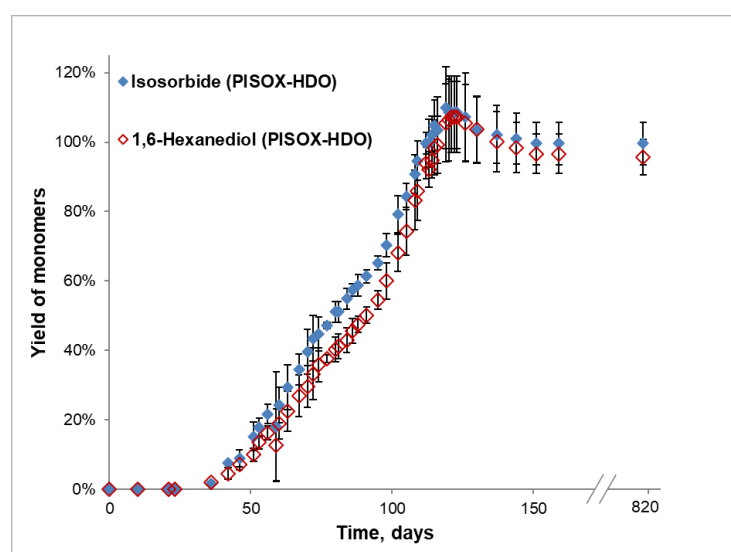
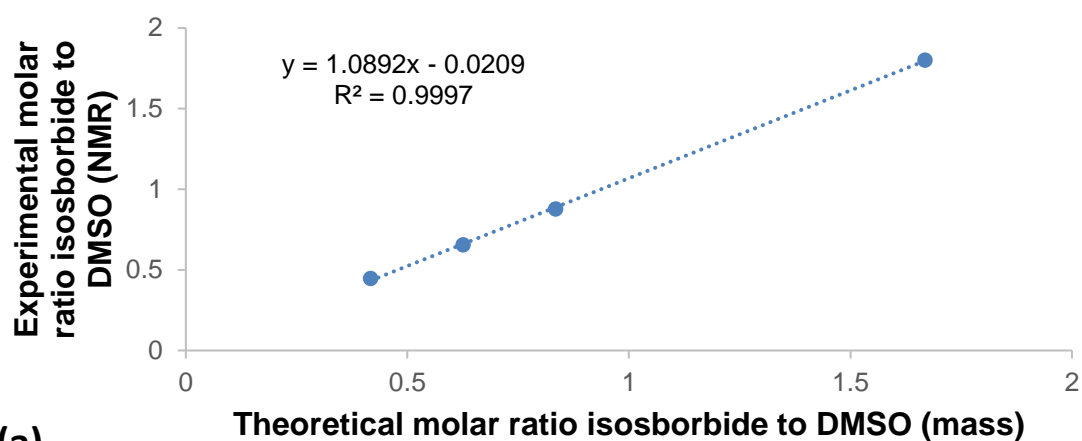
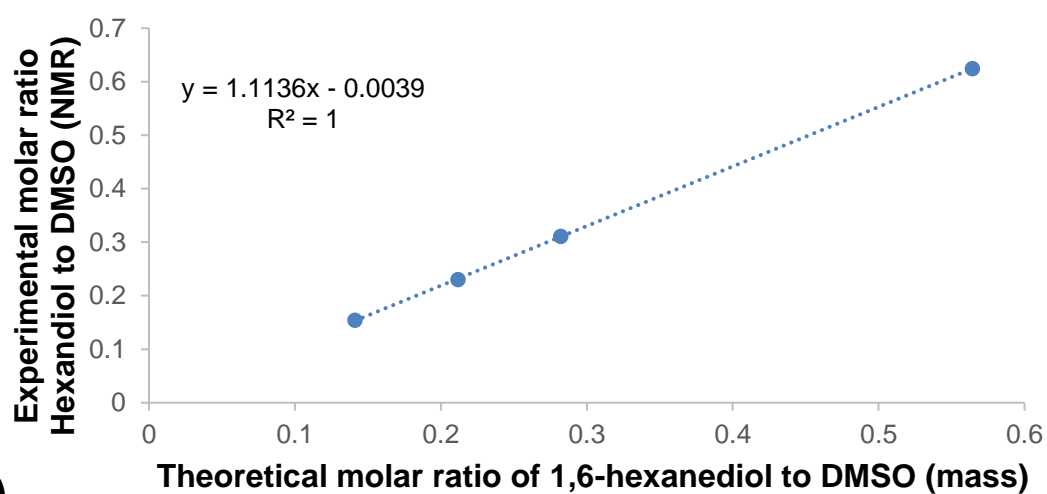


Figure S.1. Individual yield of monomers (isosorbide and 1,6-hexanediol) during hydrolysis of at 25°C in D₂O. Error bars represent standard deviation of triplicate hydrolysis experiments. Same samples were measured again over two years (shown after the break in x-axis), which confirmed the complete of hydrolysis of PISOX-HDO around 150 days.



(a)



(b)

Figure S.2. Experimental ratio (i.e. determined by ^1H NMR) against theoretical ratio of isosorbide (a) and 1,6-hexanediol (b) to dimethyl sulfoxide (DMSO, internal standard, fixed amount).

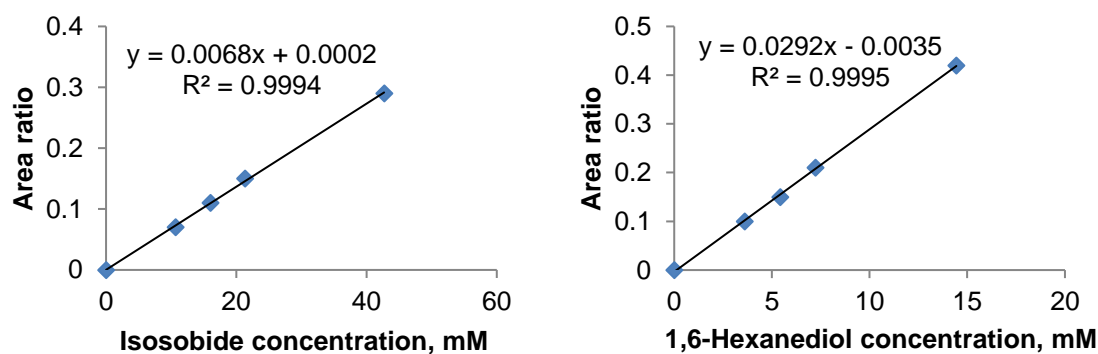


Figure S.3 Calibration for quantification of isosorbide and 1,6-hexanediol concentration in 1 mL D_2O with 2.0 mg DMSO. The area ratio of isosorbide and 1,6-hexanediol to internal standard (DMSO), as a function of corresponding monomers concentration, were measured in ^1H NMR spectra and processed in MestReNova.

Figure S.3 plots the area ratio of isosorbide and 1,6-hexanediol to fixed amount of DMSO in ^1H NMR spectra with the function of monomers concentration respectively. Fourth points (low to high) on

both graphs were measured from mixture of all monomers including oxalic acid and it fits well in both linear relationships with high R squared (>0.999). These calibrations were used for quantifying hydrolytic products of isosorbide and 1,6-hexanediol, and then accessed hydrolysis of PISOX-HDO.

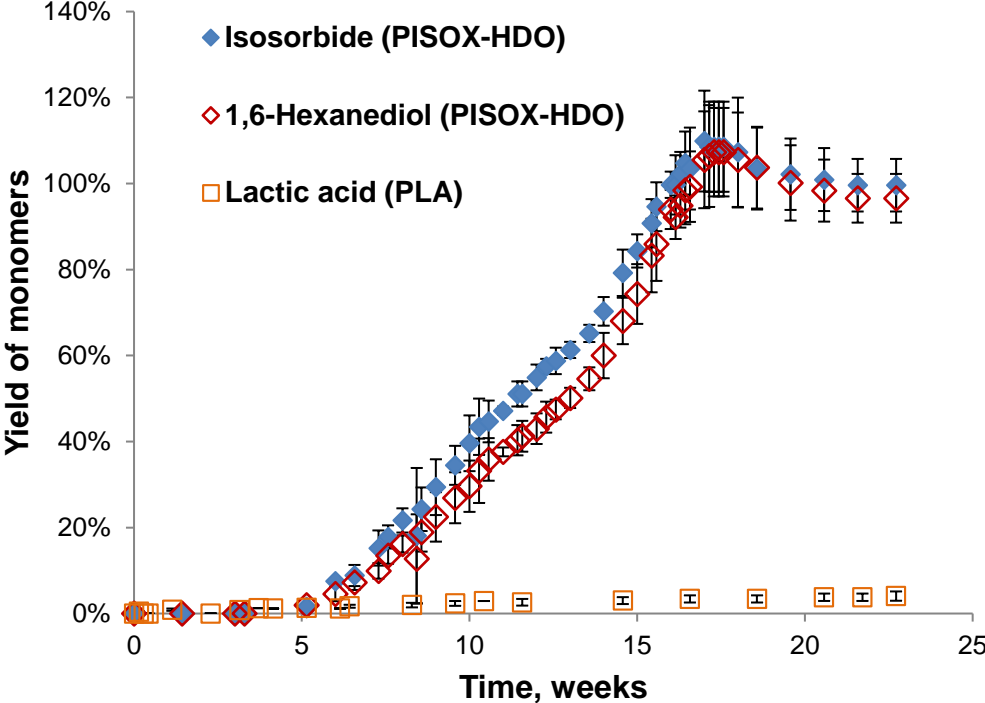


Figure S.4 Comparison of yields of monomers between PISOX-HDO and PLA during 6-month hydrolysis of at 25°C in D₂O. Error bars represent standard deviation of triplicate hydrolysis experiments (Wang et al., 2021).