

Tailor – made biocompatible, biodegradable bacterial polyesters

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INTRODUCTION: Poly[(R)-3-hydroxyalkanoates] (PHAs) (Fig.1) are biocompatible and biodegradable biopolyesters.¹⁾ Because many bacteria can accumulate these polyesters as carbon and energy storage compounds they are widespread in nature. Until now more than 100 different types with various functionalities in the side chain have been described.²⁾

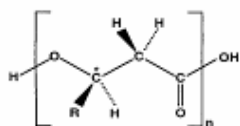


Fig. 1: PHAs are divided into short-chain-length (scl: R=1 or 2) and medium-chain-length (mcl: R=3-12) polyesters and consist of enantiomeric pure monomers.

METHODS: All the different polyesters we isolated during this study were produced by *P. putida* GPo1 (ATTC 29347) in continuous (chemostat, $D=0.1h^{-1}$) cultures in either three or ten liter laboratory bioreactors. To achieve a tailor-made, exactly reproducible composition of the polymers we used double (carbon and nitrogen) nutrient limited culture conditions³⁾ and different fatty acids as precursors for the desired polyesters. During the cultivation the cells were harvested and freeze-dried. Afterwards the polymer was extracted with green chemistry and further purified to remove all bacterially derived impurities. The monomeric composition of the polyesters was determined by GC, thermal properties were analyzed by DSC and the molecular weights were obtained from GPC measurements (Table 1).

RESULTS: We were able to produce a set of tailor-made poly(3-hydroxyalkanoates) from octanoic and 10-undecenoic acid. The chosen way of continuous fermentation under double nutrient limited growth conditions allowed us to produce amounts up to 1kg PHA of a defined, reproducible and endotoxin-free (<0.5EU/g) quality. (Fig. 2)

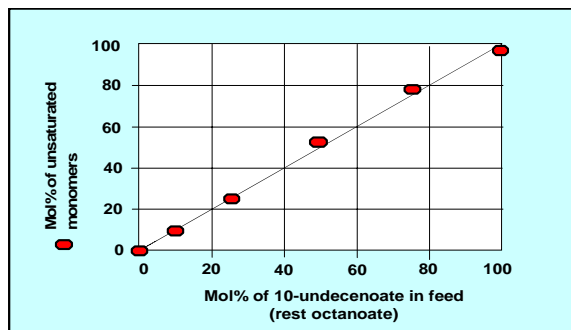


Fig. 2: The ratio of the precursor fatty acid mixture is reflected in the polymer composition.

Table 1. Physical properties of unsaturated tailor made poly(3-hydroxyalkanoates).⁴⁾

Physical parameter	Feed composition of octanoate/10-undecenoate [mol%/mol%]					
	100/0	90/10	75/25	50/50	25/75	0/100
Tm [°C]	58.1	50.8	44.5	39.9	-	-
Tg [°C]	-33.1	-35.9	-39.5	-44.6	-47.4	-49.3
Mw [kDa]	286	251	253	290	278	290
Mn [kDa]	118	132	113	156	118	122
Mw/Mn	2.4	1.9	2.2	1.9	2.4	2.4

DISCUSSION & CONCLUSIONS: More than 100 different polyhydroxyalkanoates have been described in literature until now. None of them, except PHB, PHB/HV and PHB/HHx are available in sufficient amounts for further testing and research. With our production method we are opening the field to study biocompatibility and biodegradation of novel PHAs which will lead to new developments and applications of this very interesting class of biopolyesters in medicine and industry.

REFERENCES:¹⁾ S.F. Williams, et. al. (2002) *Biopolymers 4* Wiley-VCH Verlag GmbH pp 91-127. ²⁾ de Rijk TC, et al (2002) *Biopolymers 3b* Wiley-VCH Verlag GmbH pp 1-21. ³⁾ M. Zinn, et. al. (2004) *J. Biotechnol.* **113**:263-279. ⁴⁾ R. Hartmann, et. al. (2006) *Biotechn. and Bioeng.* **93**:737-746.

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