Residual Streams From Sewage Treatment Plants As A Source for PHA-Bioplastic End Products

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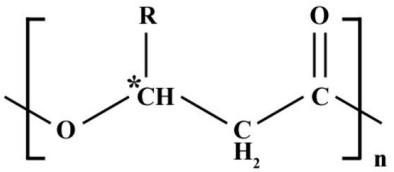
PHA Bioplastics At A Glance

- PHA: Polyhydroxyalkanoate
- Polymer consists mainly of two monomers:
  - 3HB (3-hydroxybutyrate)
  - 3HV (3-hydroxyvalerate)

  => Copolymer: PHBV
- Composition determines properties



Poly(3-hydroxyalkanoate)

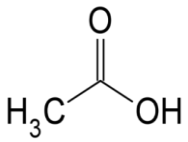
R group	Carbon no.	PHA polymer
methyl	C_4	Poly(3-hydroxybutyrate)
ethyl	C_5	Poly(3-hydroxyvalerate)

- Worldwide production capacity of 30 kT in 2019
- Biobased, biodegradable and biocompatible (non-toxic)

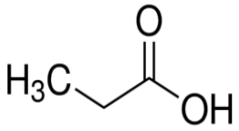
- **Currently mainly produced from corn starch or sugars** (sugar cane or sugar beet)

PHA Production Process

Acetic Acid (AA)

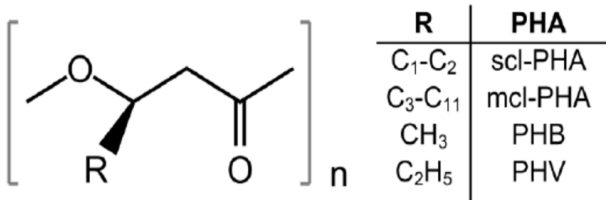


Propionic Acid (PA)

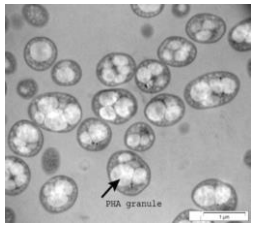


Volatile Fatty Acids (VFAs) from sugars

Fermentation



R	PHA
C_1-C_2	scl-PHA
C_3-C_{11}	mcl-PHA
CH_3	PHB
C_2H_5	PHV



Mixed Microbial Culture (MMC)

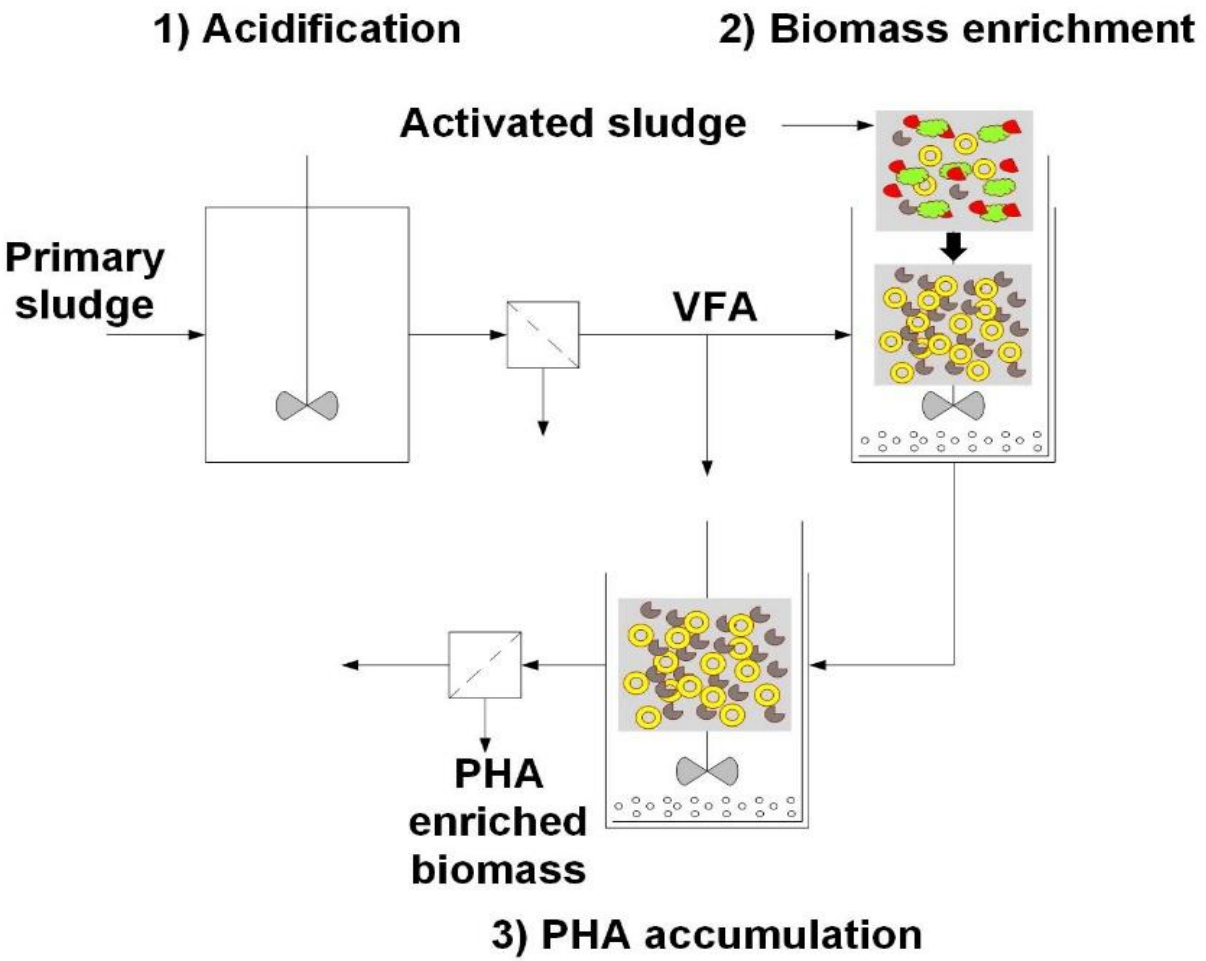
Extraction

Extracted PHA

Purification

Purified PHA

WOW! PHA Production Process



PHA Pilot Team

Interreg North-West Europe WOW! European Regional Development Fund

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

WUPPERVERBAND für Wasser, Mensch und Umwelt

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vito

Pilot scale bacterial PHA production

↓

Extraction + Lab scale PHA fermentation

↓

Extrusion and injection → Product

↓

Techno economical analyses

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PHA extraction

PHA2USE Project

18 kg of PHA extracted

Pilot Scale Extrusion and Injection

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PHA

21 mm Twin-screw Extruder

PHA Compound

Injection Machine

PHA Products

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WOW PHA vs commercial PHA

	PHA WOW!	Commercial PHA #1	Commercial PHA #2
Composition	**PHBV (30% HV)**	PHBV (2% HV)	PHBH
Young Modulus(MPA)	**915**	5 200	1 700
Flexural modulus (Mpa)	**633**	4 400	1 460
Tensile strength at break (MPA)	**10**	40	26
Tensile elongation at break (%)	**39**	2.7	6
Charpy impact strength (kJ/m^2)	**N.B**	7	14
Vicat A50 (°C)	**87**	> 150	100

WOW PHA vs conventional polymers

	PHA WOW!	PP	HDPE	PET
Young Modulus(MPA)	915	1 200	1 000	2 600
Flexural modulus (Mpa)	633	1 300	1 350	2 300
Tensile strength at break (MPA)	10	30	/	60
Tensile elongation at break (%)	39	400	600	25
Charpy impact strength (kJ/m²)	N.B	N.B	N.B	120
Vicat A50 (°C)	87	150	120	75

PHA End-Products & Applications

Coffee Capsules

Water denitrification

Vineyards Clips

Food packaging

Cosmetic

Conclusions & Future Research

- PHA is the only polymer really biodegradable in water
- Soft PHA => not really available on the market today => **WOW PHA could bring a solution**
- Could be used in films/blowing applications
- Could be used as an softening agent with biodegradable polymers (PLA, PHBV)
- Further tests to to optimize process, formulation, etc …