A Two-stage Process to Produce Ductile Bioplastics from Cellulosic Biomass

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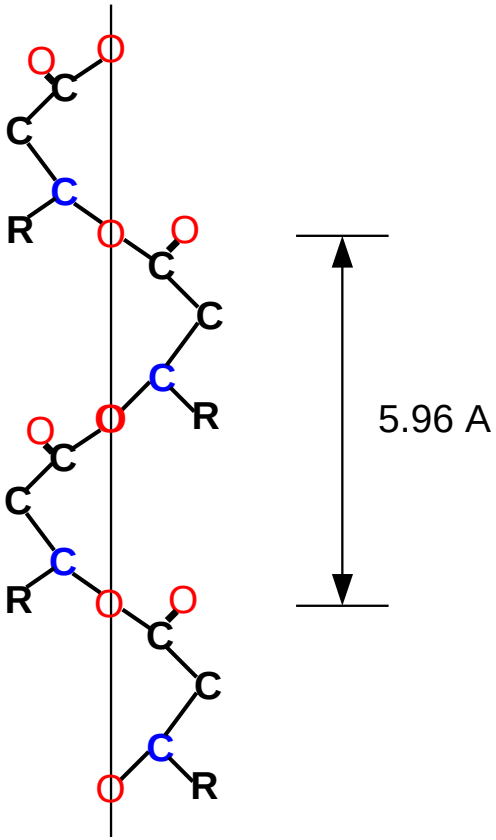
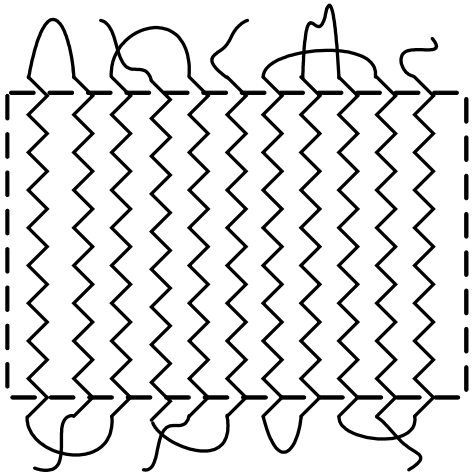
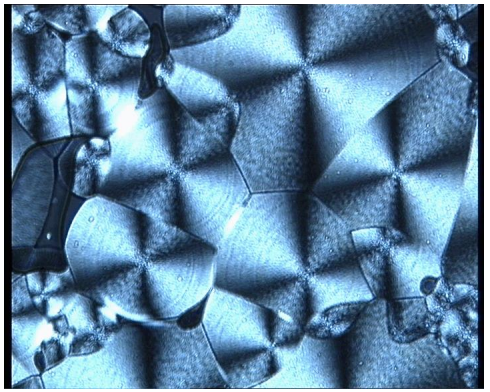
Poly(3-Hydroxyalkanoates)



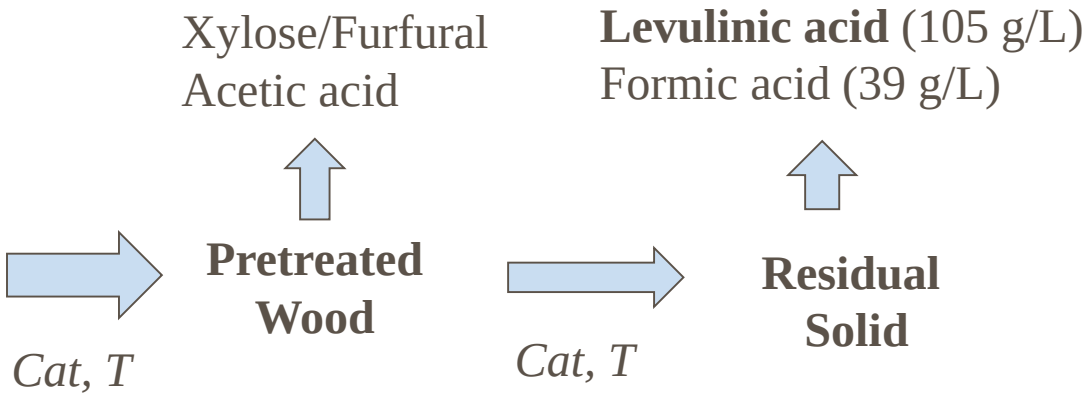




P3HB crystallization (60-70%)

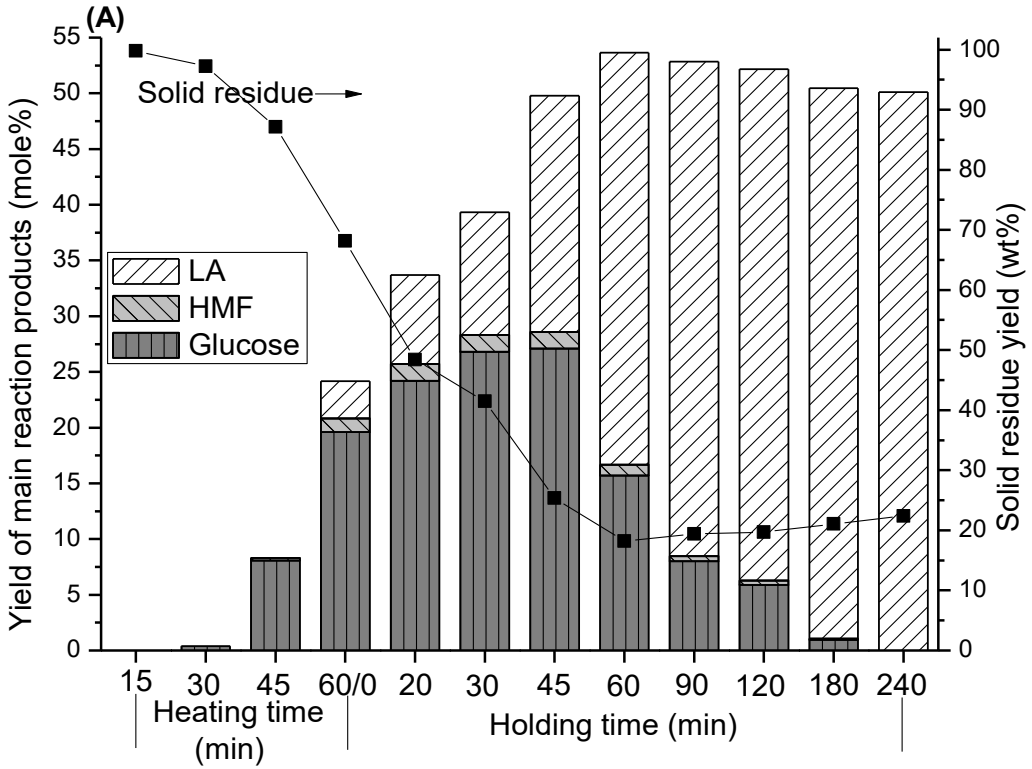
R: CH_3 (P3HB)
CH_2CH_3 (P3HB3HV)
$CH_2CH_2CH_3$ (P3HB3HHx)

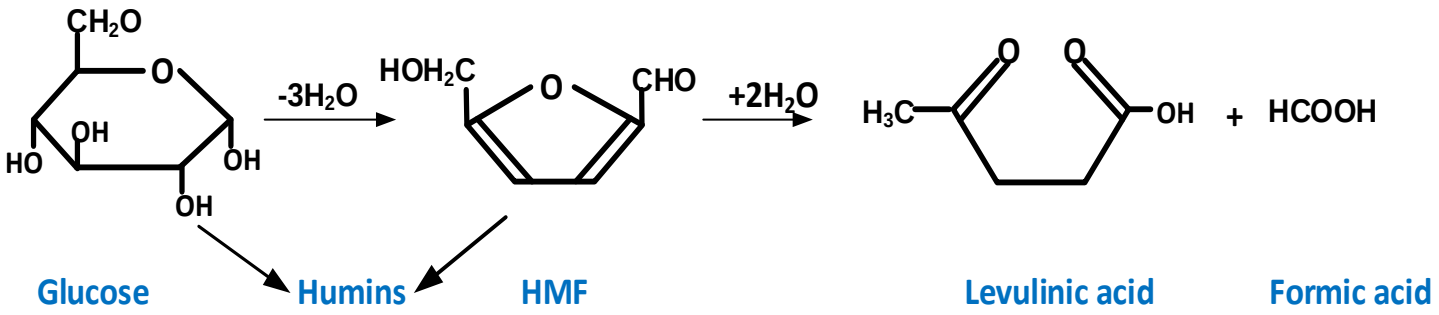
Stage 1: Wood Biomass to Levulinic Acid



Eucalyptus wood	Glucan (wt%)	Xylan (wt%)	Lignin (wt%)	C (wt%)	H (wt%)	O (wt%)	HHV (kJ/kg)
Raw	48.9	12.4	26.7	45.9	5.6	47.9	17.6
Pretreated	63.8	0	34.6	47.8	5.6	45.9	18.6
Residue	0	0	-	66.8	5.2	27.5	26.6

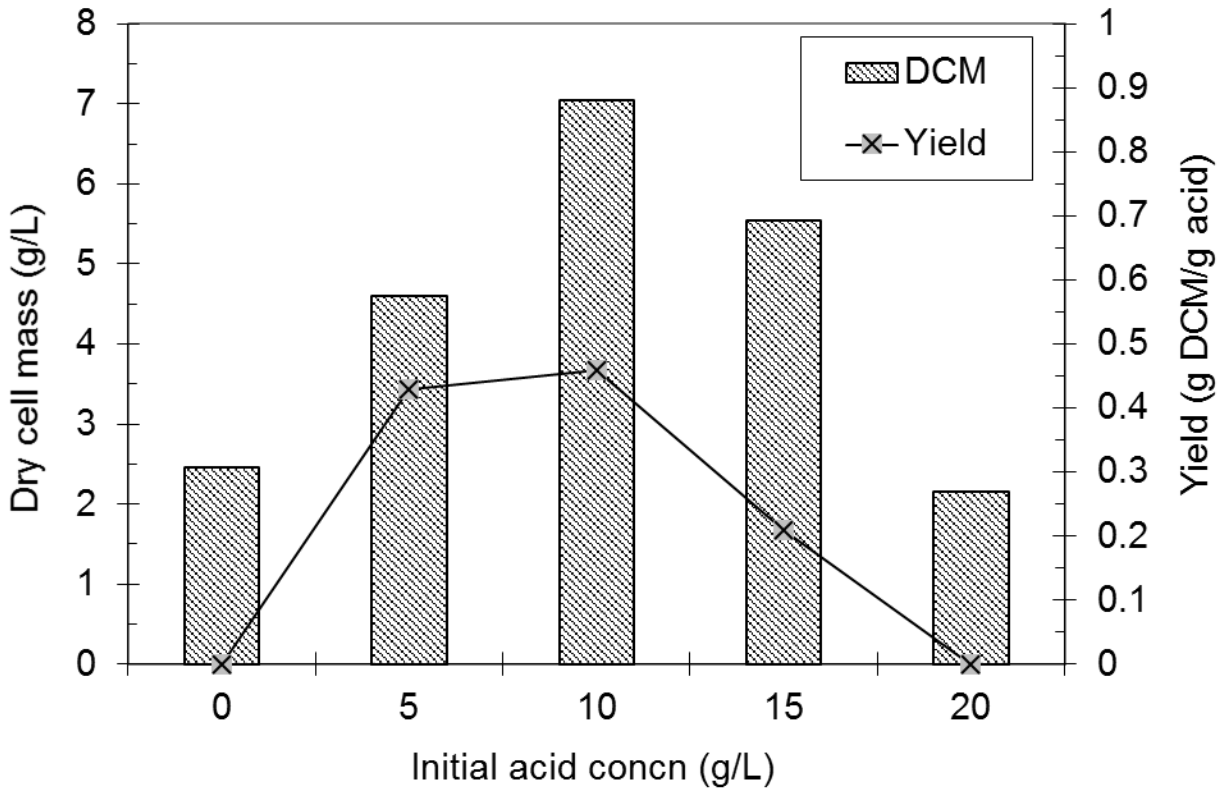
Stage 1: Cellulose to Levulinic acid



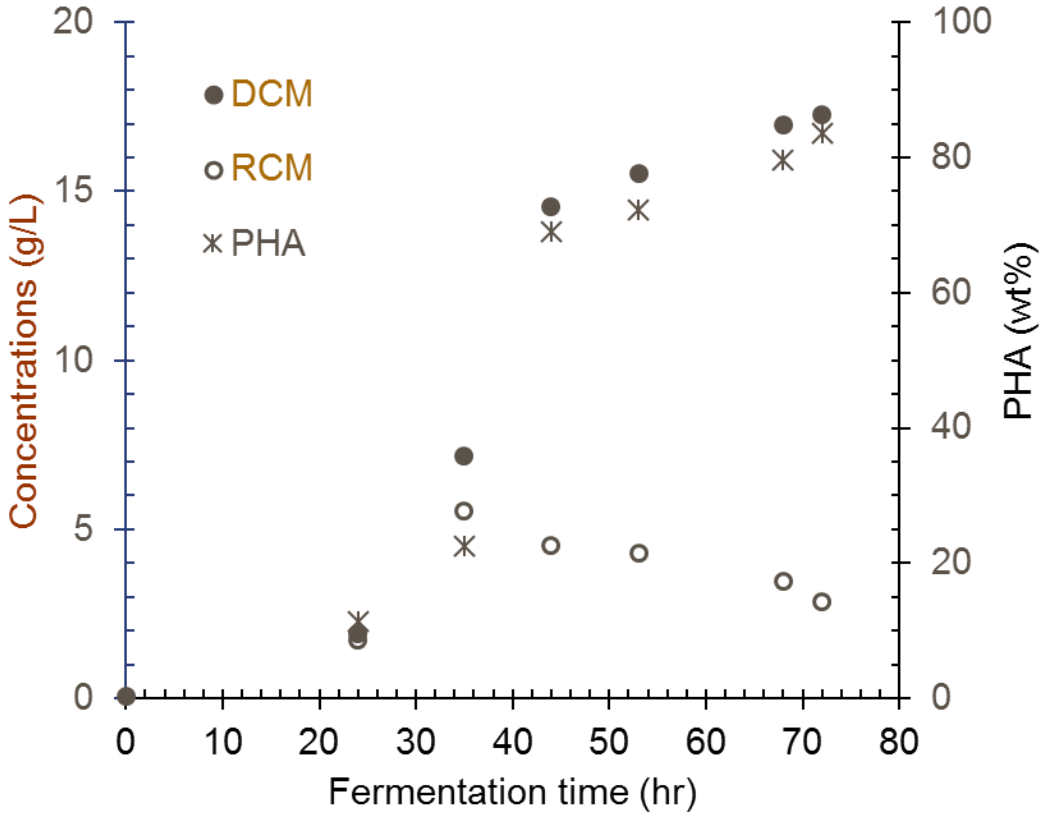


Stage 2: Levulinic acid to PHA

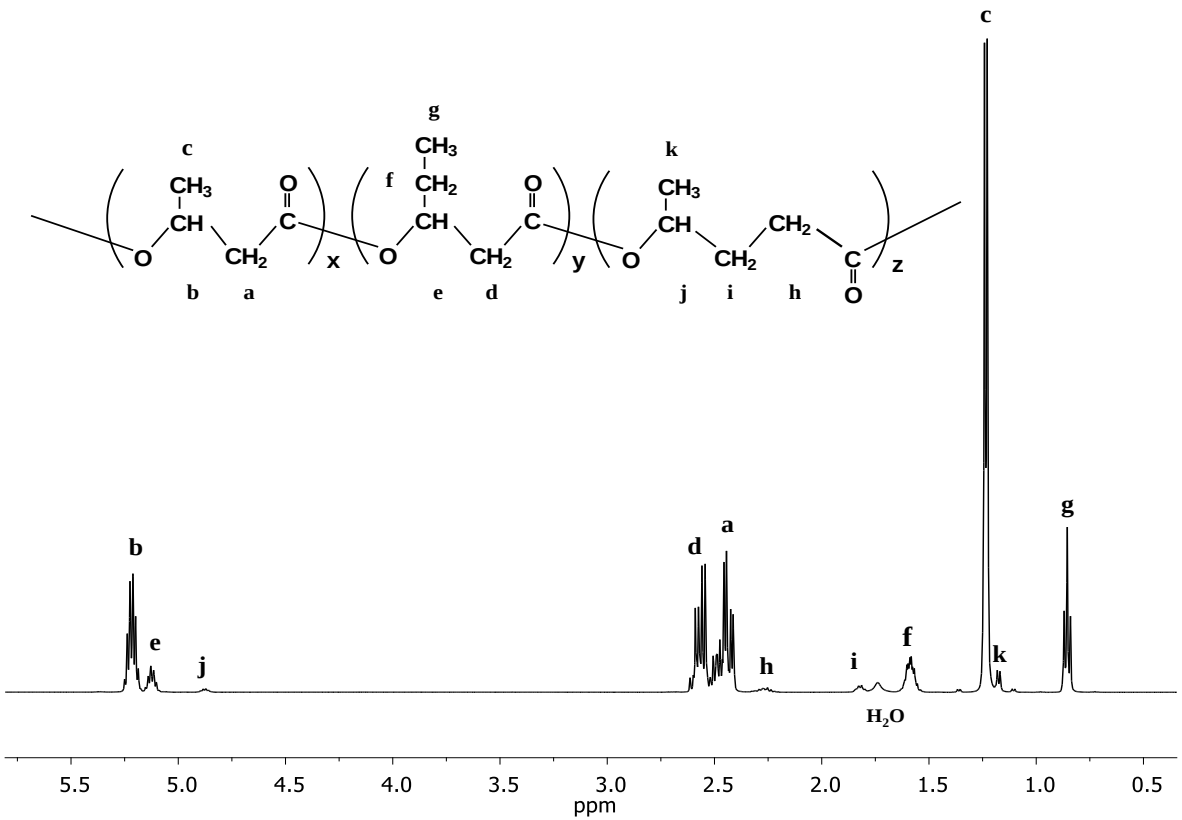
Flask cultures of an acid-tolerant *R. eutropha* strain on levulinic acid in a rotary incubator at 30 ^{o}C for 48 hours



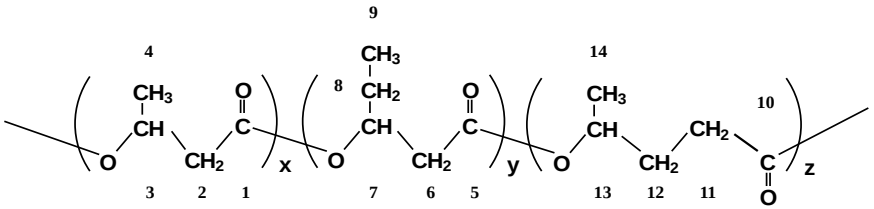
Stage 2: Fed-batch Fermentation

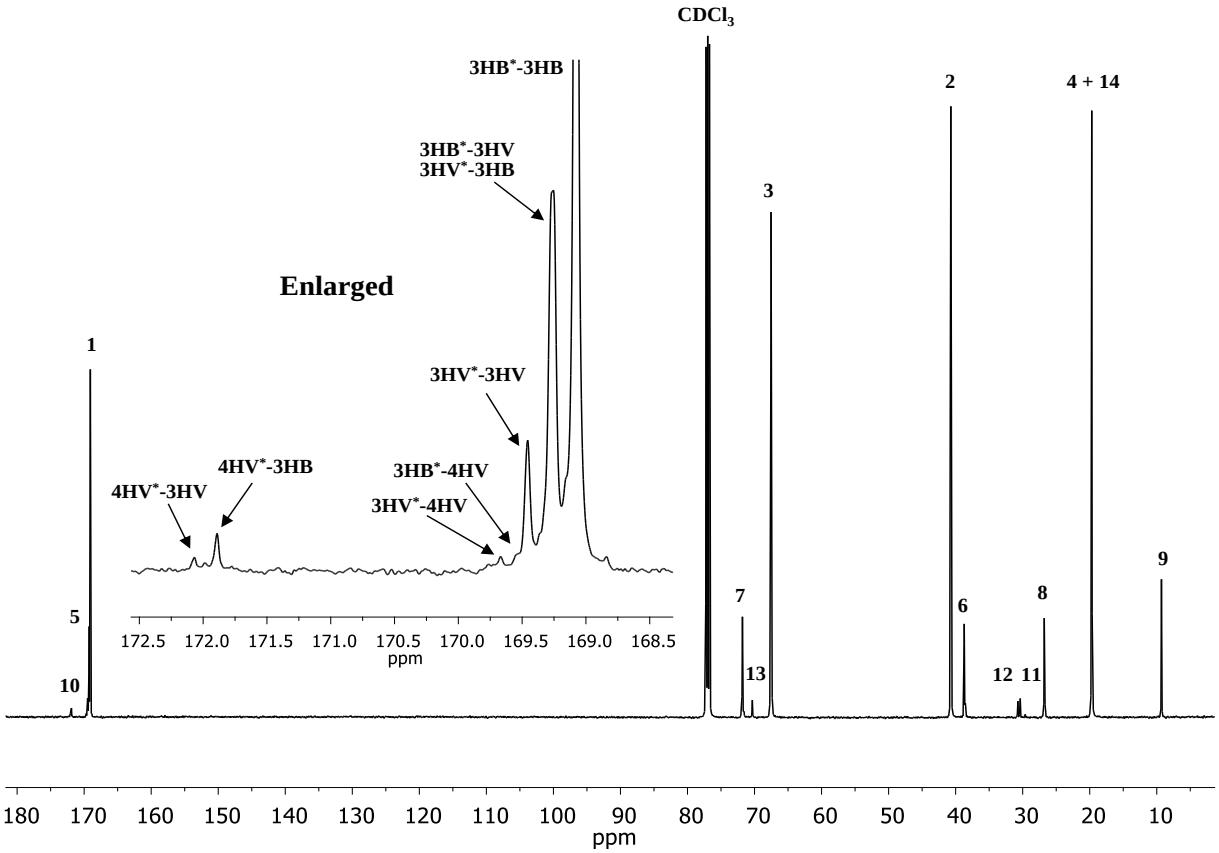


^{1}H NMR of P(3HB-3HV-4HV)

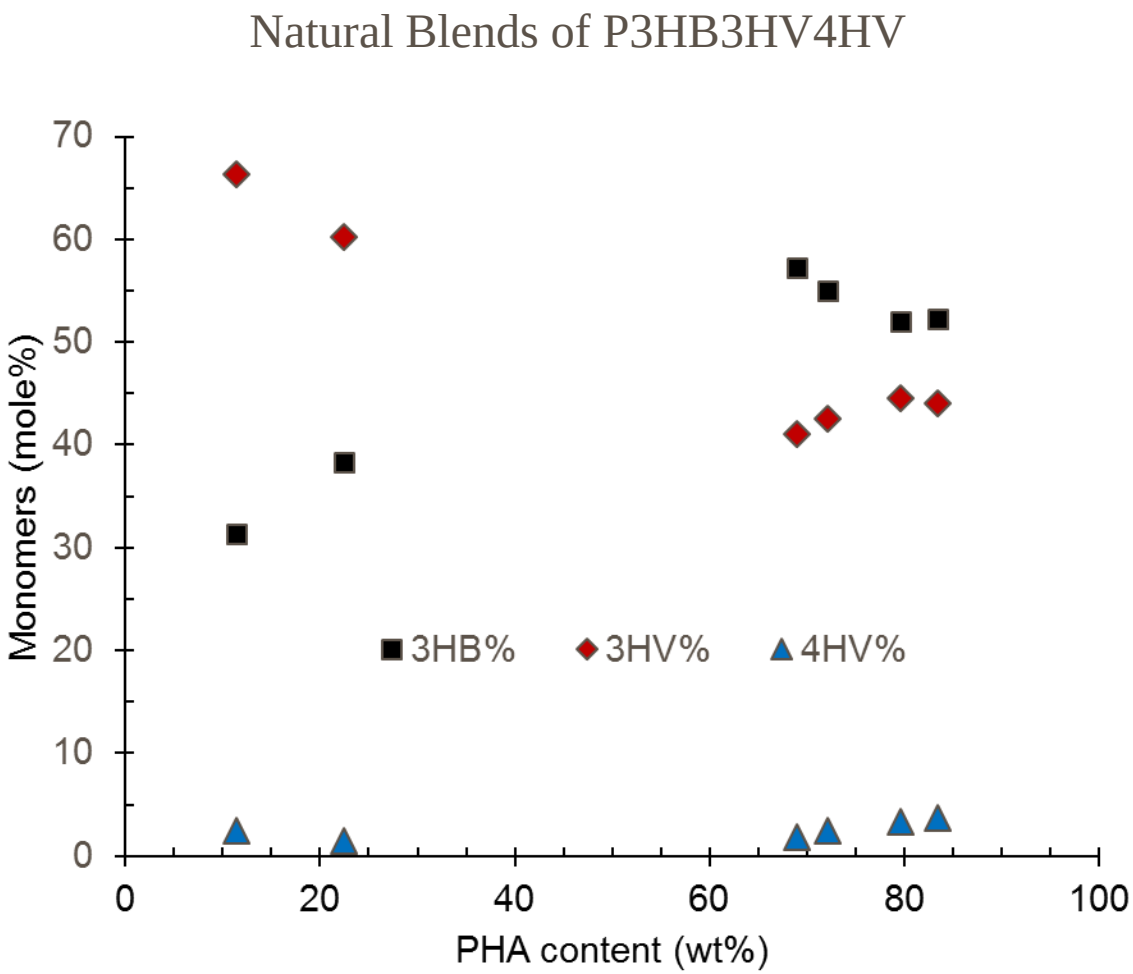


^{13}C NMR: Random 4HV Distribution





Terpolyester composition in a fed-batch



Ductile P3HB3HV4HV

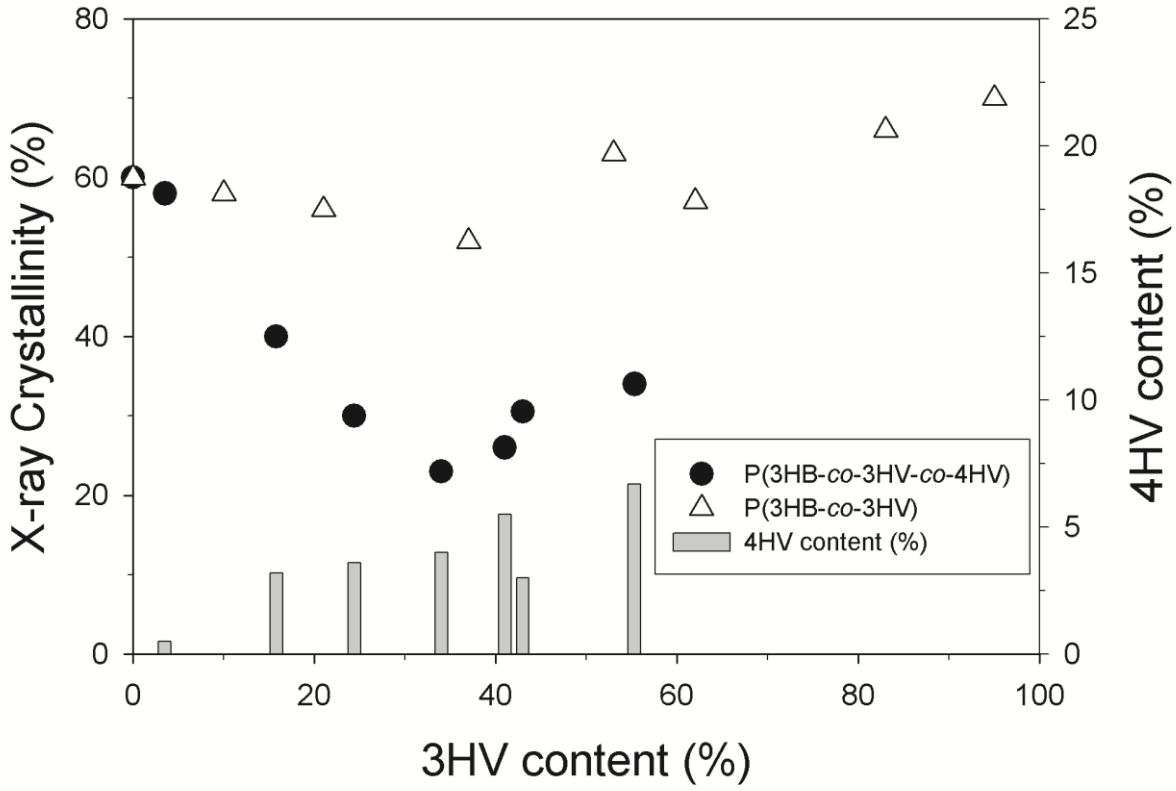
Commercial P3HB and P3HB3HV versus P3HB3HV4HV

PHA	3HB (mol%)	3HV (mol%)	4HV (mol%)	Tg (°C)	Tm (°C)	Xc (%)	E (%)
P(3HB)	100	0	0	3.9	176	60	5
P(3HB3HV)	90	10	0	-1	140	58	50
P(3HB3HV4HV)	54	43	3	- 4.2	78	31	510

Effect of 4HV on P3HB3HV Crystallinity

P3HB crystalline

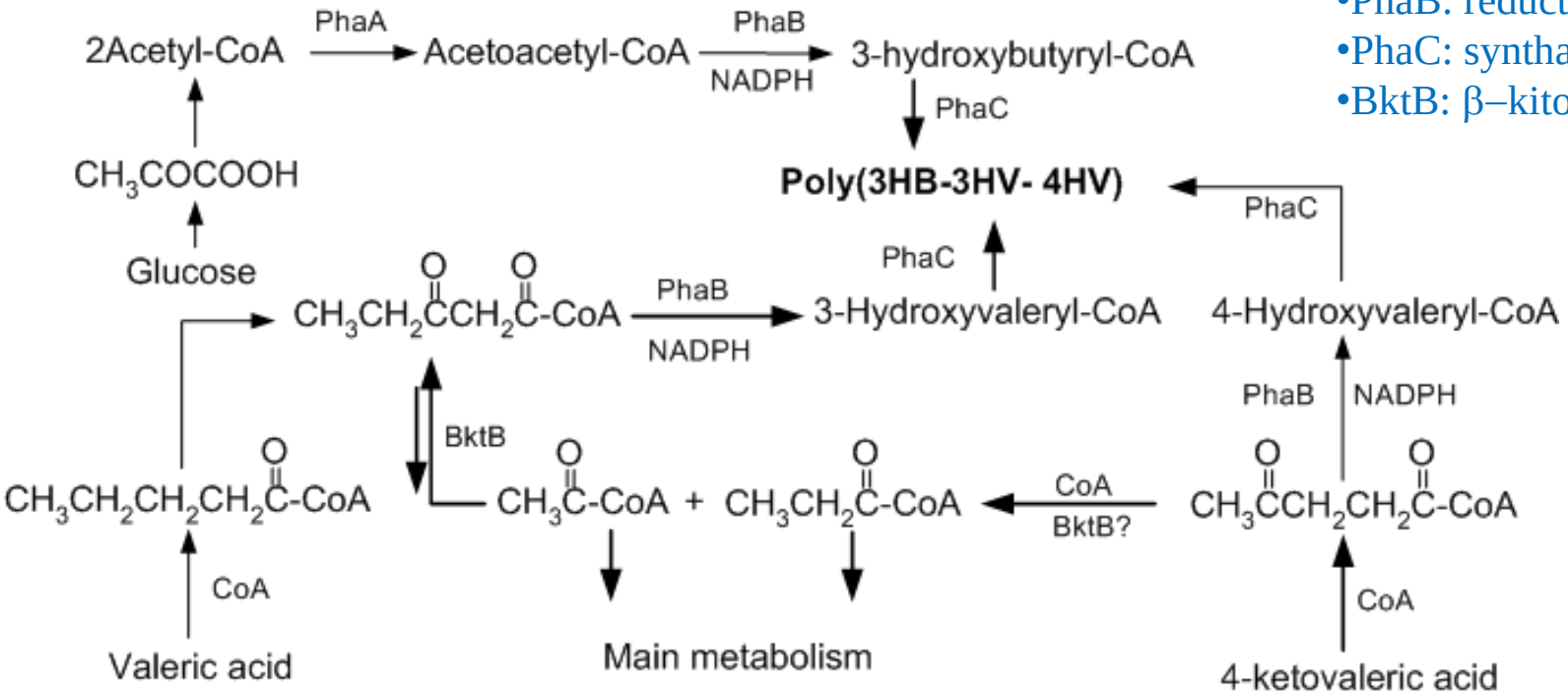
P3HV crystalline



Conclusion: the minor 4HV is the defect in P3HB crystalline

A possible metabolic pathway of 4KVA

- PhaA: β–kitothiolase
- PhaB: reductase
- PhaC: synthase
- BktB: β–kitothiolase B

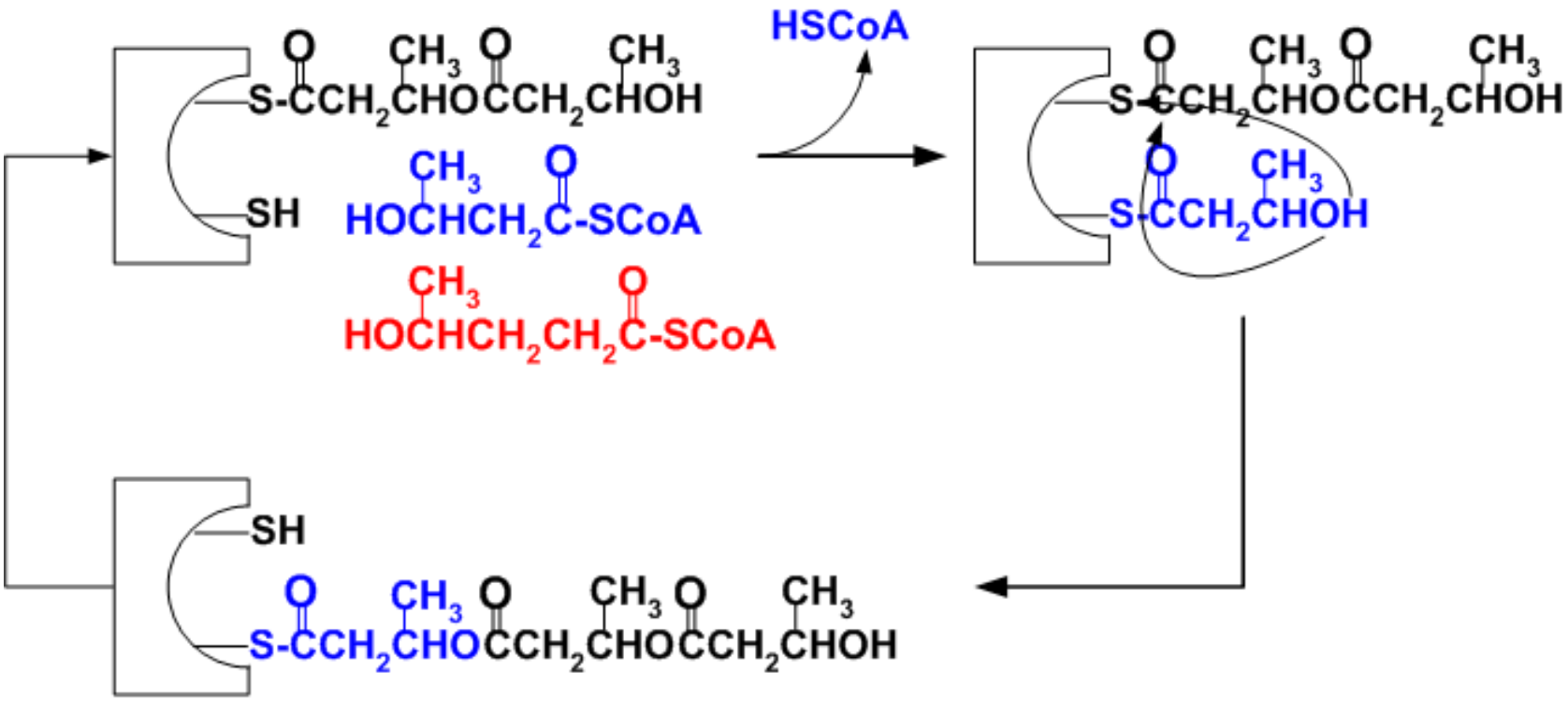


✓Minor 4HV in terpolyester

x Formation of acetyl-CoA and pyruvate via beta oxidation

✓Split into acetyl- and propionyl-CoA and re-condensed into 3-ketovaleryl-CoA

Structural constraint on 4KVA



PHA synthesis via transesterification on synthase

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Thank You !