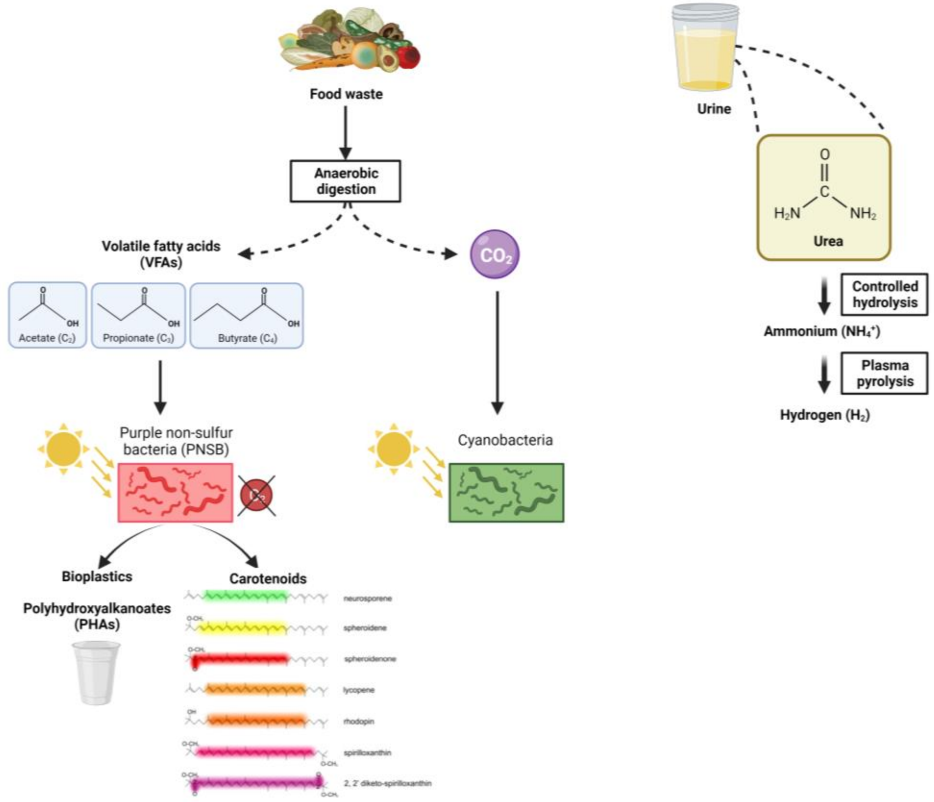
WalBioPower: Valorisation of organic waste for the production of clean energy

Simone Krings, Ruddy Wattiez, Baptiste Leroy

18/04/2024



DEPARTMENT OF PROTEOMICS AND MICROBIOLOGY

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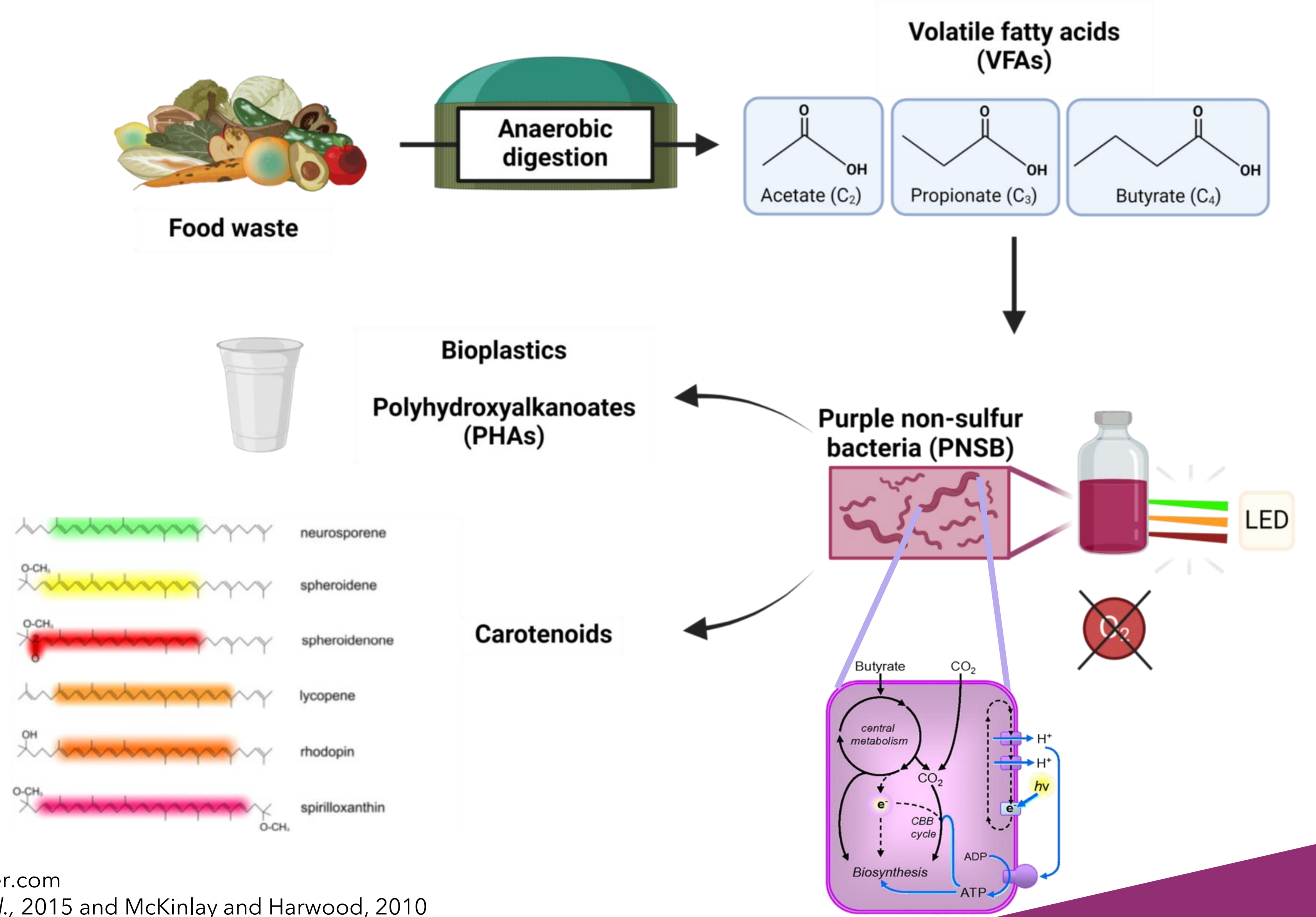
Project overview



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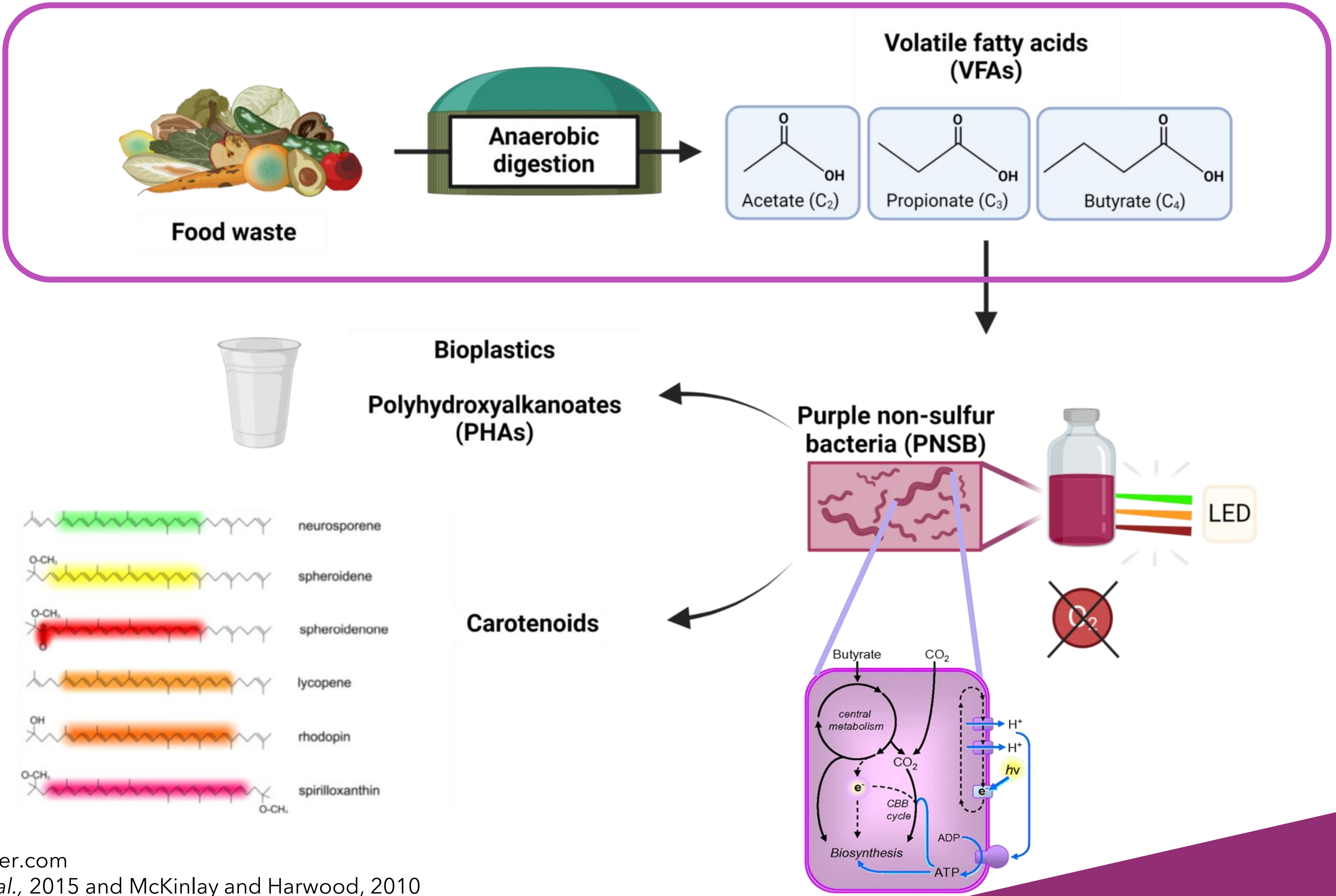

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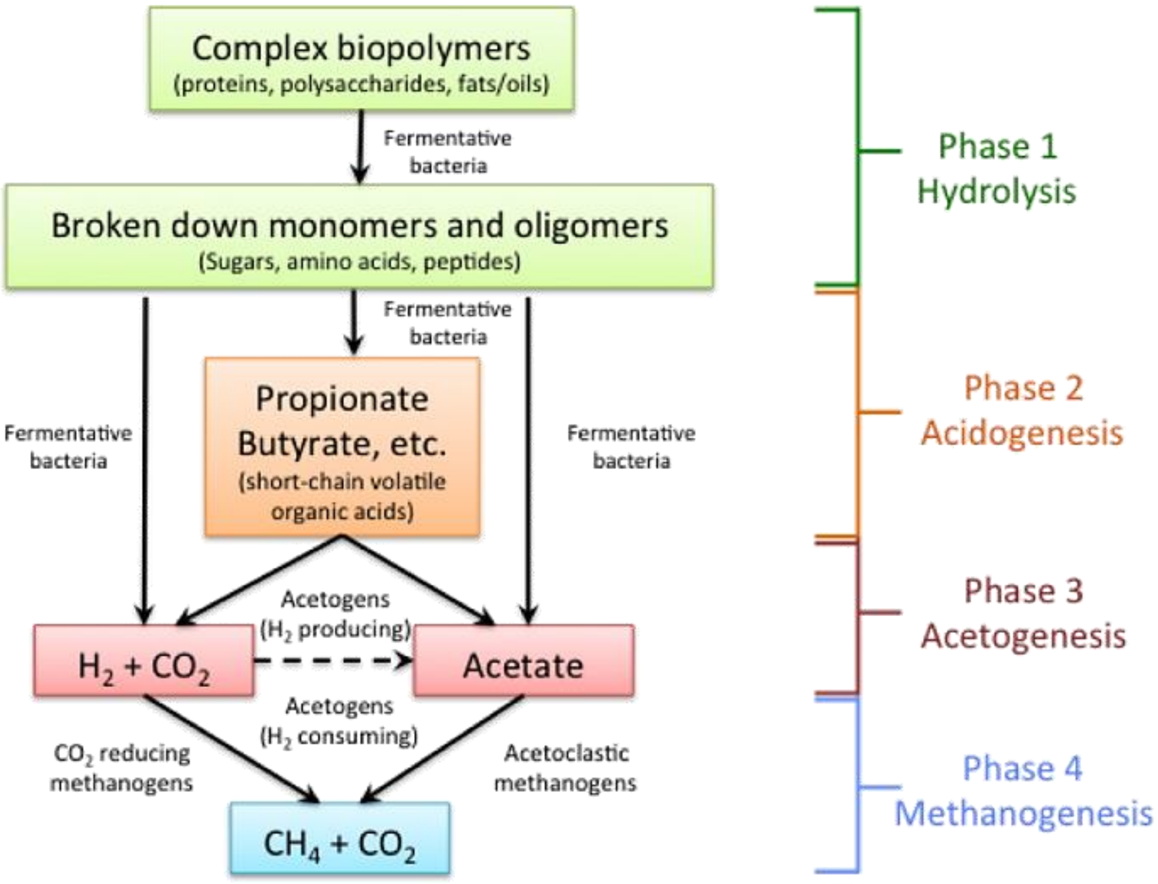
Anaerobic digestion (AD)



Waste streams

- Agriculture-based (manure and crops)
- Wastewater treatment plants
- **Food** and municipal waste

Credit: BEEMS Module B7 - Anaerobic Digestion

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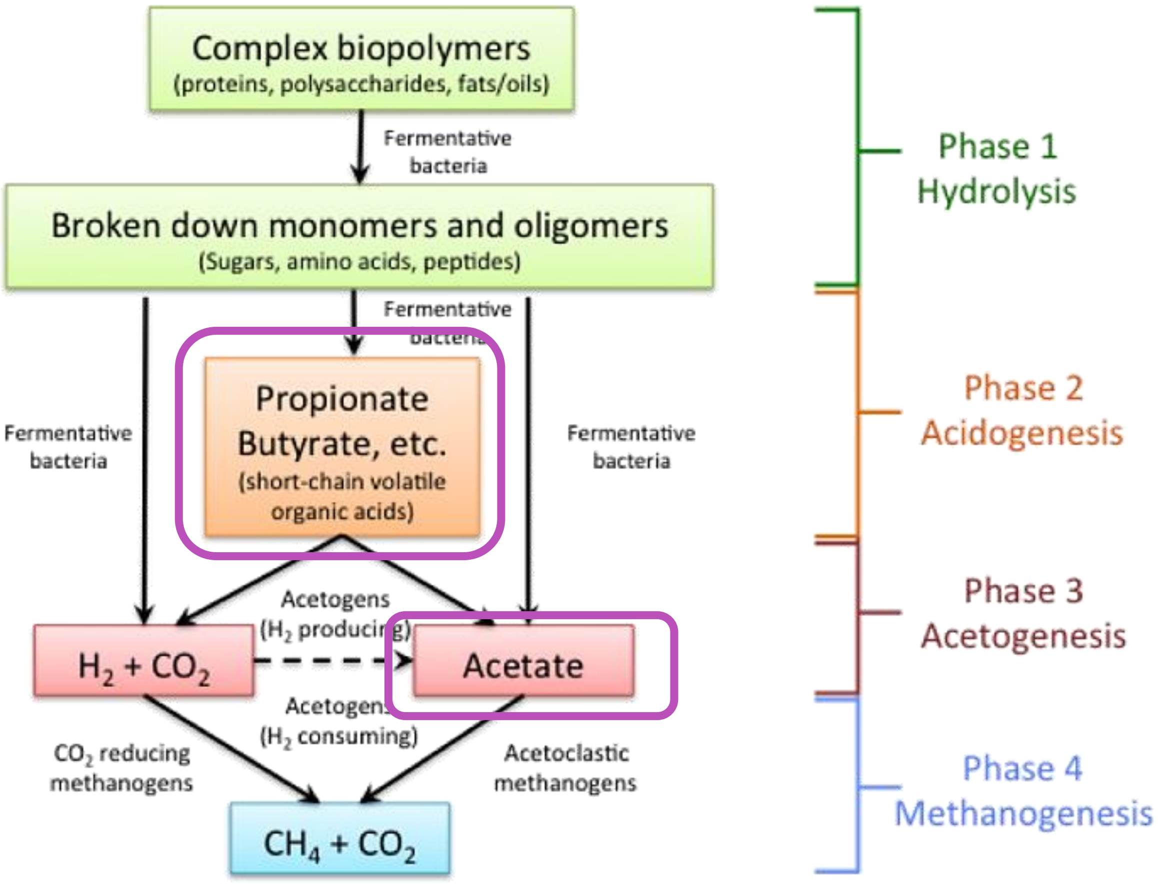

Waste streams
- Agriculture-based (manure and crops)
- Wastewater treatment plants
- **Food** and municipal waste

Short-chain fatty acids (SCFAs) = Volatile fatty acids (VFAs)
- Acetate
- Propionate
- (Iso)butyrate
- (Iso)valerate

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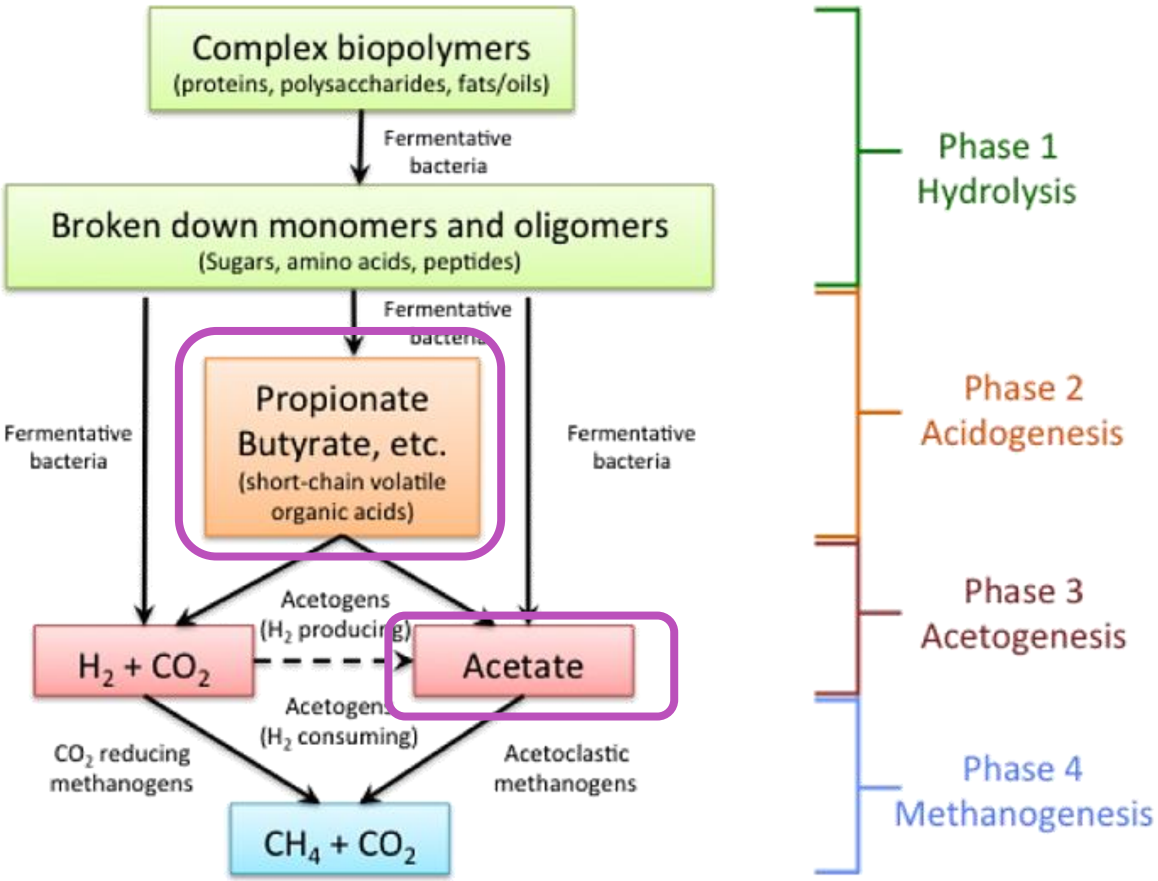
Anaerobic digestion (AD)



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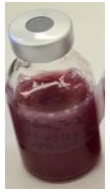

Purple non-sulfur bacteria (PNSB)

Credit: BEEMS Module B7 - Anaerobic Digestion

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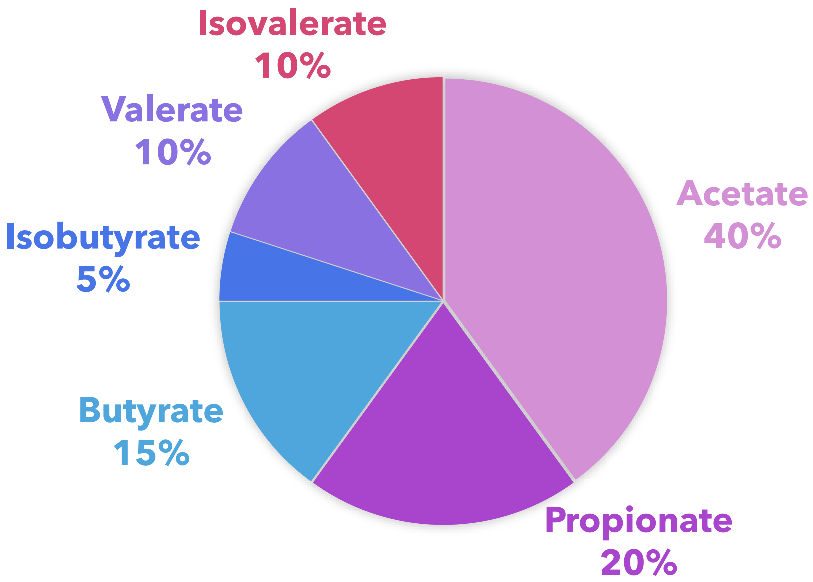
Culturing PNSB in Synthetic Digestate

Synthetic Digestate (%)



- *Rhodospirillum rubrum* 
- Co-culture *crs: Rhodobacter capsulatus, Rhodospirillum rubrum* and *Cereibacter sphaeroides* 

- Culture in SMN broth
- Preculture in MELiSSA medium + VFA (Acetate, Propionate and Butyrate (1:1:1) + 50 mM $NaHCO_3$ + Thiamine and Niacin
- Experiment in MELiSSA with synthetic digestate

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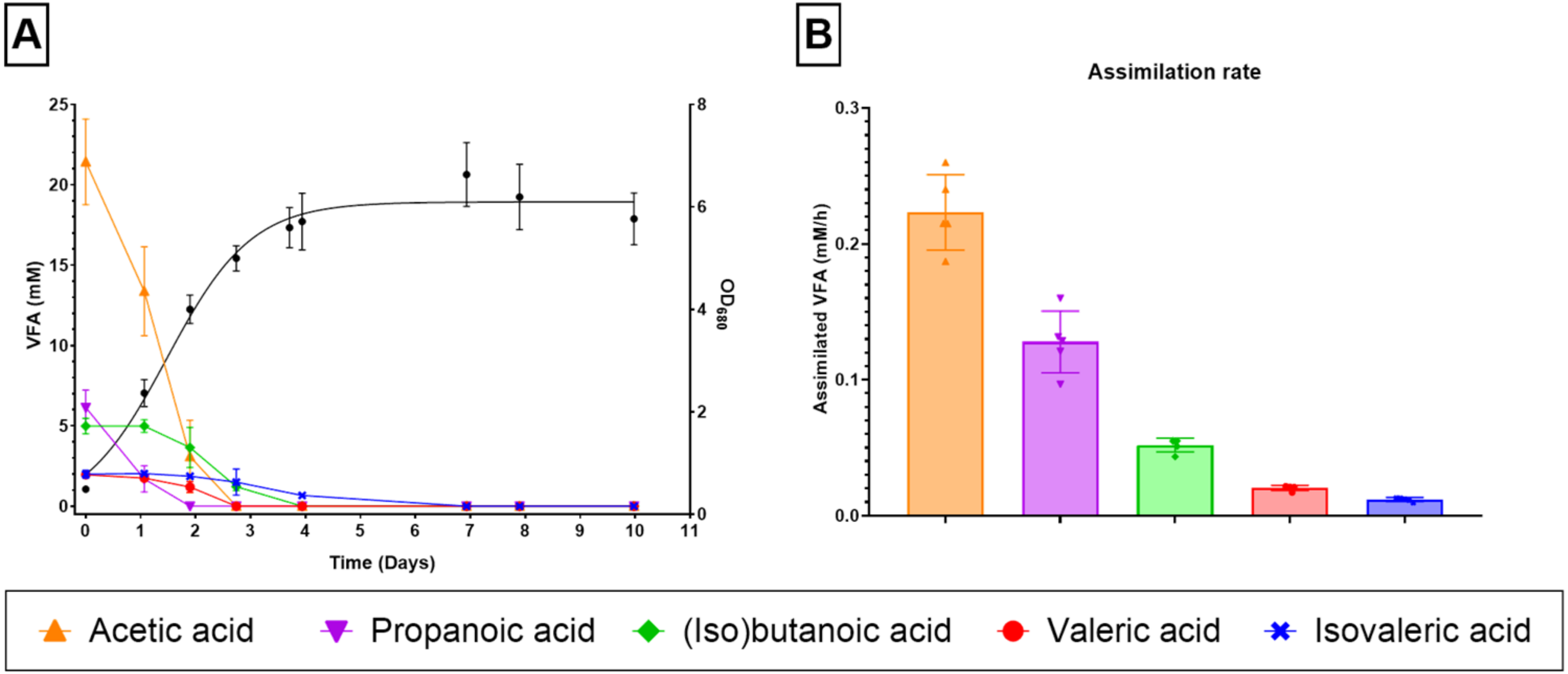
Culturing PNSB in Synthetic Digestate

- LC-MS analysis of VFA assimilation



Bacterial strain proportions

- OD_{680} = 0.133 of each strain => Achieve Start OD_{680} = 0.5

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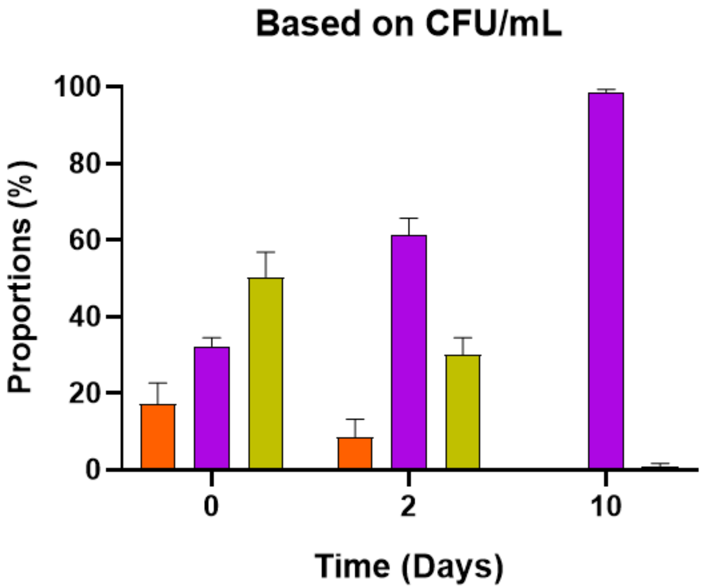

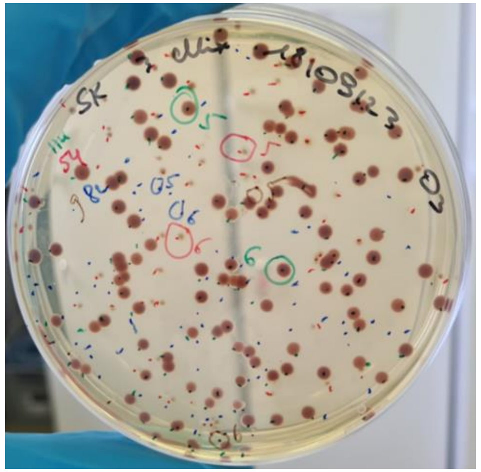

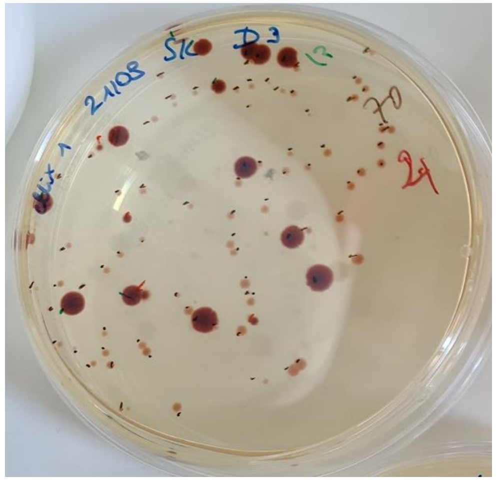

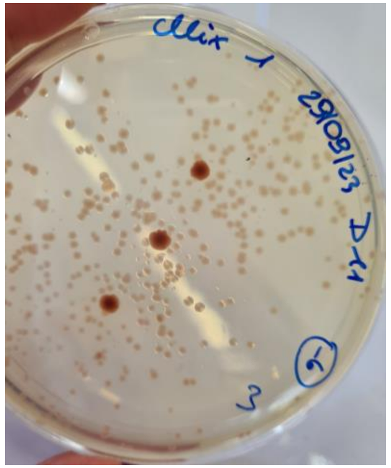

Rb. capsulatus *Rs. rubrum* *C. sphaeroides*

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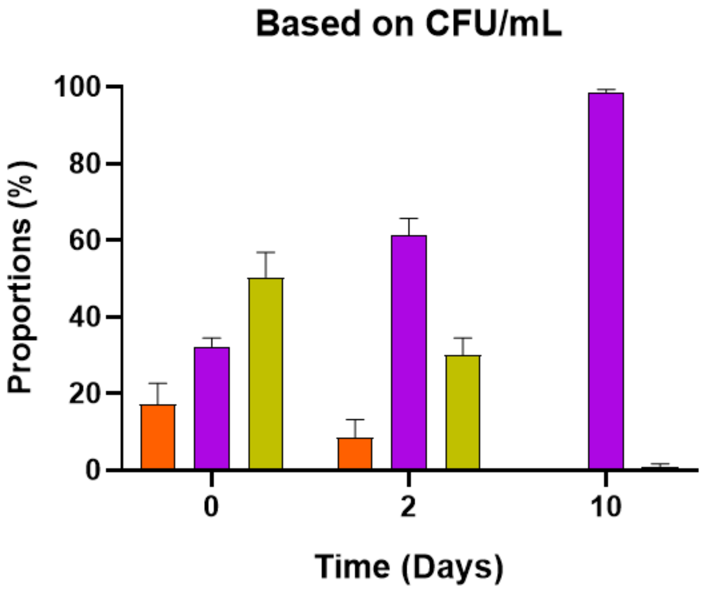

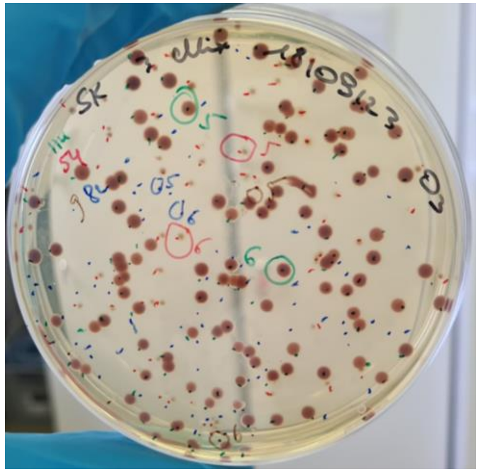

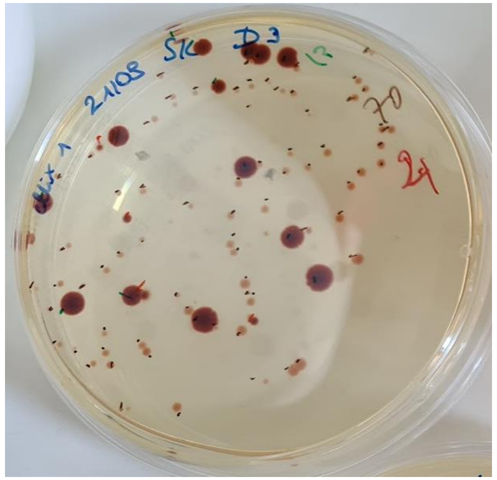

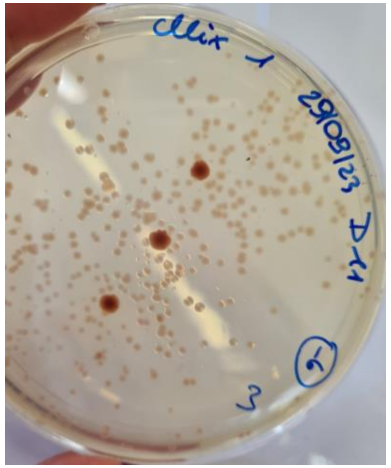

Similarity of colonies on agar plates

Bacterial strain proportions

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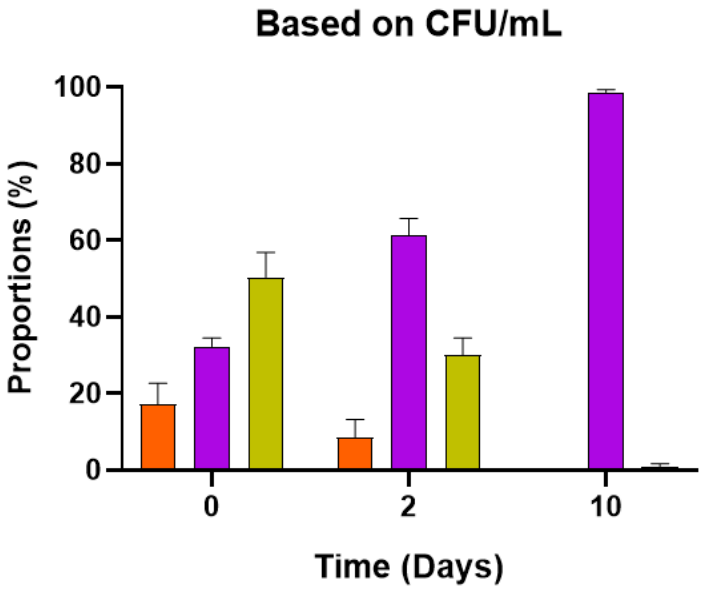

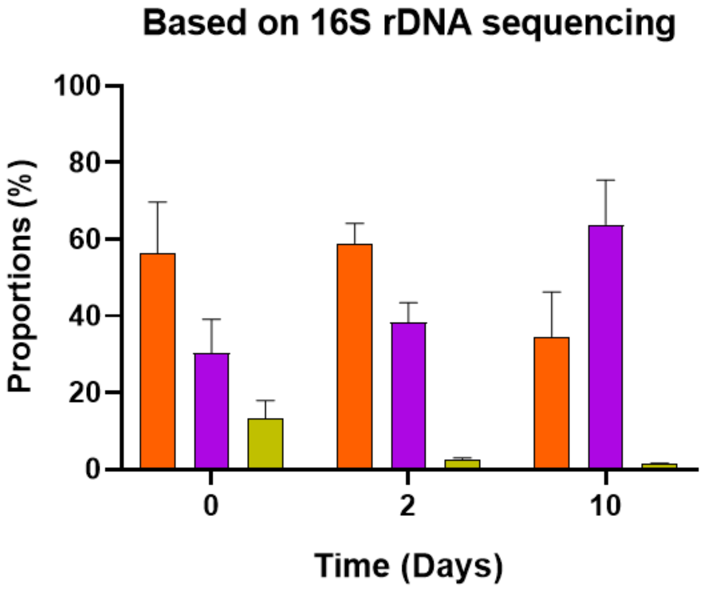

Oxford Nanopore GridION
+ 16S rDNA primers from Oxford Nanopore

Rb. capsulatus *Rs. rubrum* *C. sphaeroides*

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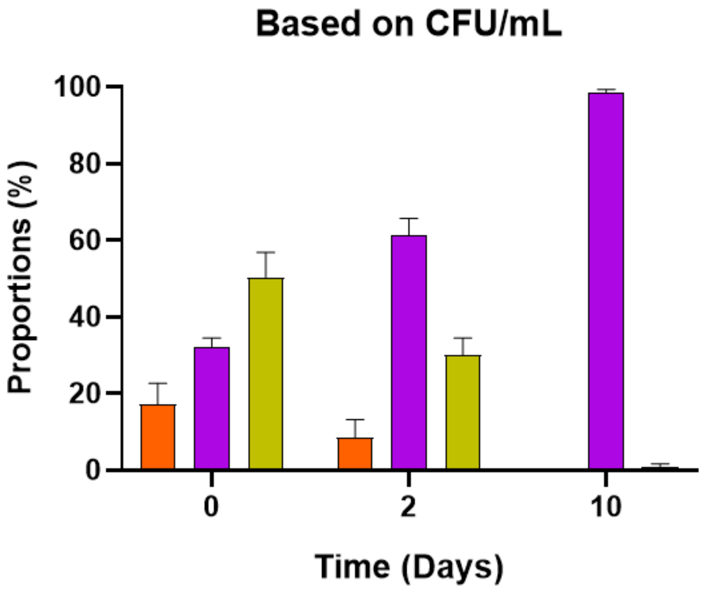

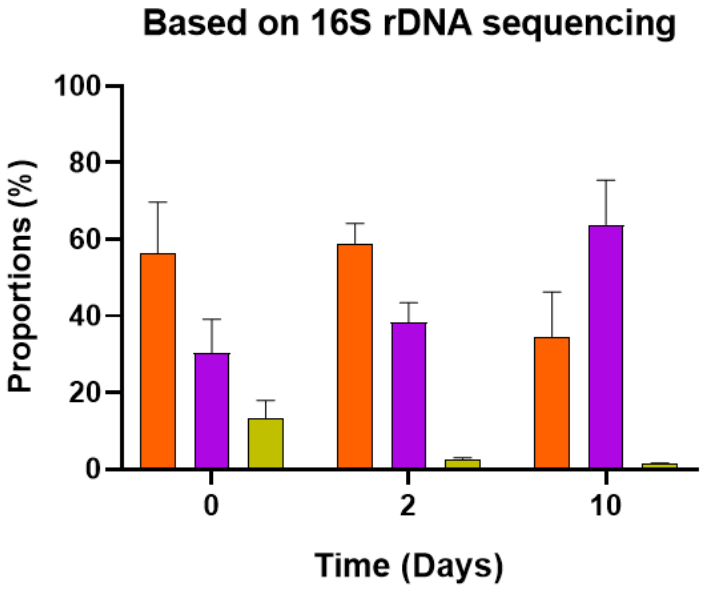

Oxford Nanopore GridION
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Rb. capsulatus *Rs. rubrum* *C. sphaeroides*

Primers have a higher affinity for *Rb. capsulatus*

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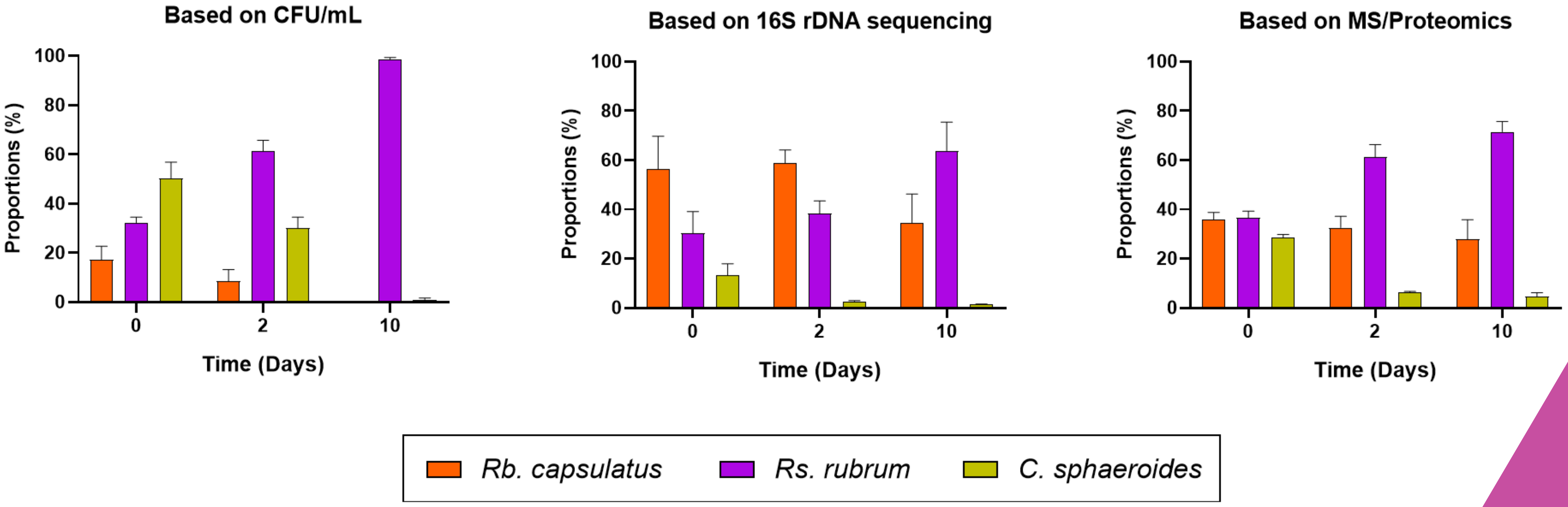

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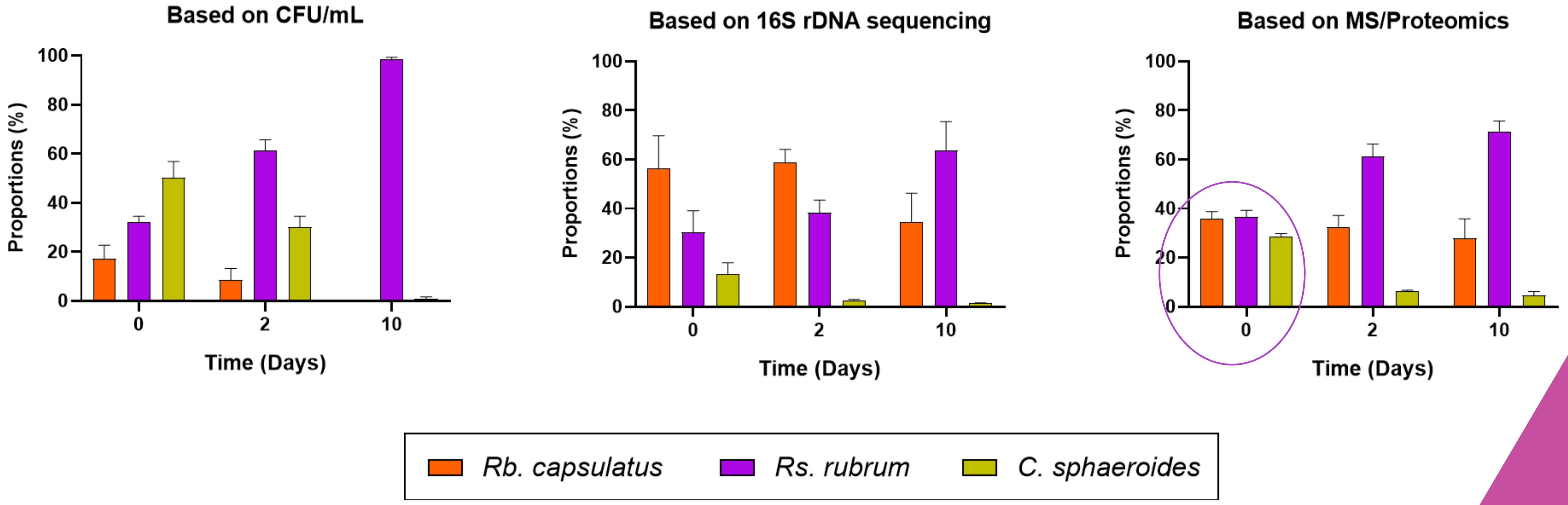

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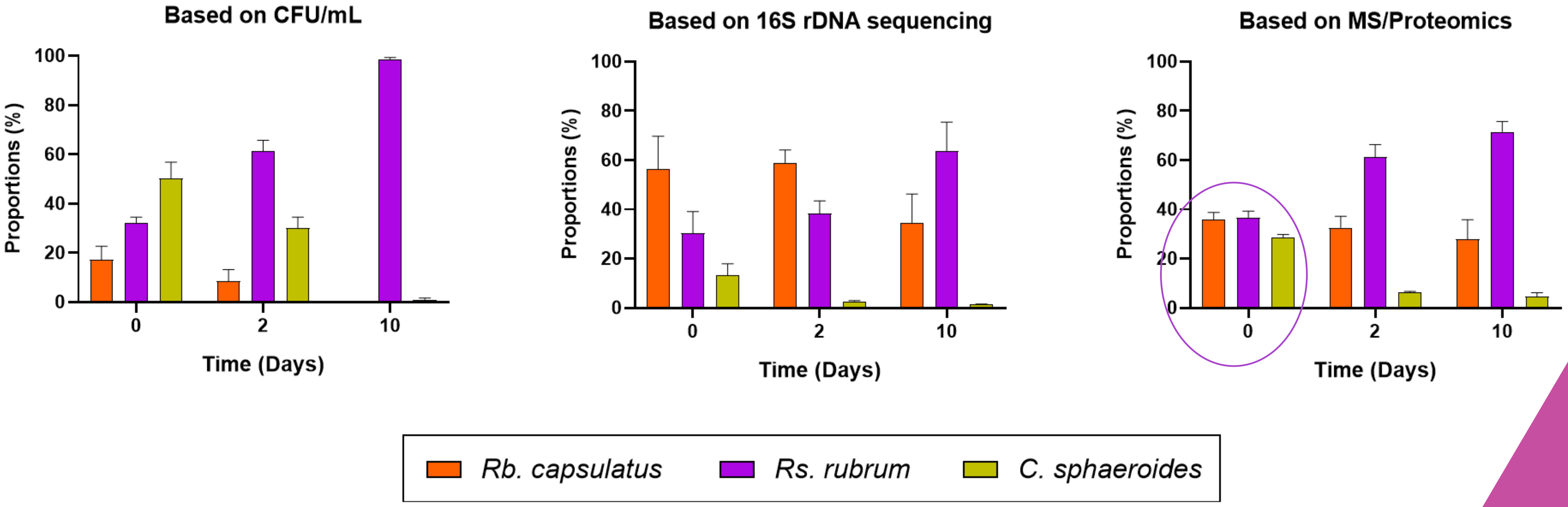


MS/Proteomics could be a great alternative to the classical methods!

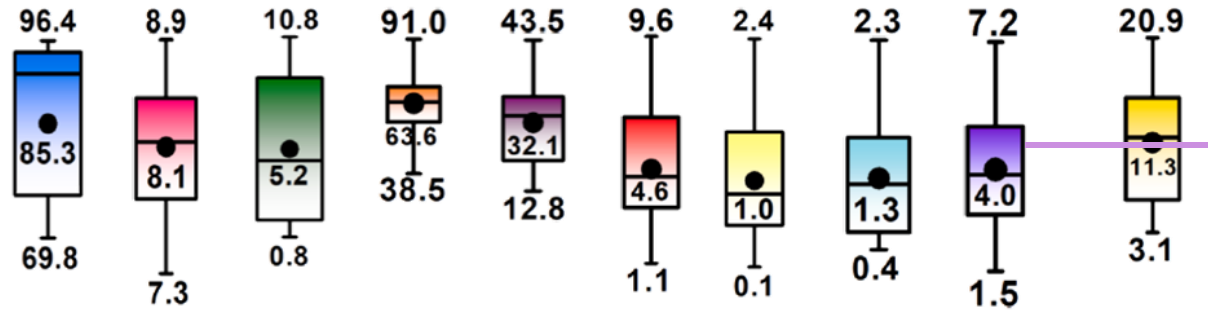
Ammonium in Food-waste Digestates

Standard MELiSSA Medium:
35 mM NH_4Cl
➔ 0.5 g/L N
➔ 0.635 g/L NH_4^+

10 x

~350 mM NH_4Cl
➔ 5 g/L N
➔ 6.35 g/L NH_4^+

Table 1
Food waste digestate characteristics (MC: moisture content; EC: electrical conductivity; OM: organic matter; TOC: total organic carbon; TN: total nitrogen; TP: total phosphorous; TK: total potassium).



Waste type	Country	MC (%)	pH	EC (dS/m)	OM (%)	TOC (%)	TN (%)	TP (%)	TK (%)	NH_4^+-N (g/kg)	C/N ratio	References
OFMSW	Spain	71.8	8.5	6.8	45.3	–	3.2	0.75	–	–	–	García-Albacete et al. (2014)
Source selected biowaste	Spain	75.6	8.31	–	63	34.1	4.3	–	–	–	11.9	Cerda et al. (2019)
OFMSW	Spain	76	8.3	–	63	34	4.3	–	–	–	11.8	Rodríguez et al. (2019)
Food waste	Ireland	80	–	–	64.7	–	–	–	–	–	–	Chen et al. (2019)
OFMSW	Italy	92.1	7.69	–	65	35.7	–	–	–	–	–	Beggio et al. (2019)
Food waste	UK	92.5	8.05–8.24	–	–	–	3.3–4.4	0.56–0.76	1.05–1.55	2.9–3.6	–	Sánchez-Rodríguez et al. (2018)
Food waste	China	–	–	–	66.1	43.5	1.92	–	–	–	–	Liu et al. (2020)
Food waste	UK	93.9–95.6	8.1–8.8	–	–	–	5.4–8	–	–	3.9–6.3	–	Nicholson et al. (2017)
Food waste	China	96.4	8.6	–	91	–	4.8	0.53	–	2.54	–	Wang et al. (2020)
Residual household waste	France	69.8	8.2	–	38.5	–	–	–	–	4.18	–	Zeng et al. (2016)
Organic household waste	Germany	–	–	–	85.1	34.3	1.9	–	–	–	–	Cao et al. (2019)
Food waste	USA	–	–	2.5	–	–	6.96	1.2	1.9	3.4	–	Barzee et al. (2019)
Food waste	Italy	–	8.4–8.9	–	50.1–58.8	30.2–31.3	1.6–3.5	0.5–0.9	0.4–0.5	2.3–2.4	8.9–18.9	Grigatti et al. (2020)
Food waste	Poland	–	8.1	–	63	–	6.6	1.6	1.63	–	–	Czekala et al. (2020)
Segregated biodegradable waste	Italy	–	7.7	–	64	31.4	4.9	–	–	3.48	–	Peng et al. (2018)
Food waste	Singapore	–	7.81	–	–	–	–	0.5	–	4.7	–	Cheong et al. (2020)
Food waste	Austria	–	7.8	–	–	39.7	1.4	–	–	5.1	–	Franke-Whittle et al. (2014)
OFMSW	Canada	–	8.5	10.8	48	24.5	1.6	1.5	1.5	6.19	–	Arab and McCartney (2017)
Food waste	Finland	–	7.6–8.3	–	50.2–63.7	25.9–26.9	7.8–8.7	0.1–0.3	1.9–3.2	3.2–4.5	3.1–3.3	Tampio et al. (2016)
OFMSW	Canada	–	8.5	0.8	–	–	–	1	–	5	–	McLachlan et al. (2004)
Food waste	Australia	–	8.02	–	–	42.1	5.8	1.97	0.62	1.5	–	Opatokun et al. (2016)
Food waste	Italy	–	7.97	–	80.4	–	3.97	0.9	2.3	–	–	Peng and Pivato (2019)
OFMSW	Italy	–	8.8	–	68–71	12.8–22.7	1.09	1.49	0.78	–	12.1–20.9	Peng and Pivato (2019)
Food waste	Germany	–	7.3–8.3	–	–	–	4.2–6.7	–	–	5.1–7.2	–	Fuchs and Drosg (2013)
Bio waste	Germany	–	7.6–8.1	–	–	–	3–6.8	–	–	1.5–5.6	–	Fuchs and Drosg (2013)
Fruit waste	Australia	94.8	–	–	73.1	43.5	9.6	0.8	1	–	–	Serrano et al. (2020)
Household organic waste	Switzerland	–	–	–	64.7	33.1	4.7	2.45	0.63	–	–	Loes et al. (2018)

Manu *et al.*, 2021. *Bioresource Technology*, *334*, p.125032.

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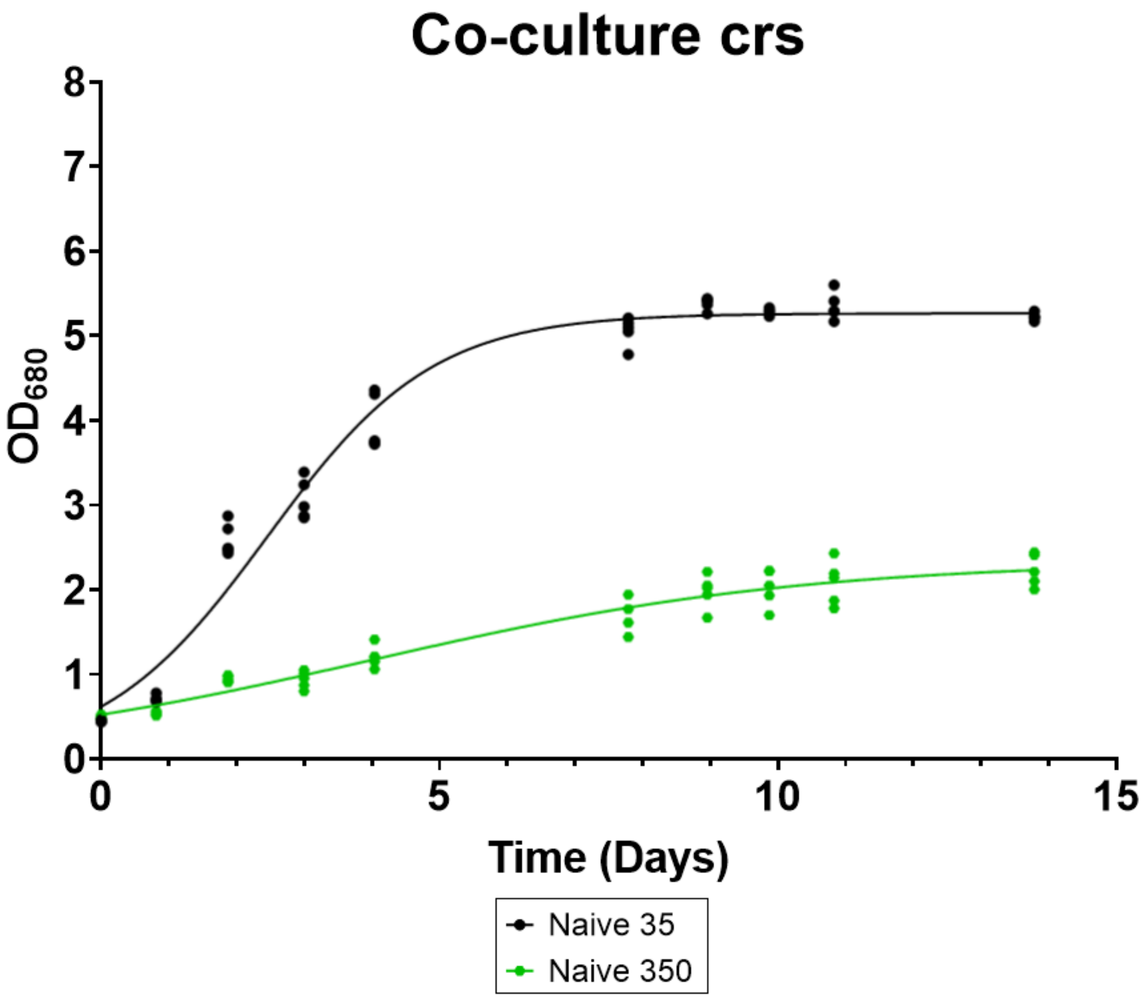
Effects of High Ammonium Levels



Reduced growth of co-cultures of *Rb. capsulatus, Rs. rubrum, C. sphaeroides* in high-ammonium medium

⇒ *Why do the bacteria suffer in high-ammonium medium?*
⇒ *What is the minimal inhibitory concentration?*
⇒ *How can they adapt to these stringent conditions?*

⇒ *Organic acid contents, proteomic analysis and bacterial strain proportions will follow*

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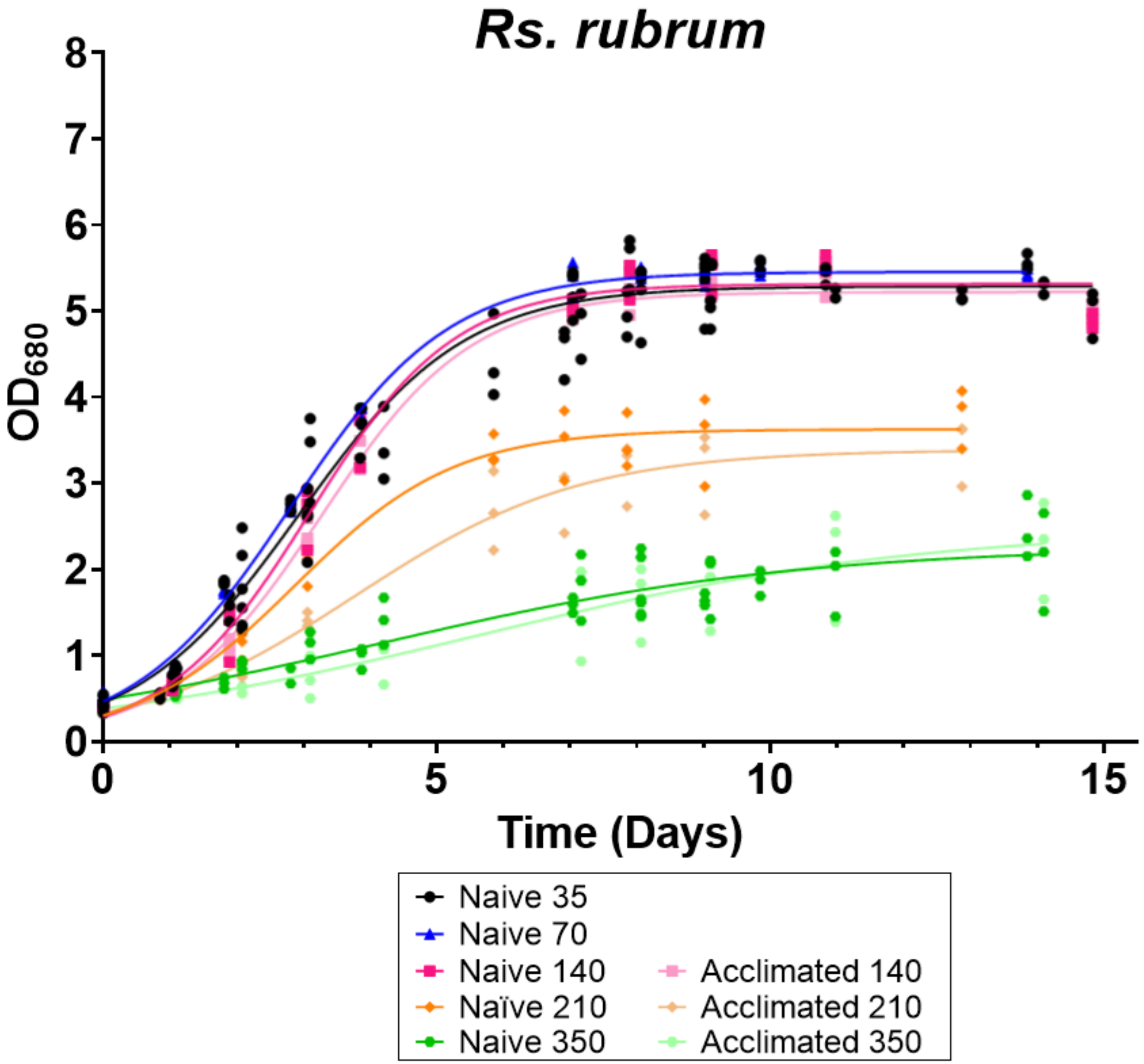

⇒ Growth is impaired at 210 mM and 350 mM NH_4Cl and the cultures did not reach the same OD_{680} as in lower NH_4Cl medium

⇒ Acclimatation did not take place

⇒ *Organic acid contents and proteomic analyses will follow*

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Acknowledgements

Thank you for your attention!

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Cofinancé par l'Union européenne

Wallonie

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PURPLEGAIN

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