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Production of protein-rich purple bacteria biomass from sugar-beet molasses for food application: Process optimisation and economic feasibility.

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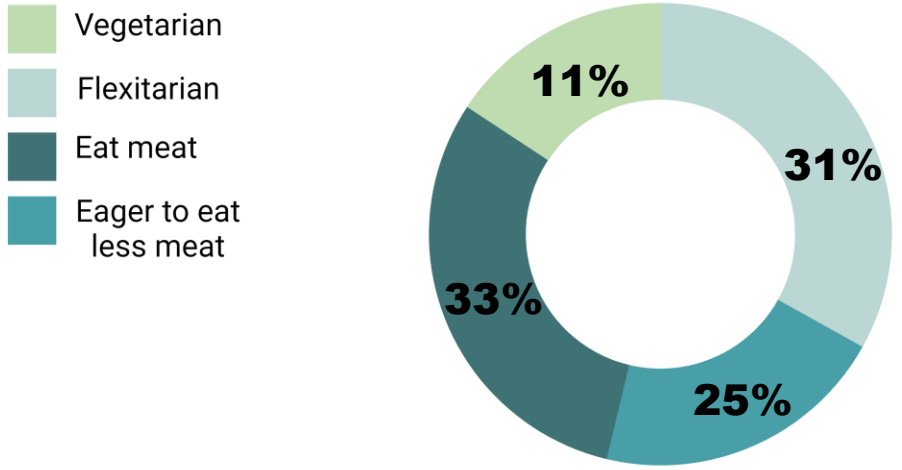
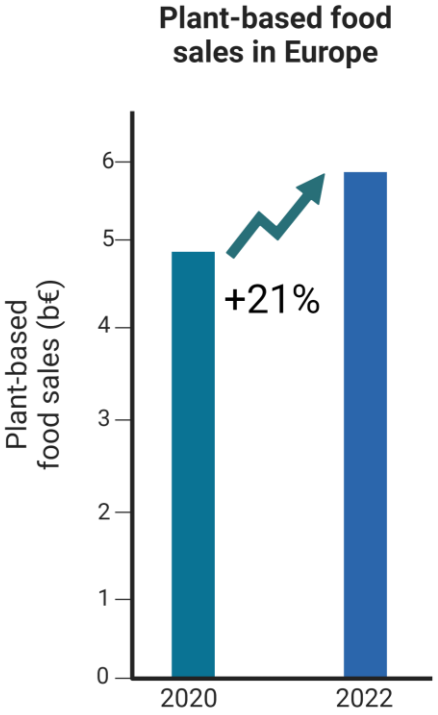
University of Mons

Context of the alternative protein field

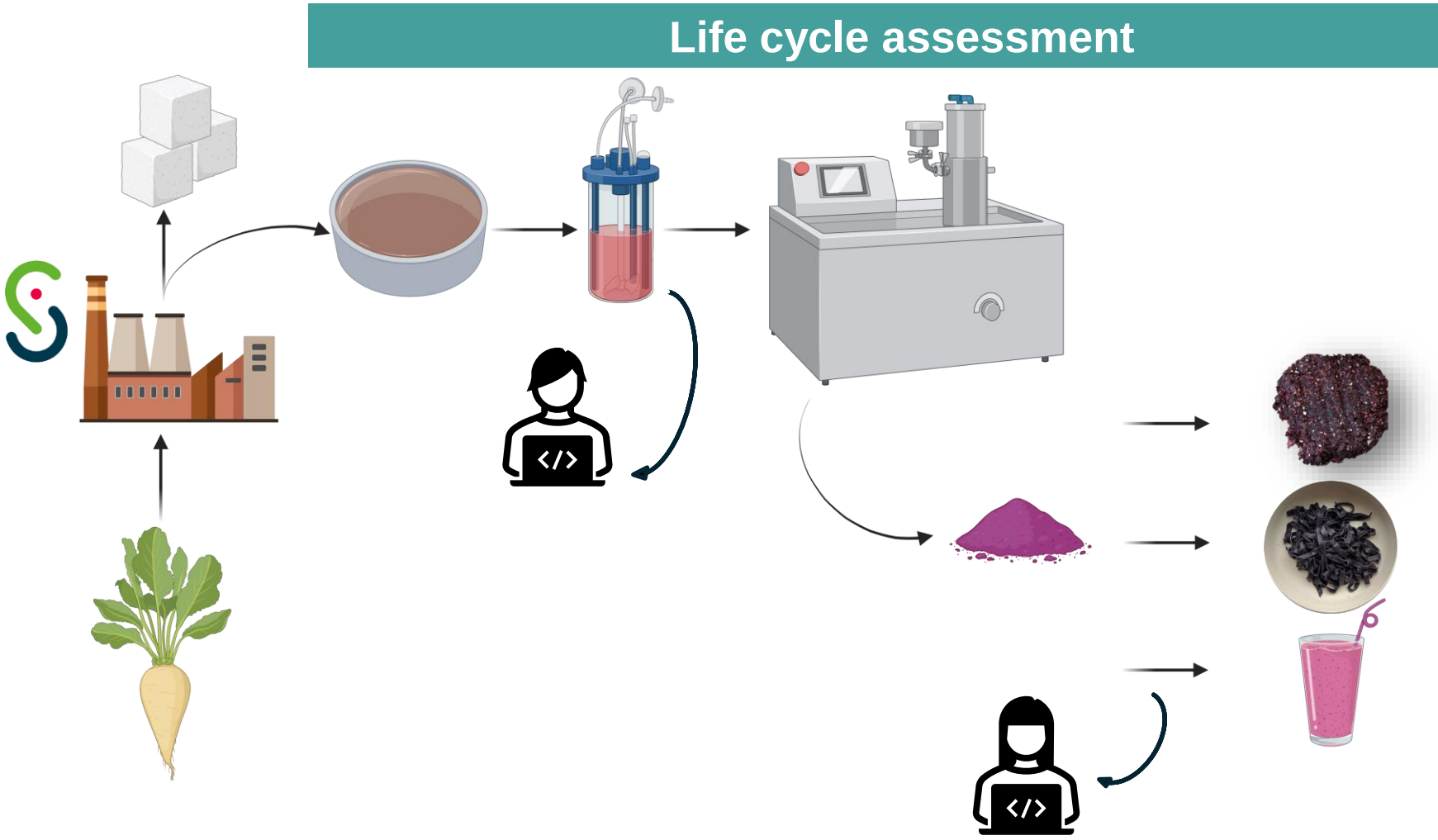




- Increasing proportion of the population eager to switch toward meat-less food
- Increase by 21% of plant-based food sales in Europe between 2020 and 2022
- Europe protein independance is needed

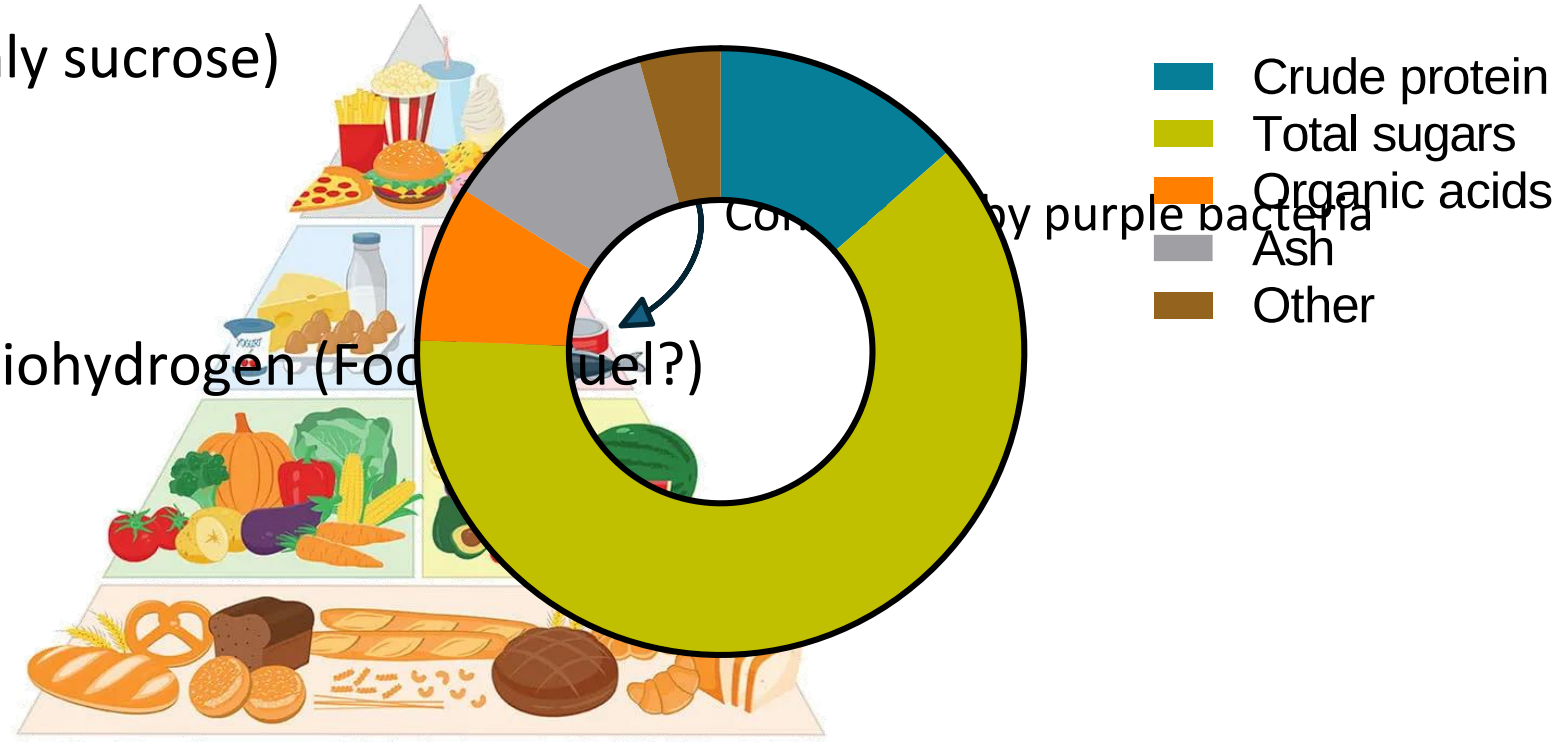
Data taken from Next Food Chain Memorandum Elections 2024

Context of the PROTEBoost project

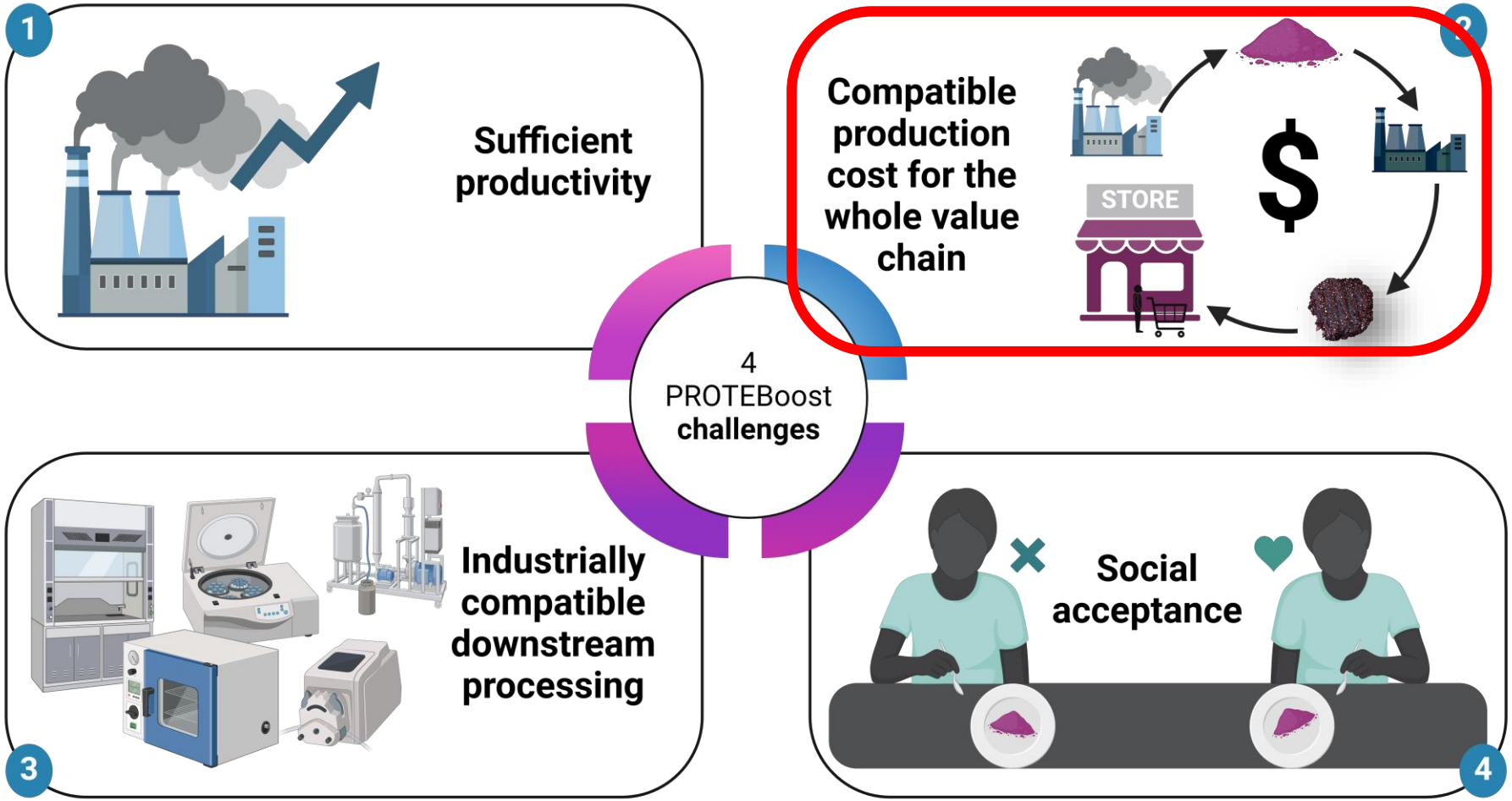


Why using molasses as feedstock for protein-rich biomass?

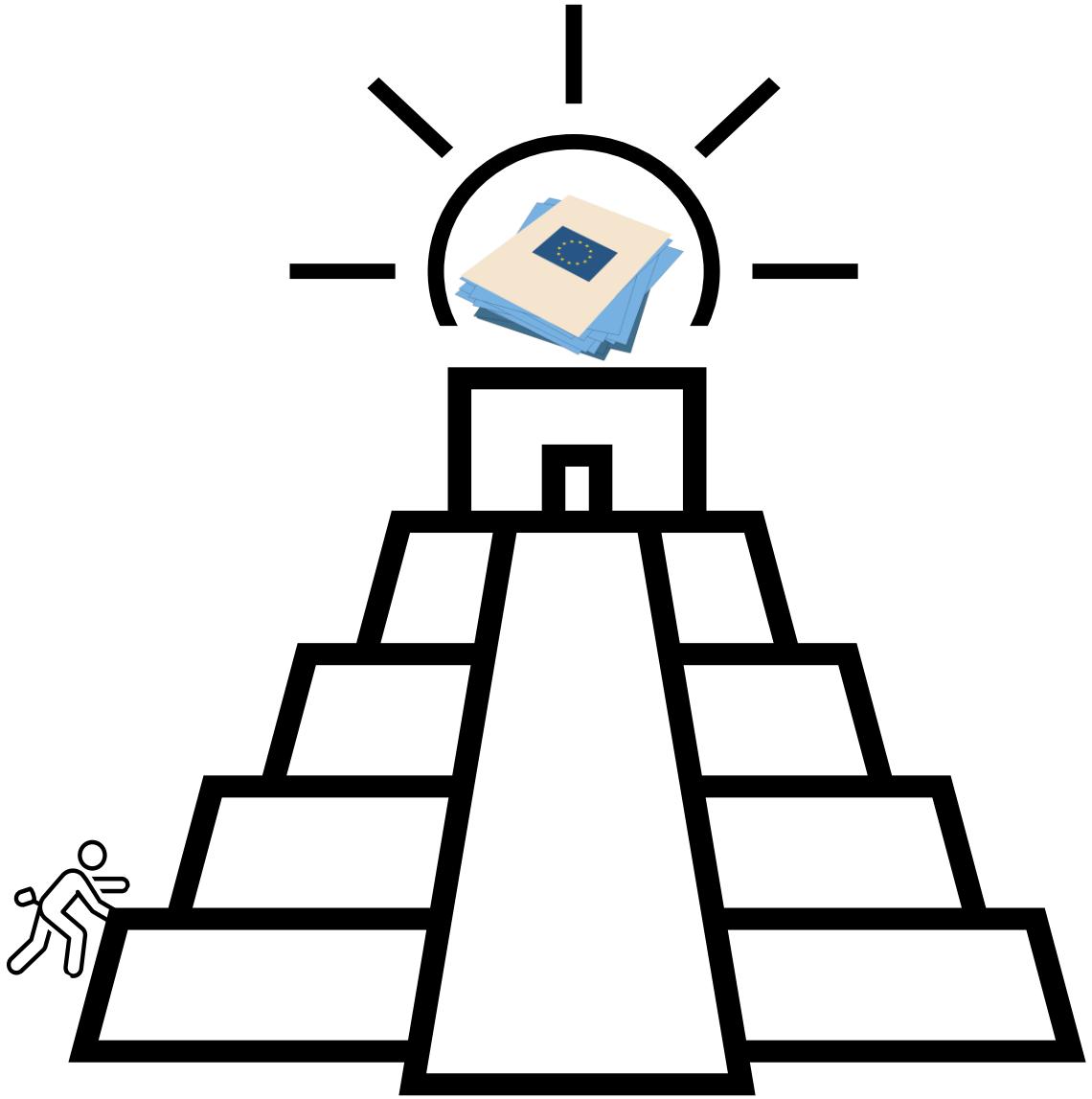
- ✓ Low-value co-products from the sugar industry
- ✓ Tremendous quantity produced each years (70 millions tons per year)
- ✓ High content in sugar (mainly sucrose)
- ✓ The food pyramid
- ✓ Production of bioethanol, biohydrogen (Foo uel?)



Industrial expectations and challenges in the field of alternative proteins



Novel food agreement



Techno-economic assessment

Production cost (medium + energy)

Cost to produce 1kg of fresh purple bacteria biomass										
Needed Volume (L)	Molasses (g)	NH_4Cl (g)	Invertase (mL)		Molasses price(€)	NH4Cl price (€)	Invertase price(€)	Medium cost (€)		
100	1120	380	0.008		0.224	0.2299	0.064	0.52		
										Total cost(€)
	Energy 525nm (kW)	Energy 592nm (kW)	Energy 850nm (kW)	Total energy(kW)	Culture time	Kw/h experiment (kW/h)	Energy price Belgique (August 2023) (€)	Energy cost(€)		15.19
	0.0936	0.0936	0.0624	0.2496	7	41.9328	0.35	14.67		

Installation cost (high-tech photobioreactor)

Instrument	Installation cost (€)	Capacity (L)	Productivity (g/L*d)	Investment return per year (€)	Investment return over 7 years (€)	Full investment return (years)
High-tech tubular photobioreactor	80000	300	2	470.87*	3296.10	169.90
Maximal installation cost	NA	100	1.25	98.10*	686.69	**7€/L**

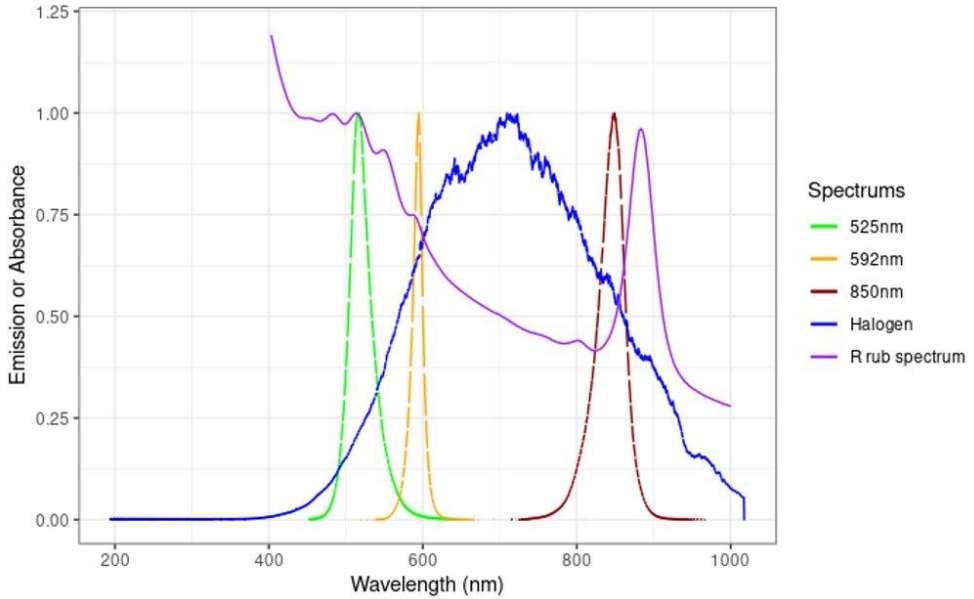
* Based on a selling price of 5€/kg

Economic process optimisation

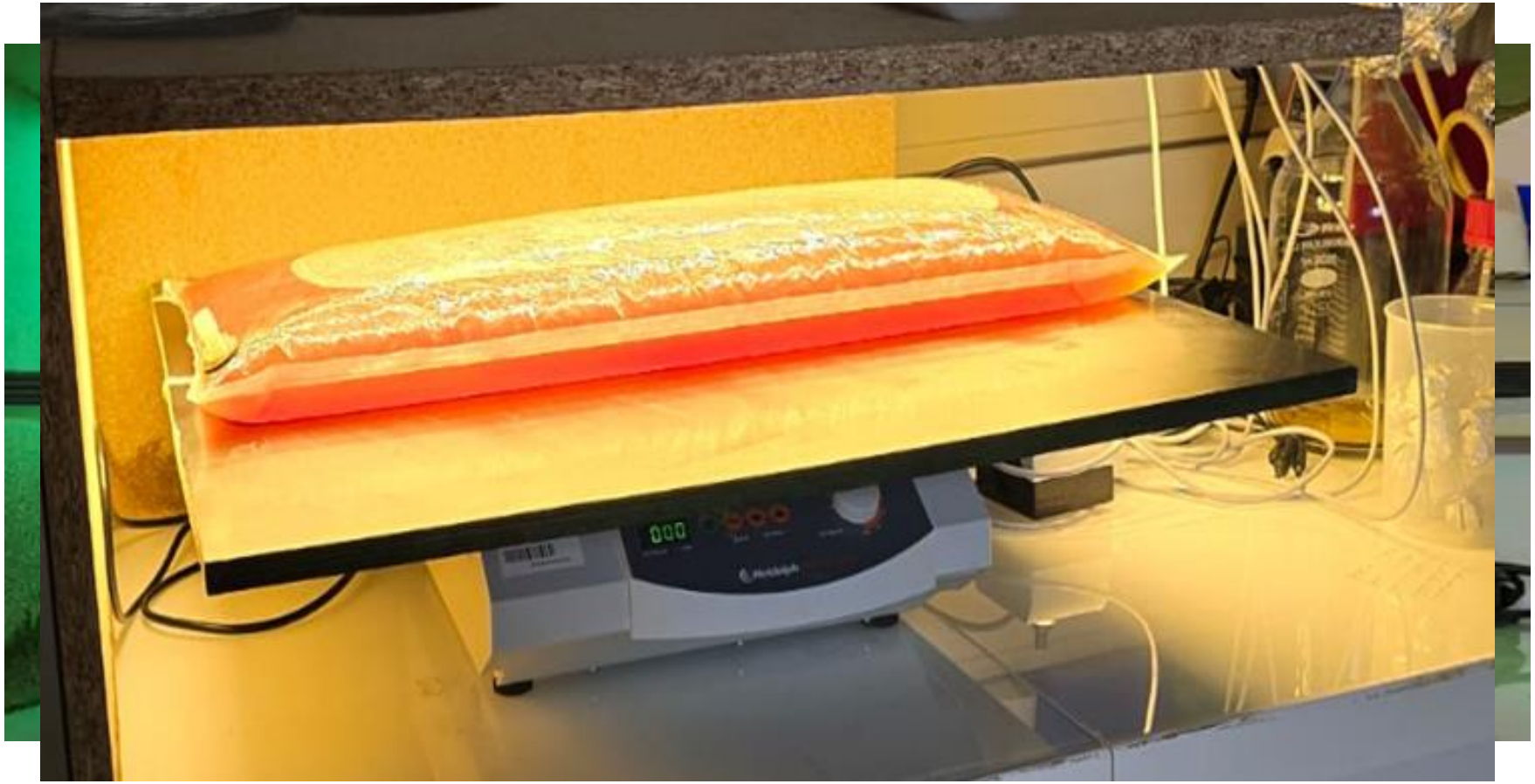
Low-cost process

Development of a low-cost photobioreactor

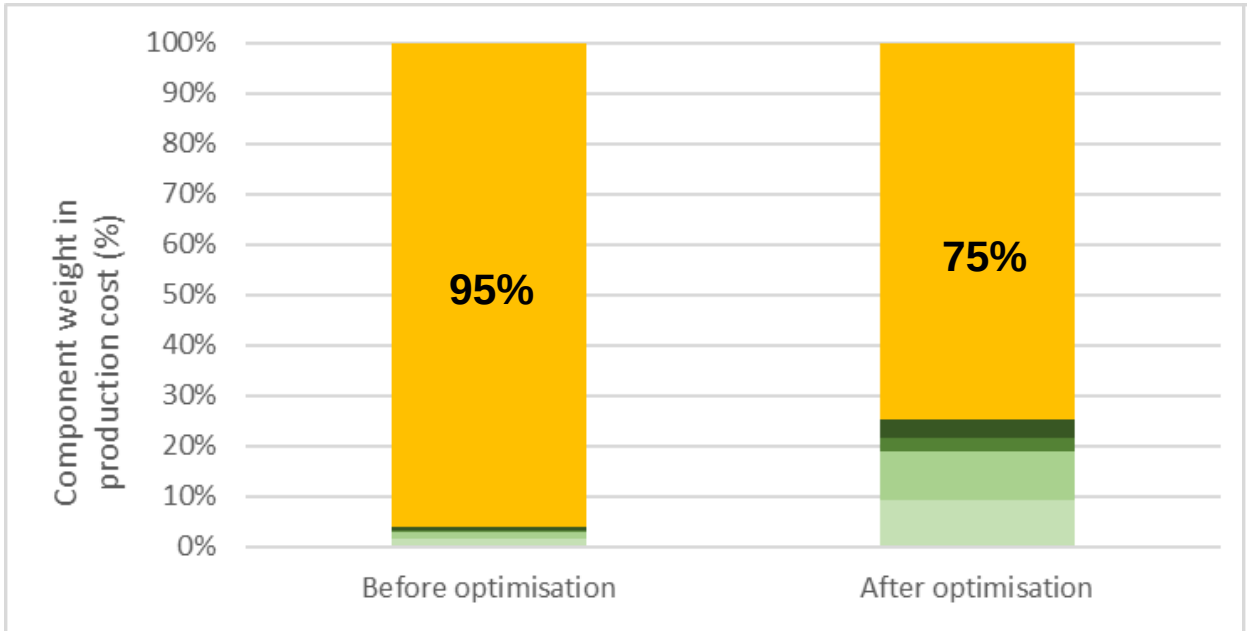
Optimisation of the light parameter

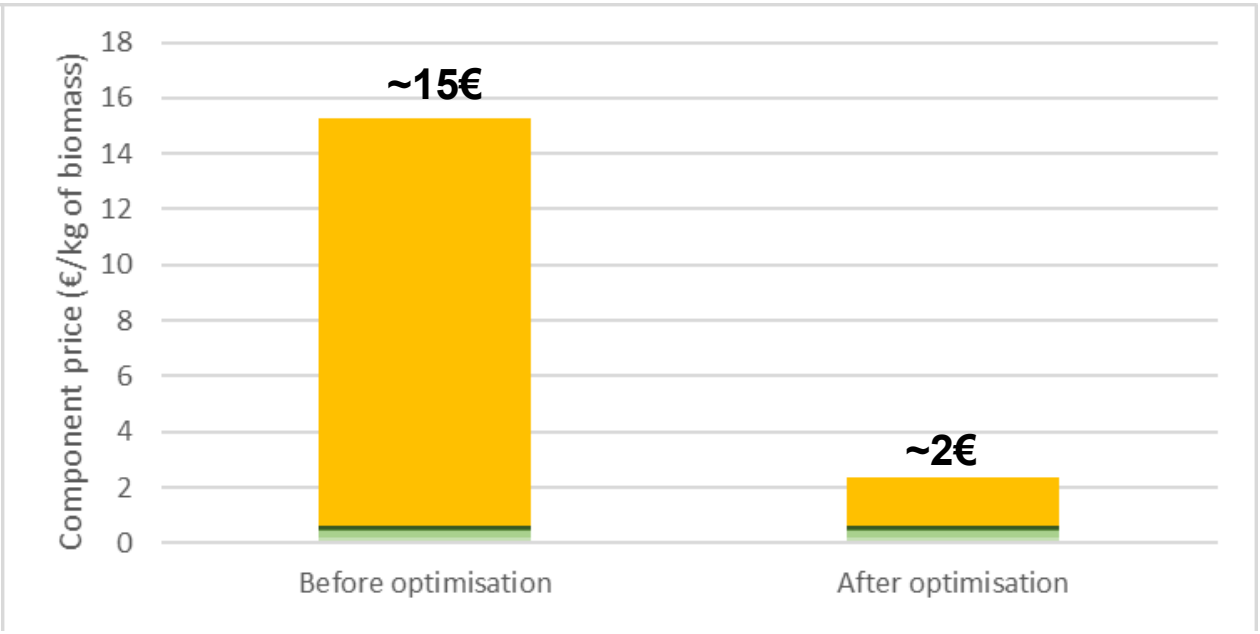


Low-cost photobioreactor



Process optimisation – energy demand

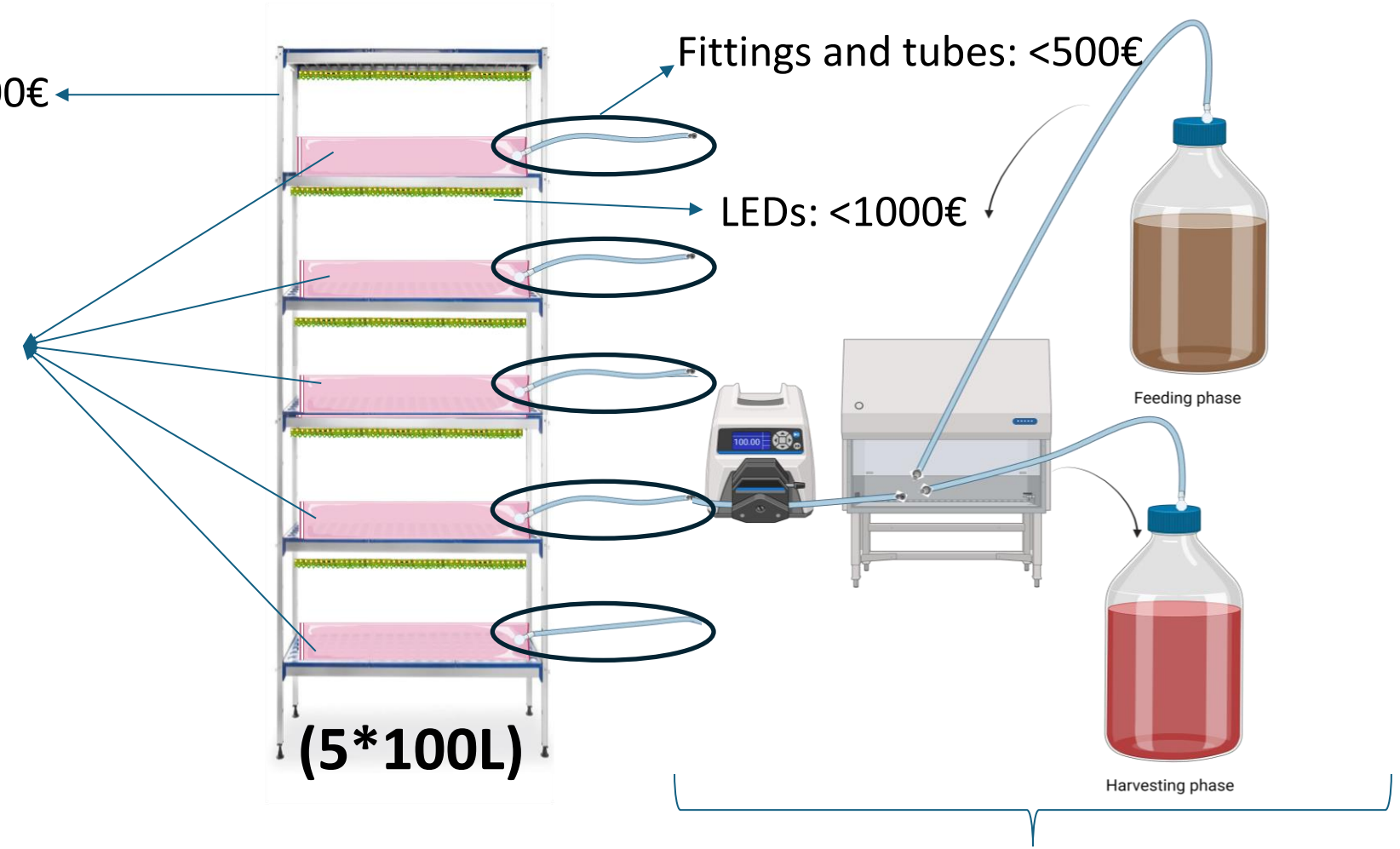




Molasses cost (€) NH4Cl cost (€) Invertase cost (€)

Bicarbonate cost (€) Energy cost (€)

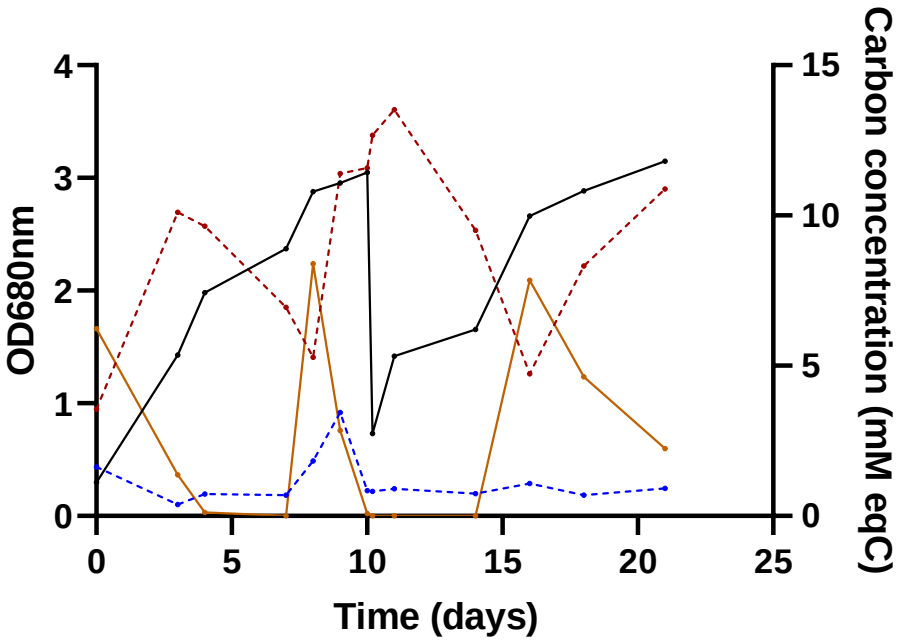
Process optimisation – installation cost



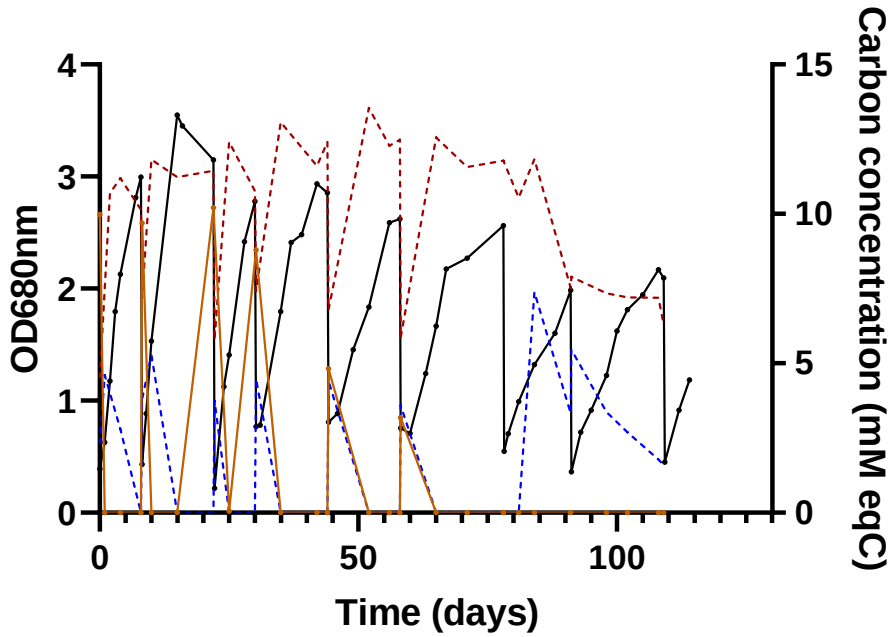
Less than 2500€ for 500L (<5€/L)

High-tech *vs* Low cost photobioreactor

2L Photobioreactor (high tech photobioreactor)

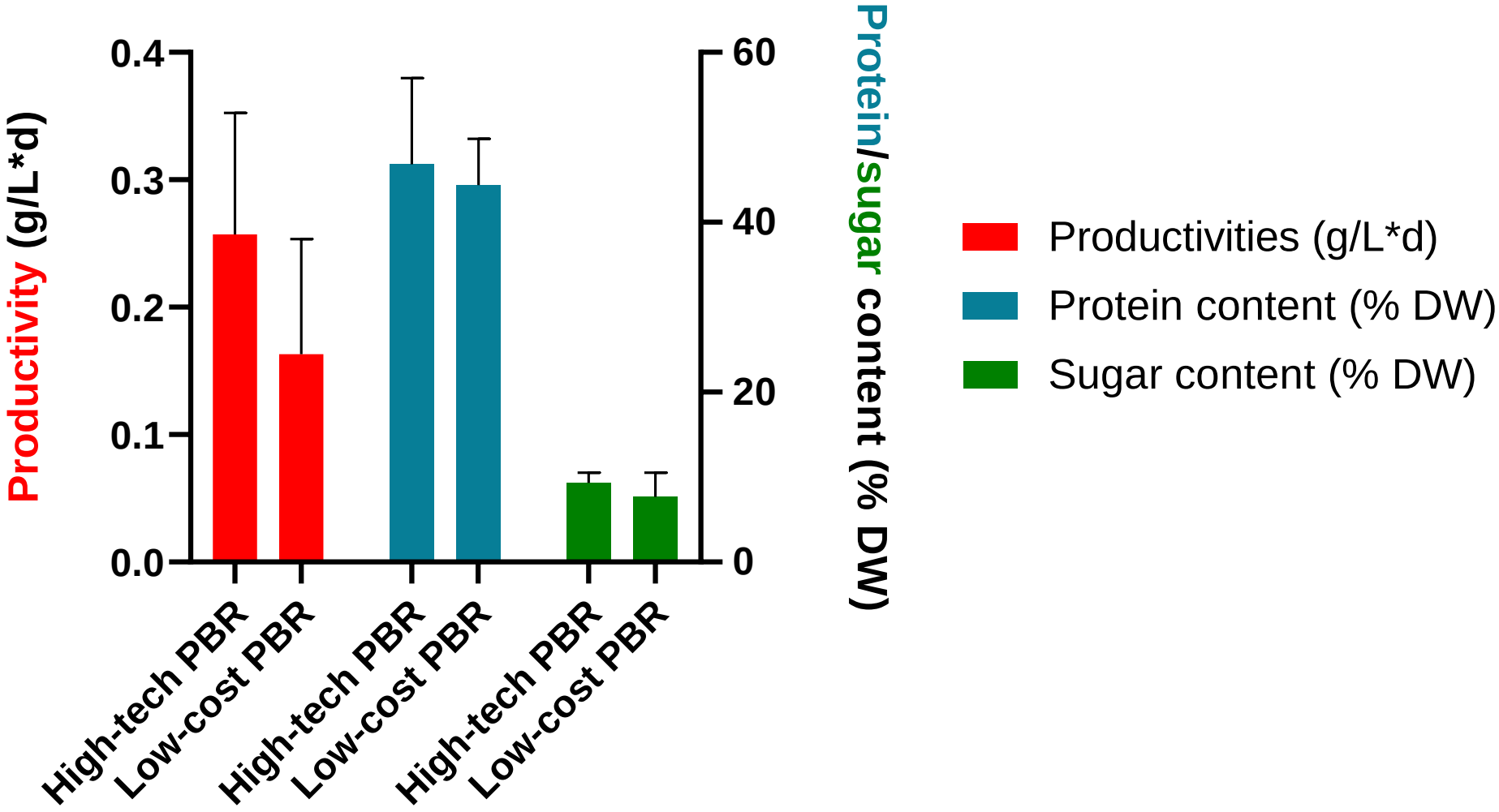


Low cost photobioreactor



Growth curve
Fructose
Glucose
Sucrose

What about biomass quality



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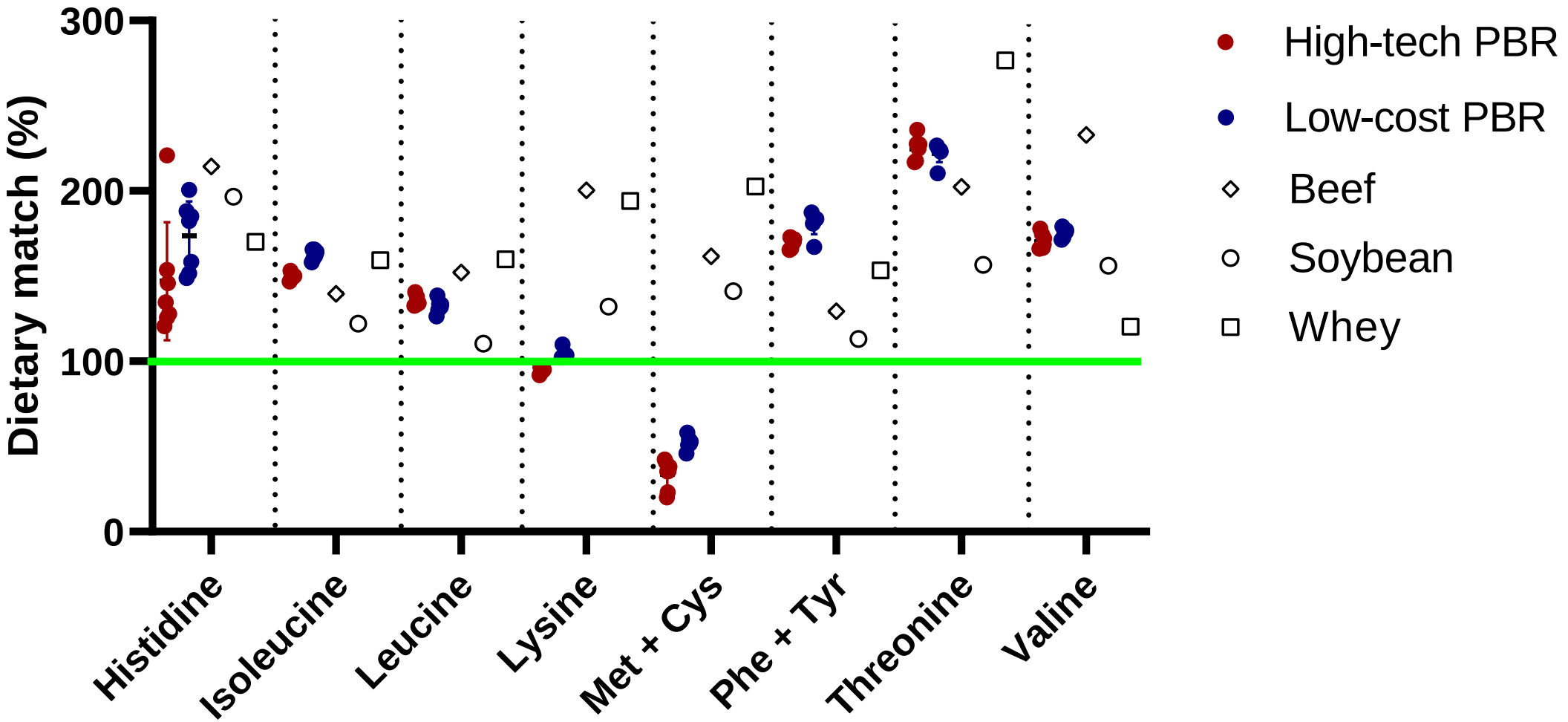

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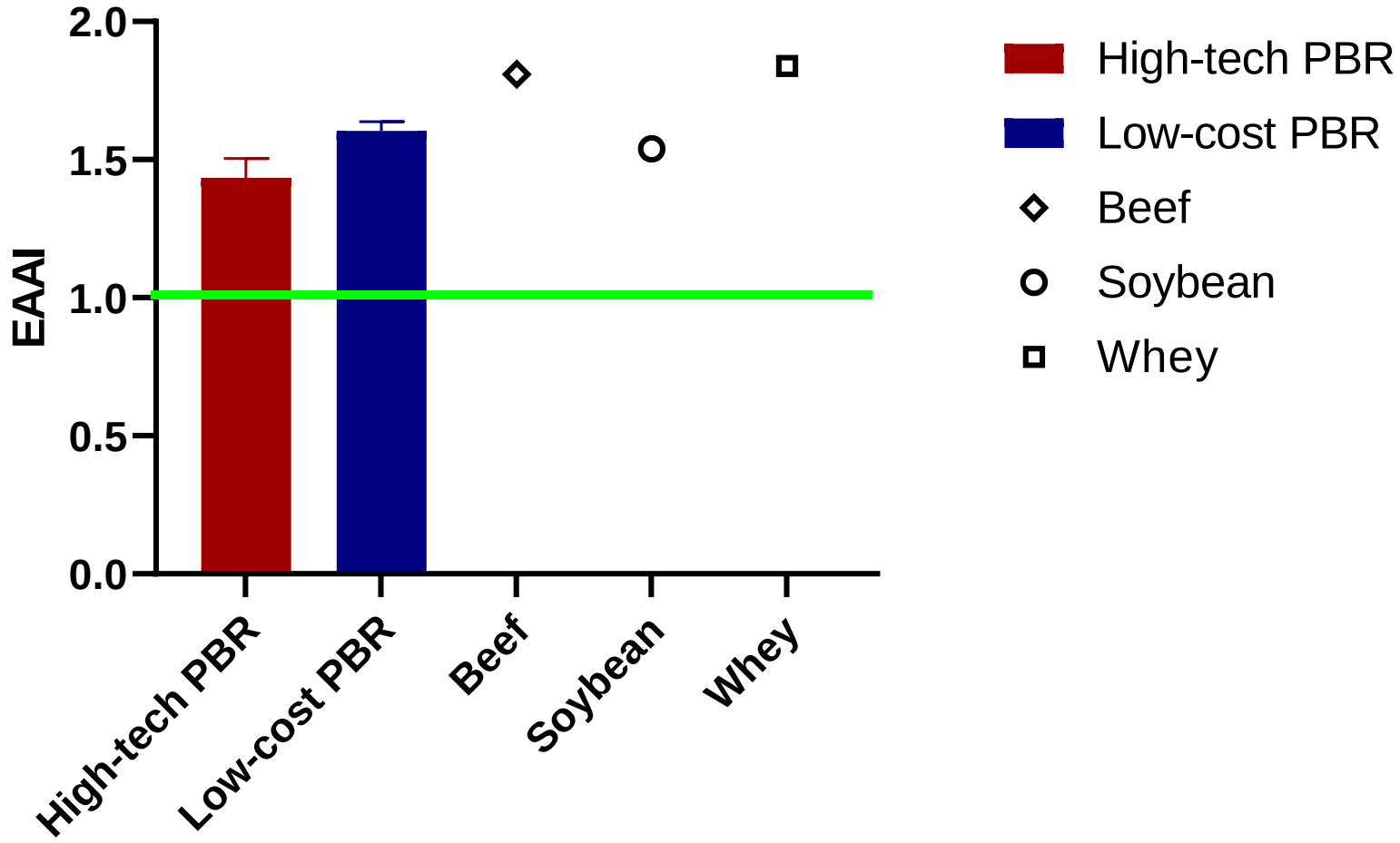

Take home message

- Development of purple bacteria production at bioindustrial scale should be subjected to optimisation
- Both OPEX and CAPEX should be reduced (2€/kg for OPEX and 7€/L for CAPEX)
- Design of Low-cost photobioreactor is feasible
- Proteins present in *Rhodospirillum rubrum* are comparable to those find in different protein rich aliment
- Proteins present in *Rhodospirillum rubrum* are recognised as « superior » quality