„Grün-weiße Biotechnologie“ – Nutzung von Grasschnitt in der Weißen Biotechnologie

Dirk Holtmann, Institut für Bio- und Lebensmitteltechnik

1. Grass clippings

- Growth medium - Terpenoids
- Enzymes
- Electrodes
- Outlook

2. Grassland

- Proteins

Municipal green waste as resource - Grass clippings

Large quantities available

- e.g. Berlin 120 000 t a^{-1}

Biomass waste from gardens and parks in Berlin: 12 700 t/a
Technical biomass potential of Berlin: 263 990 t/a

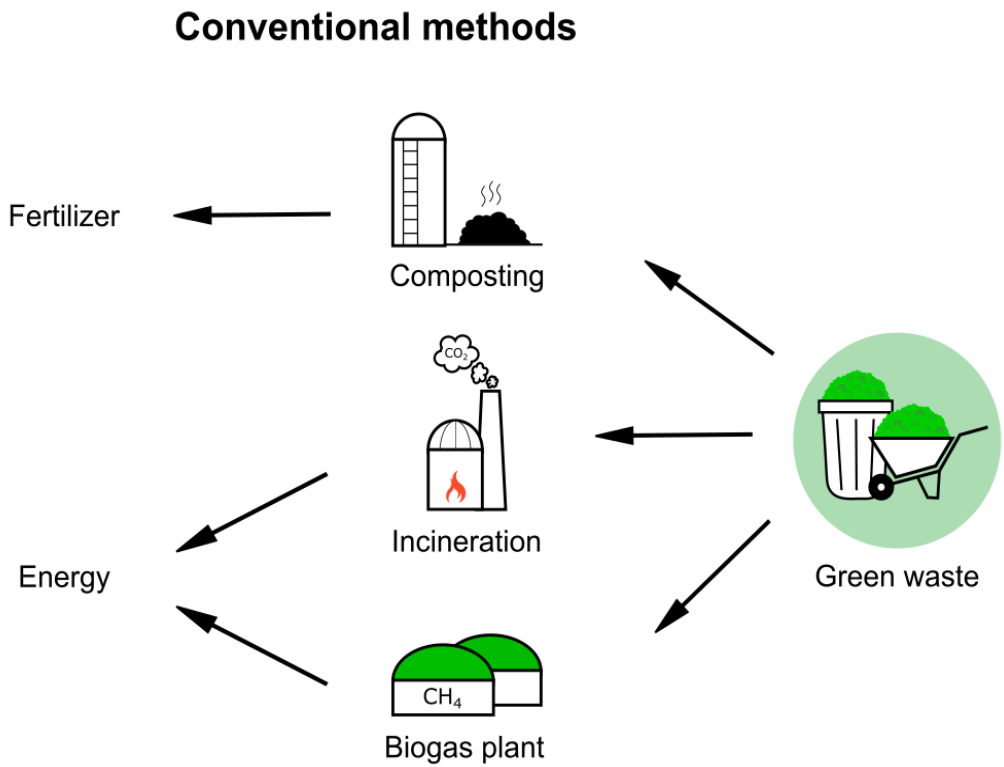
Grass clippings

Large quantities available
- ➢ e.g. Berlin 120 000 t a^{-1}

Current use
- ➢ Composting and subsequent use as fertilizer
- ➢ Biogas production

Overall, the use of grass clippings still costs significantly more than it generates

→ New conversion routes required



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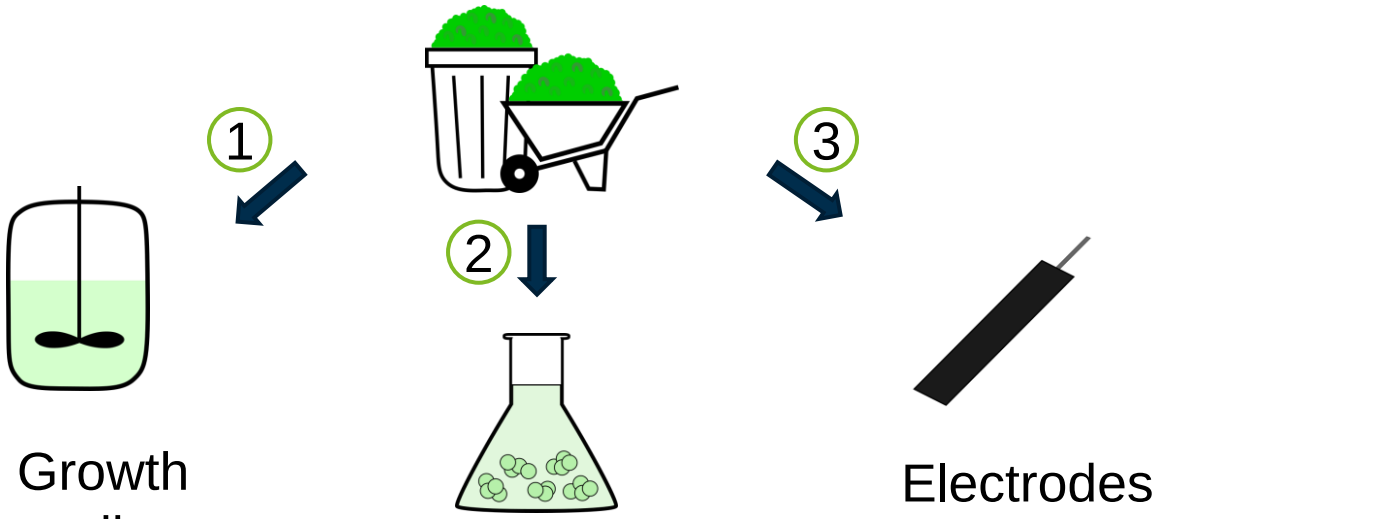
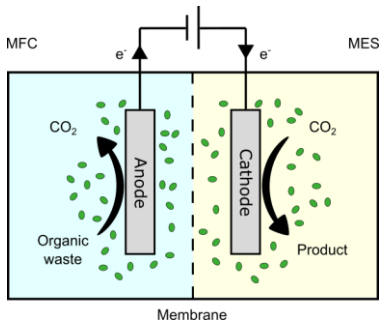
Our approach

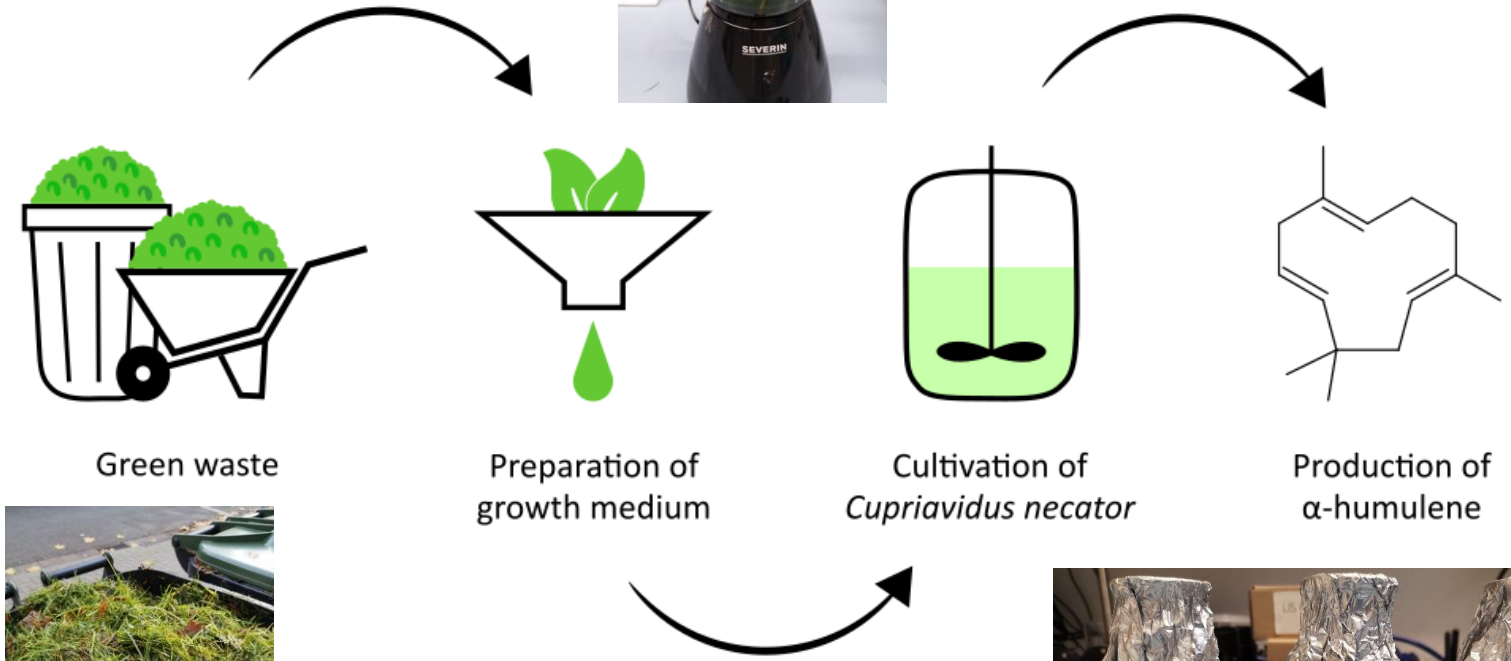


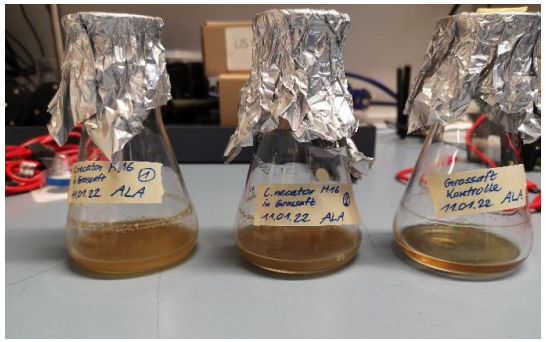
MFC



MES

Growth medium





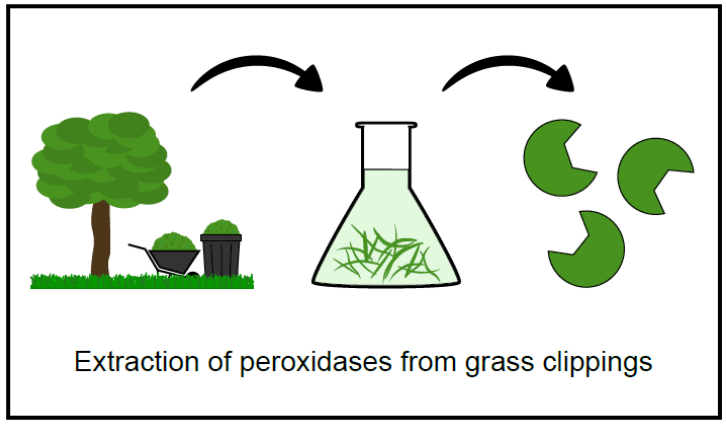
- Growth comparable to standard media without the need for further additives
- Broad applicability
- Reduced CO_2 footprint

10.3390/molecules27248684
10.1186/s40643-023-00663-2

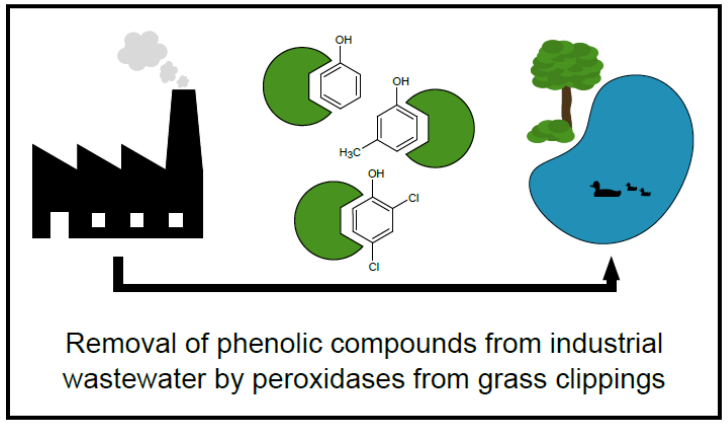
Broad applicability

Substrate	Product	Organism
extracted juice from mixed grass clippings	2 $mg_{\alpha\text{-humulene}} \cdot L^{-1}$ [1]	*Cupriavidus necator*
100% press juice from mixed grass cuttings without supplements	9.4 $g_{ethanol} \cdot L^{-1}$ 0.61 ± 0.03 $g_{ethanol} \cdot g_{sugar}^{-1}$ [2]	*S. cerevisiae*
100% press juice from mixed grass cuttings without supplements	16.93 $g_{lactic\ acid} \cdot L^{-1}$ 1.36 ± 0.04 $g_{lactic\ acid} \cdot g_{sugar}^{-1}$ [2]	*Lactobacillus delbrueckii* subsp. *lactis*
Mineral salt medium + 70% (v/v) press juice of mixed grass cuttings	19.18 $g_{itaconic\ acid} \cdot L^{-1}$ 0.51 $g_{itaconic\ acid} \cdot g_{glucose}^{-1}$ [2]	*U. maydis* MB215 ΔCyp3 P_{etef}Ria1
Mineral salt medium + 40% (v/v) enzymatic hydrolysate of mixed wood chips after organosolv pretreatment	17.2 $g_{itaconic\ acid} \cdot L^{-1}$ 0.40$g_{itaconic\ acid} \cdot g_{glucose}^{-1}$ [2]	*U. maydis* MB215 ΔCyp3 P_{etef}Ria1
mineral salt medium + 30% (v/v) enzymatic hydrolysate of mixed wood chips after organosolv pretreatment	15.5 $g_{ABE} \cdot L^{-1}$ 0.31 ± 0.01 $g_{ABE} \cdot g_{glucose}^{-1}$ [2]	*C. acetobutylicum*

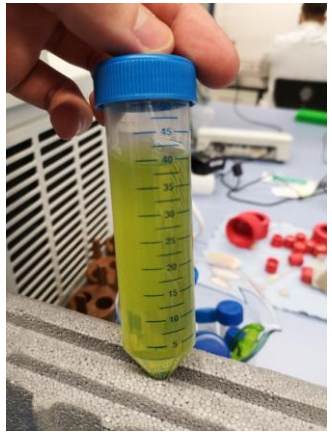
Enzyme extraction

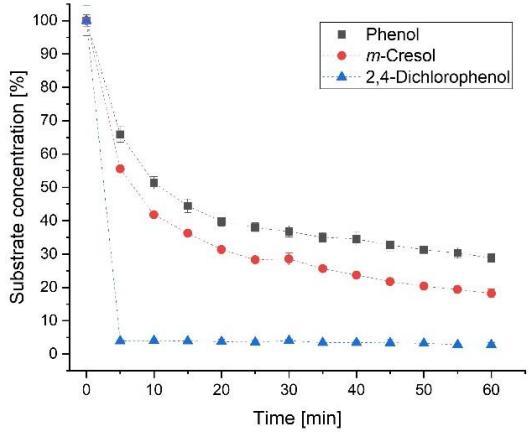


Extraction of peroxidases from grass clippings



Removal of phenolic compounds from industrial wastewater by peroxidases from grass clippings

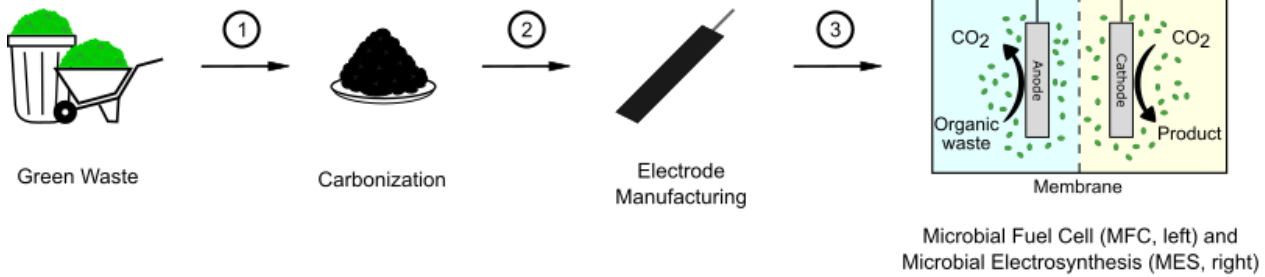




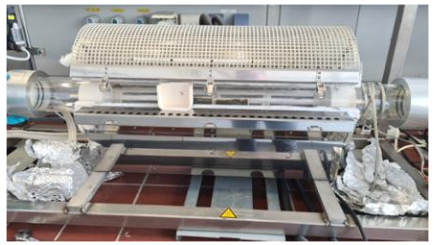
- Novel source of enzymes
- Easy purification and application
- Applications in environmental science and biocatalysis

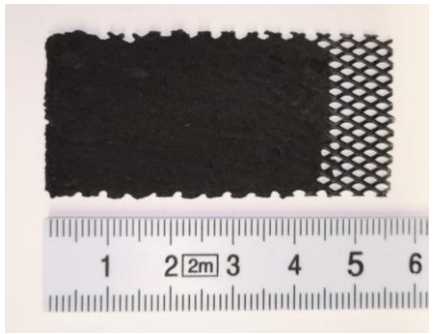
10.1016/j.biteb.2023.101471

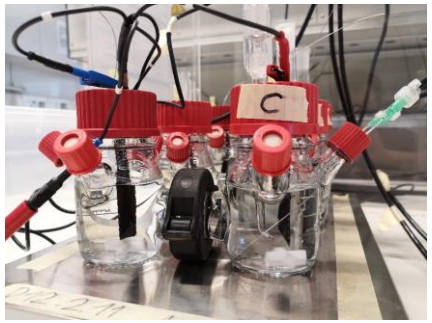
Electrodes



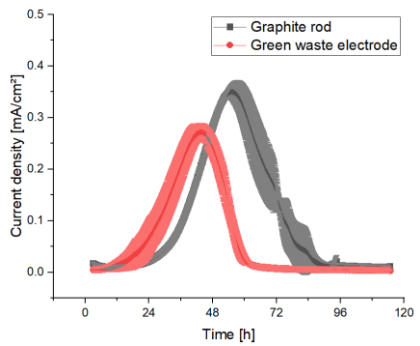
Microbial Fuel Cell (MFC, left) and Microbial Electrosynthesis (MES, right)

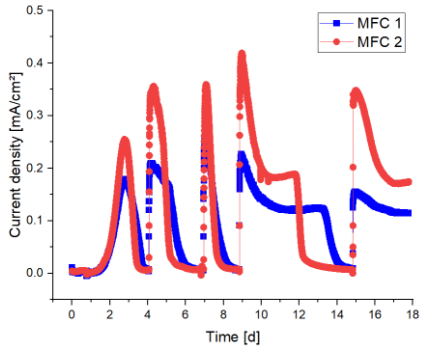






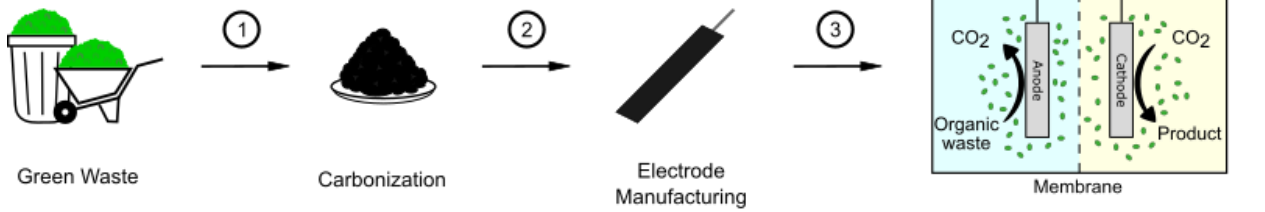
- Sustainable electrodes
- Long-term stable electrodes
- Performance comparable to established electrodes





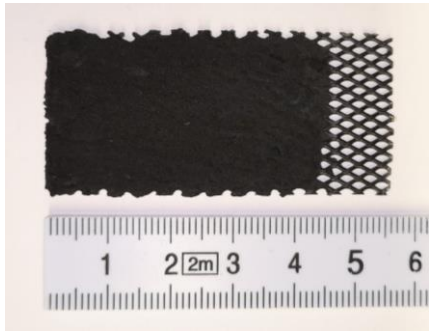
10.1016/j.clce.2024.100118

Electrodes

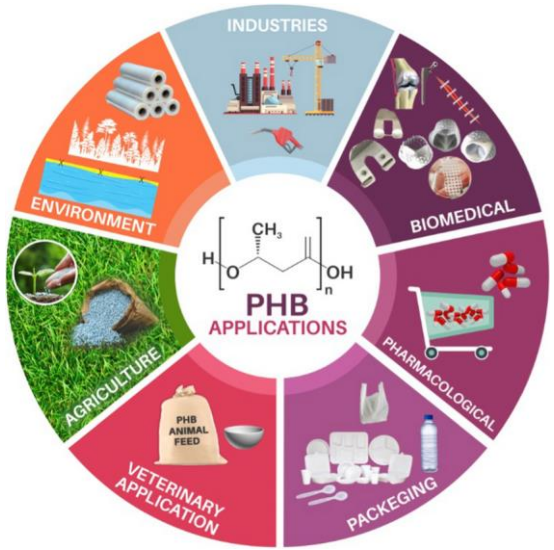


Microbial Fuel Cell (MFC, left) and Microbial Electrosynthesis (MES, right)

- Coupling with CO_2 utilization
- Production of bioplastic

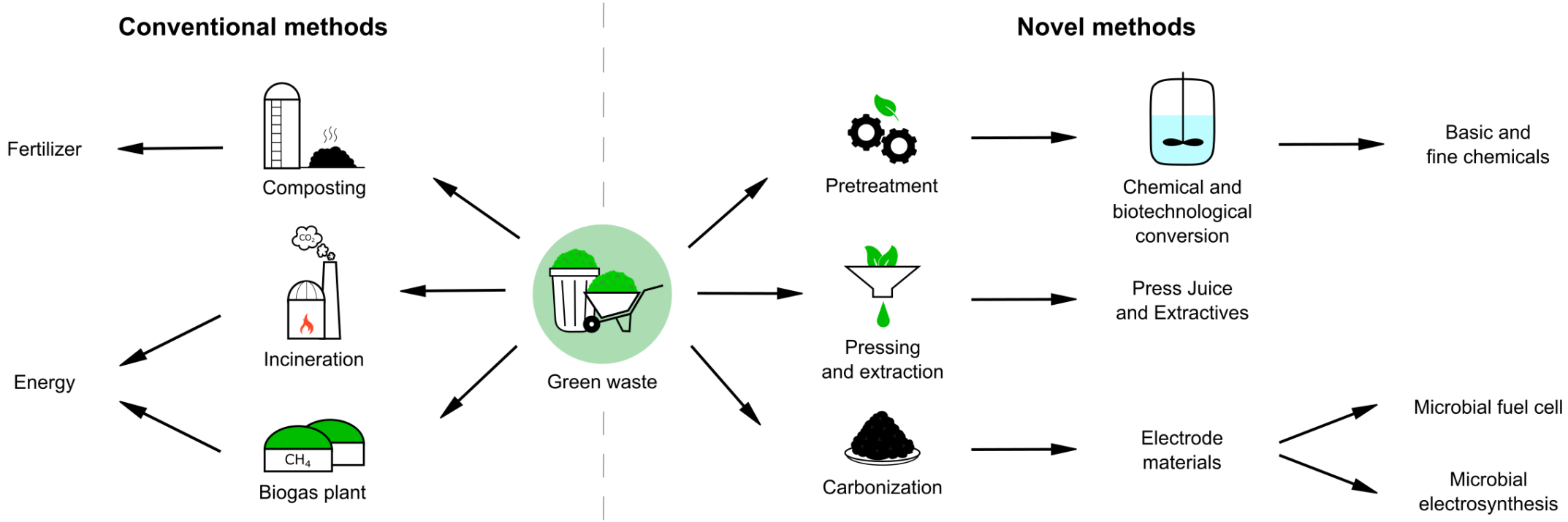


mainova



10.1016/j.jcou.2024.102800

Successful development of new conversion routes



Routes can be integrated!

From lab to innovation

Green Green ➡ Green scale

TRL 3 (proof of functionality of a technology) ➡ TRL 5 (test setup in an operational environment) / TRL 6 (prototype in an operational environment)

Outlook

Green scale

- Scale-up of processes

Outlook

- Scale-up of processes
- Development of logistics concepts/ decentralized bio-economy concepts
  Broadening the feedstock base





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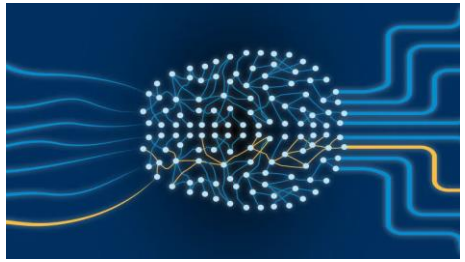
Outlook

- Scale-up of processes
- Development of logistics concepts/ decentralized bio-economy concepts
  Broadening the feedstock base
- Paradigm shift by robust processes
  - one substrate → products to many substrates → products



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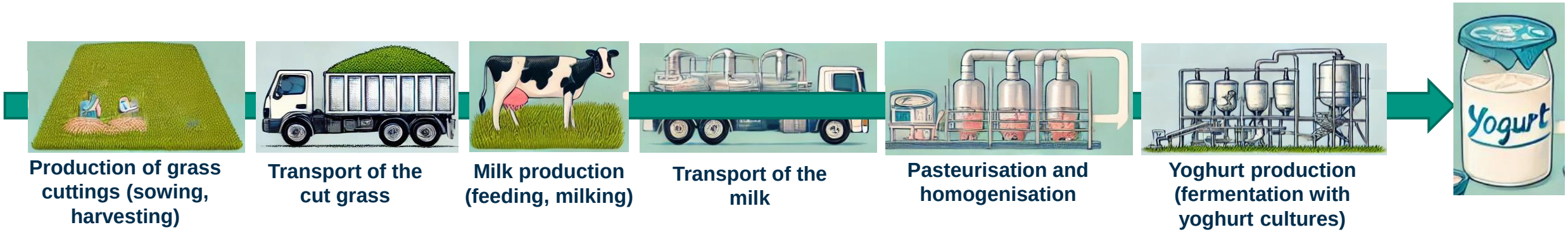
Alternative sources of protein are needed in order to feed the world's population

Source: Canva (raw material overview of plant-based alternative products)

Source: Canva (alpine upland with cows)

Protein production based on grassland



Production of grass cuttings (sowing, harvesting)

Transport of the cut grass

Milk production (feeding, milking)

Transport of the milk

Pasteurisation and homogenisation

Yoghurt production (fermentation with yoghurt cultures)

"Green" starting materials enable "green" processes in white biotechnology

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