

Production of ester cocktails through the coupling of biological and chemical processes valorizing residual biomasses

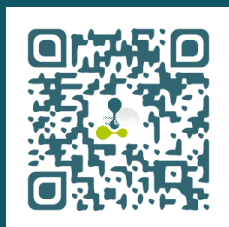


Biobased
molecules

 FRACTIONATION & BIOREFINERY
SYNTHONS & FUNCTIONALIZATION

 Pretreatment – Flow separation –
Coproduct management –
Functionalization

COCKESTER



> Participating units



> Contacts

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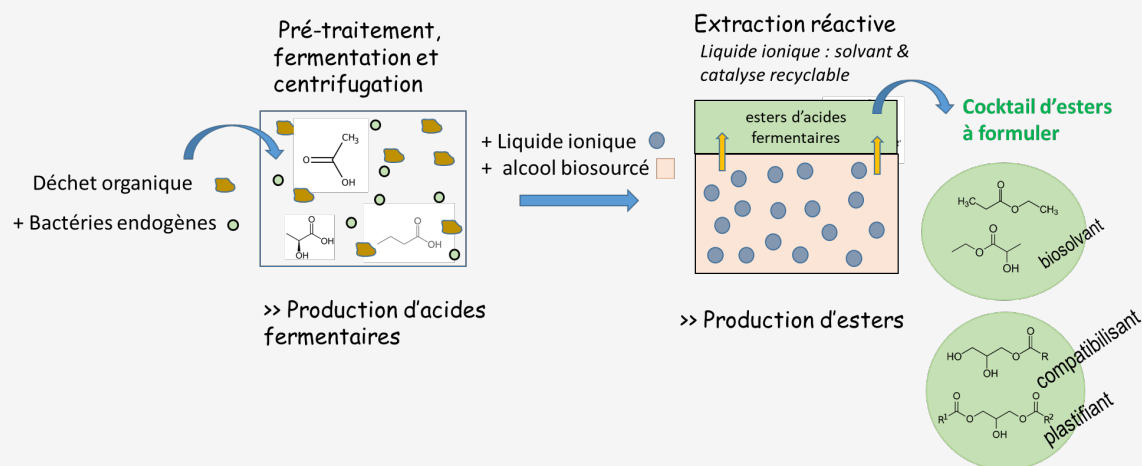
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Context

In the context of the transition towards a circular and low-carbon bioeconomy, the flavors, fragrances, and green solvents industries are seeking sustainable alternatives to petrochemical-based molecules.

The COCKESTER project, carried out within the 3BCAR network (AAP 2022), fits into this dynamic. It aims to valorize agricultural by-products, particularly beet pulp residues, through an innovative strategy combining acidogenic fermentation followed by an eco-designed chemical transformation into biosourced esters with aromatic properties.

Graphical abstract



Project description / Results

The project combined two complementary approaches:

- Acidogenic fermentation of beet pulp residues (without inoculum or sterilization) to produce volatile fatty acids (VFAs: acetic, butyric propionic acids).
- Reactive extraction and esterification of VFAs using biosourced alcohols (C4, C5, C6, C12) in the presence of a recyclable catalyst (ionic liquid or macroporous resin).

Key results:

- High conversion yields: 75 to 98%, depending on alcohol type and conditions.
- Recyclable catalyst (2 cycles, with limited yield loss of 5%).
- Production of ester cocktails (C4, C5, C6, C12) with differentiated aromatic profiles.
- First demonstration in the literature of an extraction/reaction coupling directly applied to a fermentation medium.
- Green chemistry compliant process: energy saving, atom economy, absence of organic solvents, recyclable catalysis.

Scientific and technological outcomes

- Demonstration that a complex fermentation medium can be directly valorized into esters via an intensified extraction/reaction process.
- Development of a novel integrated process coupling fermentation and esterification, with a strong focus on process intensification.
- Optimization of GC-FID analysis methods for quantifying VFAs and esters in complex matrices.
- Exploration of in situ alcohol phase addition into the fermentation reactor, paving the way for new integrated biorefinery concepts.





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Advantages

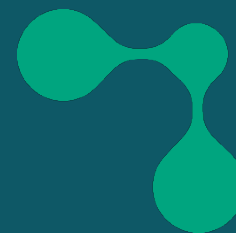
- 100% biosourced: esters produced from agricultural by-products and biosourced alcohols.
- Eco-designed process: intensified steps, recyclable catalysis, energy efficiency, waste minimization.
- Adaptability: several alcohols tested (C4 to C12), enabling tailoring of aromatic profiles.
- Residue valorization without heavy pretreatment: beet pulp fermented without sterilization, inoculation, or chemical pretreatment.
- Biological / chemical synergy: combining fermentation and green chemistry.
- Transferability: robust and simple process, transposable to other agricultural residues.

Potential applications

The biosourced ester cocktails produced show interesting aromatic properties for several markets:

- Flavors & fragrances industry: formulation of new natural olfactory notes.
- Cosmetics: functional biosourced ingredients.
- Food industry: natural flavors for beverages and processed foods.
- Green chemistry: biosourced solvents and functional intermediates.

Each ester series (C4, C5, C6, C12) has distinct aromatic characteristics, enabling targeted market applications.



Transfer opportunities

Depending on the industrial partner's profile, several options are possible:

- Licensing of the process or its technological bricks (extraction/reaction coupling, recyclable catalysis, analytical methodology).
- R&D collaboration to adapt the process to other feedstocks or targeted esters.
- Technology / know-how transfer services (analytics, process intensification, extractive fermentation).
- Co-financing of a maturation / demonstration project to scale up to pilot level.

The process is mature enough to be transferred to stakeholders in flavors, cosmetics, or green chemistry, with a medium-term market potential.

Development stage / TRL

1 2 3 4 5 6 7 8 9

TRL 3–4: Proof of concept validated at laboratory scale, with first tests on real fermentation media.

Next step: TRL 5–6, through the development of a pilot demonstration unit integrating fermentation, extraction, and esterification in continuous mode.