Bioengineering for flexible biorefineries: which role and which required education competences ?

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ijpb

INRA SCIENCE & IMPACT

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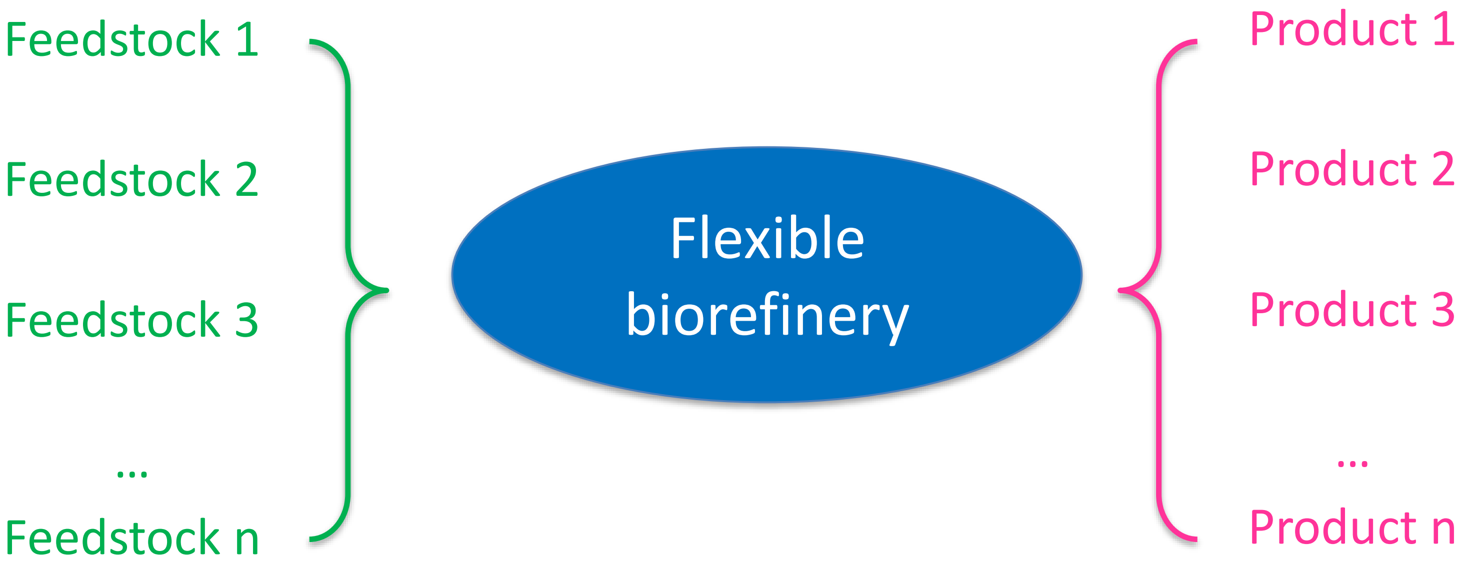
AgroParisTech

Outline

- Introduction : flexible biorefineries
- Cascade approach : example of Zelcor concept
- Education needs : example of Bioceb European EMJMD program

Flexible biorefineries: multi-feedstocks / multi-products



- Adaptation to market fluctuations
- Levelling and accomodation of biomass variability
- Feedstock supply securisation
- Wastes valorisation

Flexible biorefineries: European support

"A new flexible biorefinery will bridge the gap between agricultural and chemical industries, providing a stream for various biomass feedstock and producing a menu of finished green chemical products,"
(FP7 EuroBioRef project coordinator Franck Dumeignil, 2014).

Apr 19, 2016

Flexible biorefining technologies able to handle different feedstock, leading to new value chains or enlarging existing ones by using the same processing plant

ID: BBI-2016-R04

Type of action:

- BBI-RIA Bio-based Industries Research and Innovation action

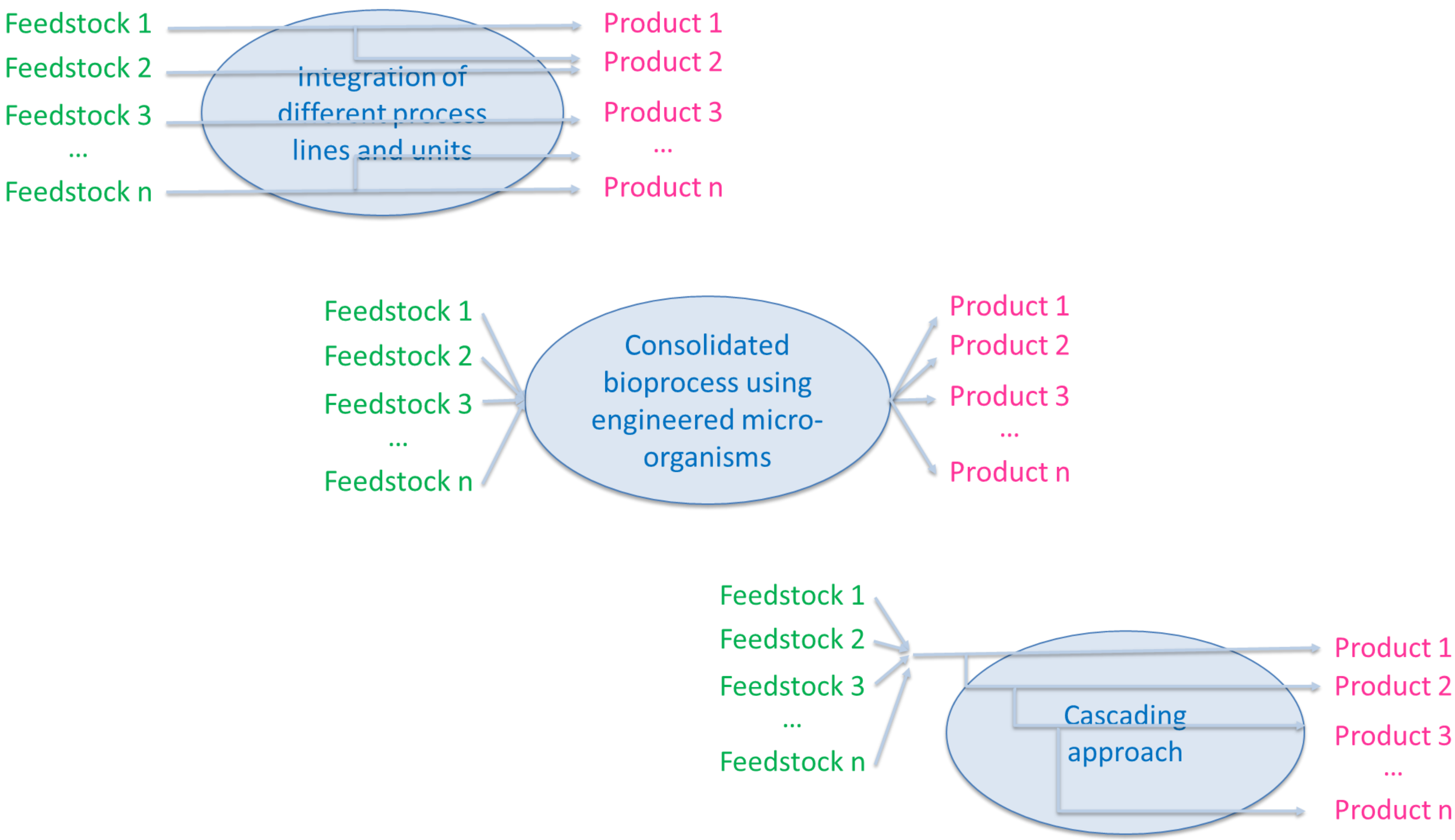
Deadline Model : single-stage

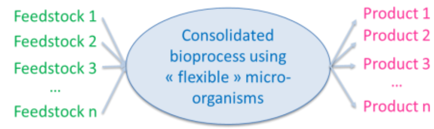
Opening: **19 April 2016**

Deadline: **08 September 2016 17:00:00 Brussels time**

Closed

Different strategies



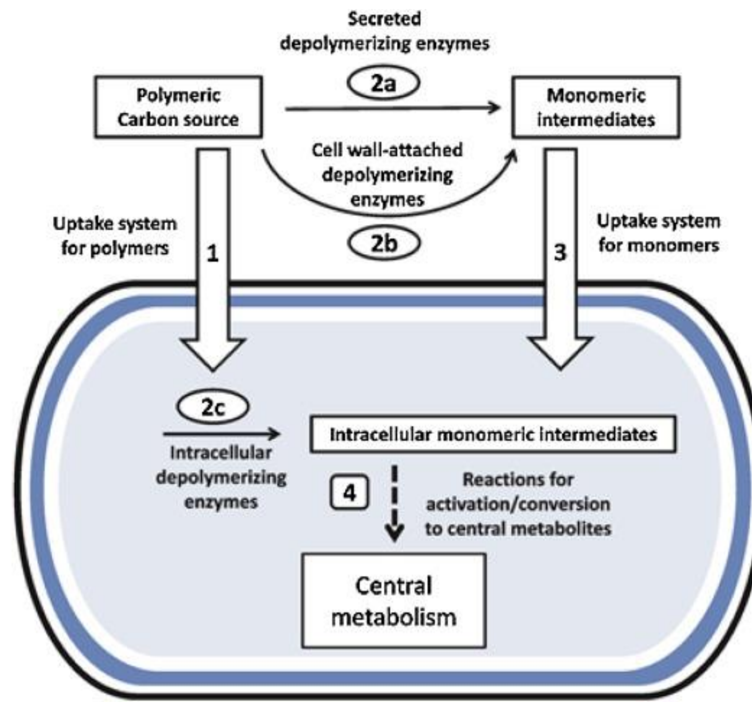


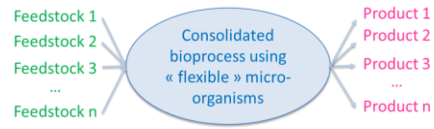
Use of « flexible » micro-organisms

- *Metabolic engineering of Escherichia coli, Corynebacterium glutamicum, Pseudomonas, Bacillus* and yeast strains → use of alternative carbon sources *(Wendisch et al., J Biotechnol, 2016)*

Cellulose
Starch
Chitin
Algal biomass
Glycerol
Organic acids
...

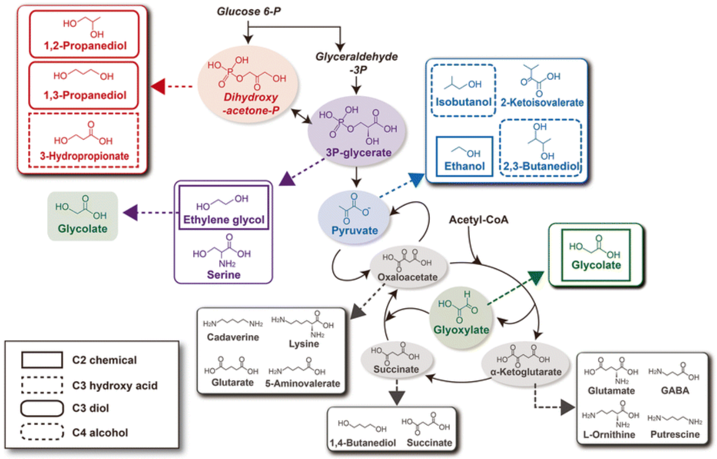
} Carbone sources

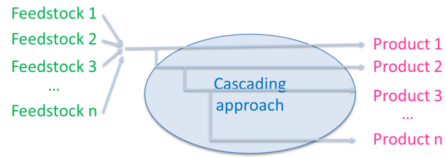




Use of « flexible » micro-organisms

- *Ex. Corynebacterium glutamicum* = non-pathogenic industrial bacterium species *(Baritugo et al., Appl Microbiol Biotechnol, 2018)*
  - Flexible metabolism allowing the use of a broad spectrum of carbon sources and the prodution of various amino acids
  - Classical breeding, synthetic biology, metabolic engineering → production of value-added platform chemicals (C2 chemicals, C3 hydroxyacids, C3 diols, C4 alcohols, …)





Cascade approach: example of Zelcor concept

- Zelcor objective:

  Demonstrate the feasibility of transforming lignocellulose recalcitrant side streams into high added-value bio-based products

Residues from cellulosic ethanol production

Technical lignins from pulping processes

Lignin-like humins formed by sugar conversion

Combining chemical and enzymatic catalysis with insect-based bioconversion

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program under grant agreement No 720303

Zelcor in brief

- Research & Innovation BBI JU Project (2016-20, 5 M€ from EU)
- Topic: Value chain 1 R1: BBI.VC1.R1 Conversion of lignin rich-reach streams from biorefineries
- Project: « Zero waste ligno-cellulosic biorefineries by integrated lignin valorisation»
- Coordinator: INRA (S. Baumberger)
- 16 partners from 7 countries

7 public:	7 SME:	2 companies:
INRA, INRA T	Ardilla,	Tereos
UPEC	Arterra,	Sabic
Univ. Warwick	Avantium,	
WUR	Biome,	
Aalto	Ynsect,	
Ineris	Nova, Quantis	

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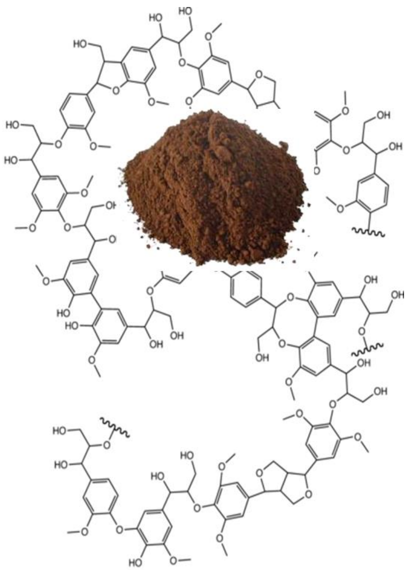
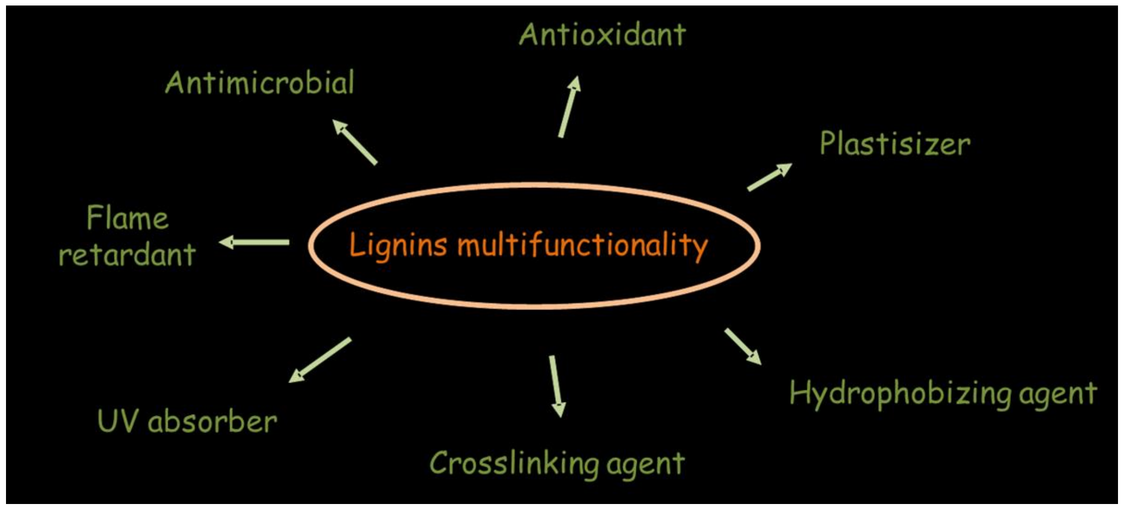
Why fractionating lignins ?

- Lignins = multifunctional bioproducts ↔ existing markets



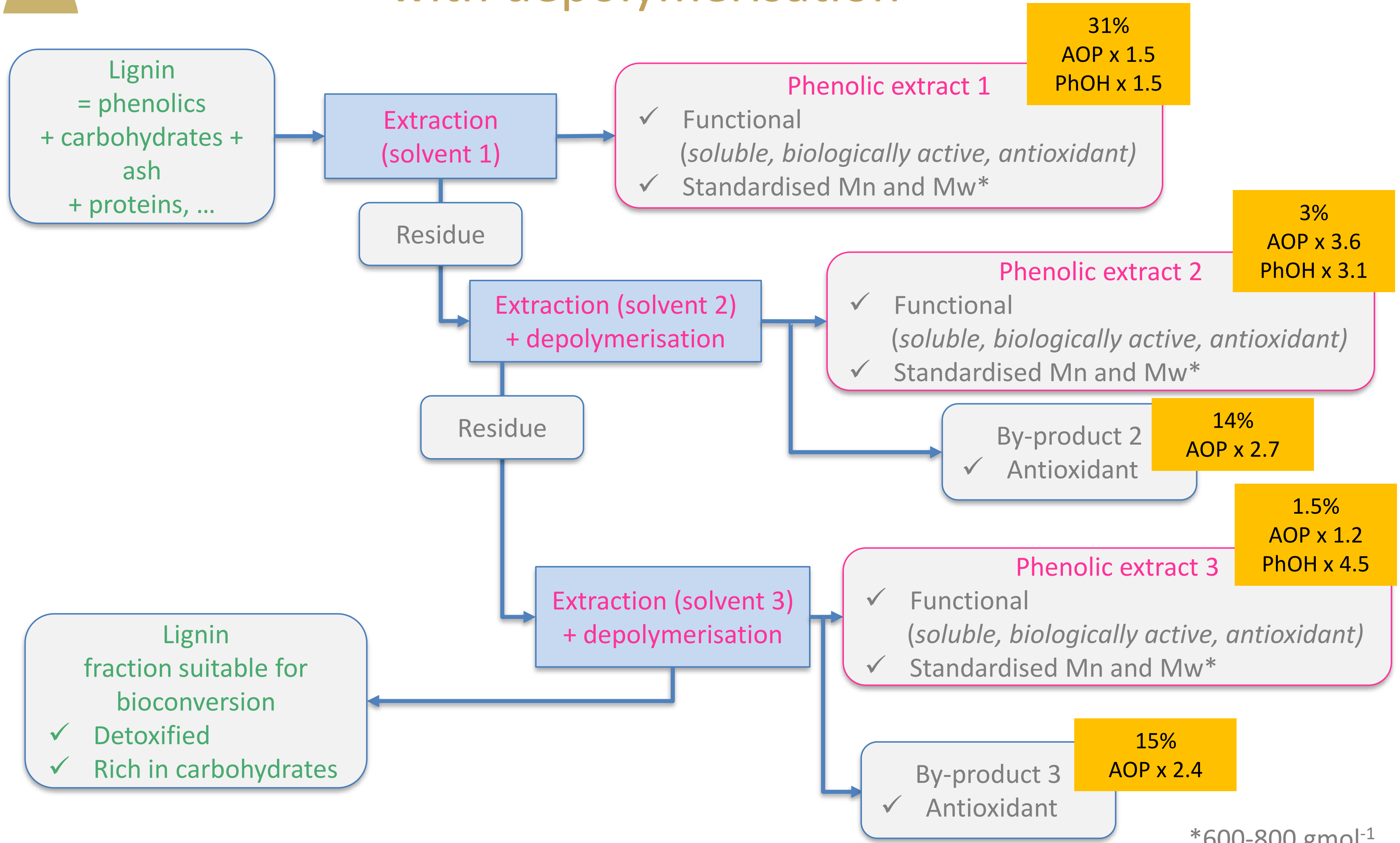


« Lignin is a renewable, non-toxic, commercially available and low costing resource which has the potential of being utilized as a basic raw material for the chemical industry. In spite of many years of development effort however, **this potential has not been fully realized**. One of the many reasons …is the fact that the technical processes by which lignin is obtained, … reduce its reactivity » *(Feldman et al 1986)*

However

- Low solubility
- Variability
- Heterogeneity

Interest of combining fractionation with depolymerisation



*600-800 $gmol^{-1}$

Interest of combining fractionation with depolymerisation

COVER PICTURE

A. Majira, B. Godon, L. Foulon, J. C. van der Putten, L. Cézard, M. Thierry, F. Pion, A. Bado-Nilles, P. Pandard, T. Jayabalan, V. Aguié-Béghin, P.-H. Ducrot, C. Lapierre, G. Marlair, R. J. A. Gosselink, S. Baumberger, B. Cottyn**

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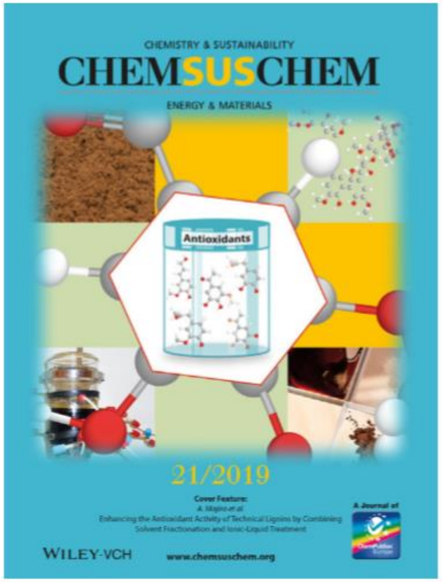
Enhancing the Antioxidant Activity of Technical Lignins by Combining Solvent Fractionation and Ionic-Liquid Treatment



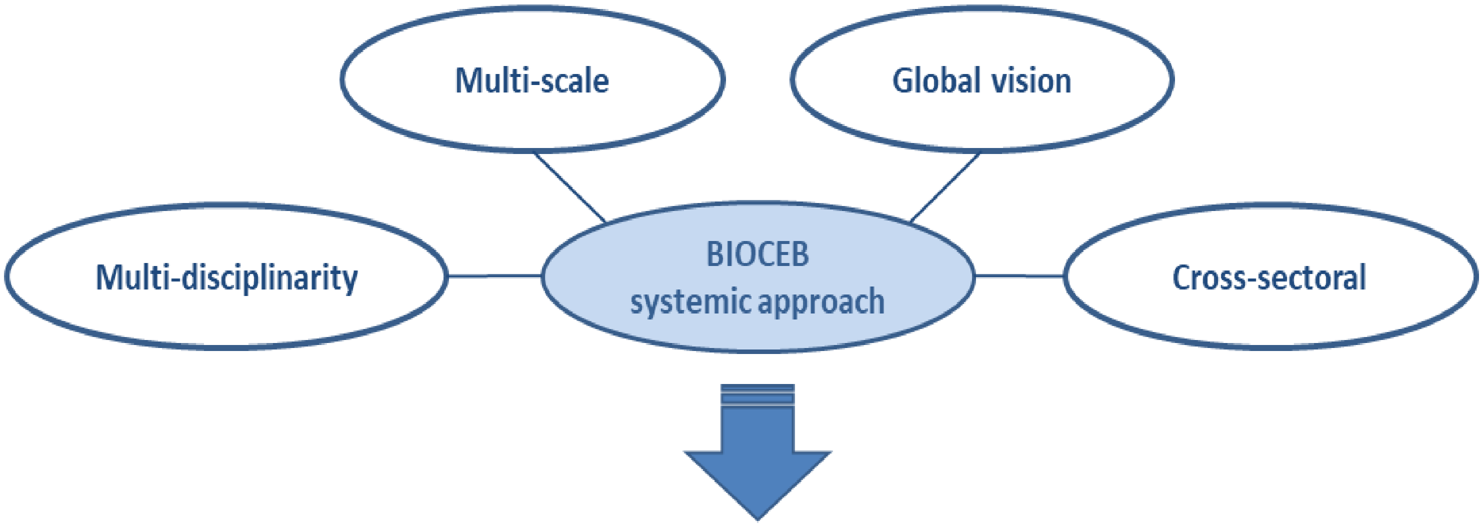
The Cover Feature shows a cascade biorefinery process for the upgrading of technical lignins and sustainable production of phenolic oligomers of interest as substitutes for commercial antioxidants. A grass soda technical lignin undergoes a process combining solvent fractionation and treatment with an ionic liquid, and a comprehensive investigation of the structural modifications is performed. More information can be found in the Full Paper by A. Majira et al.

Includes data and consideration relative to sustainability

Education needs: example of Bioceb European EMJMD program

Bioceb
European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy

« European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy »

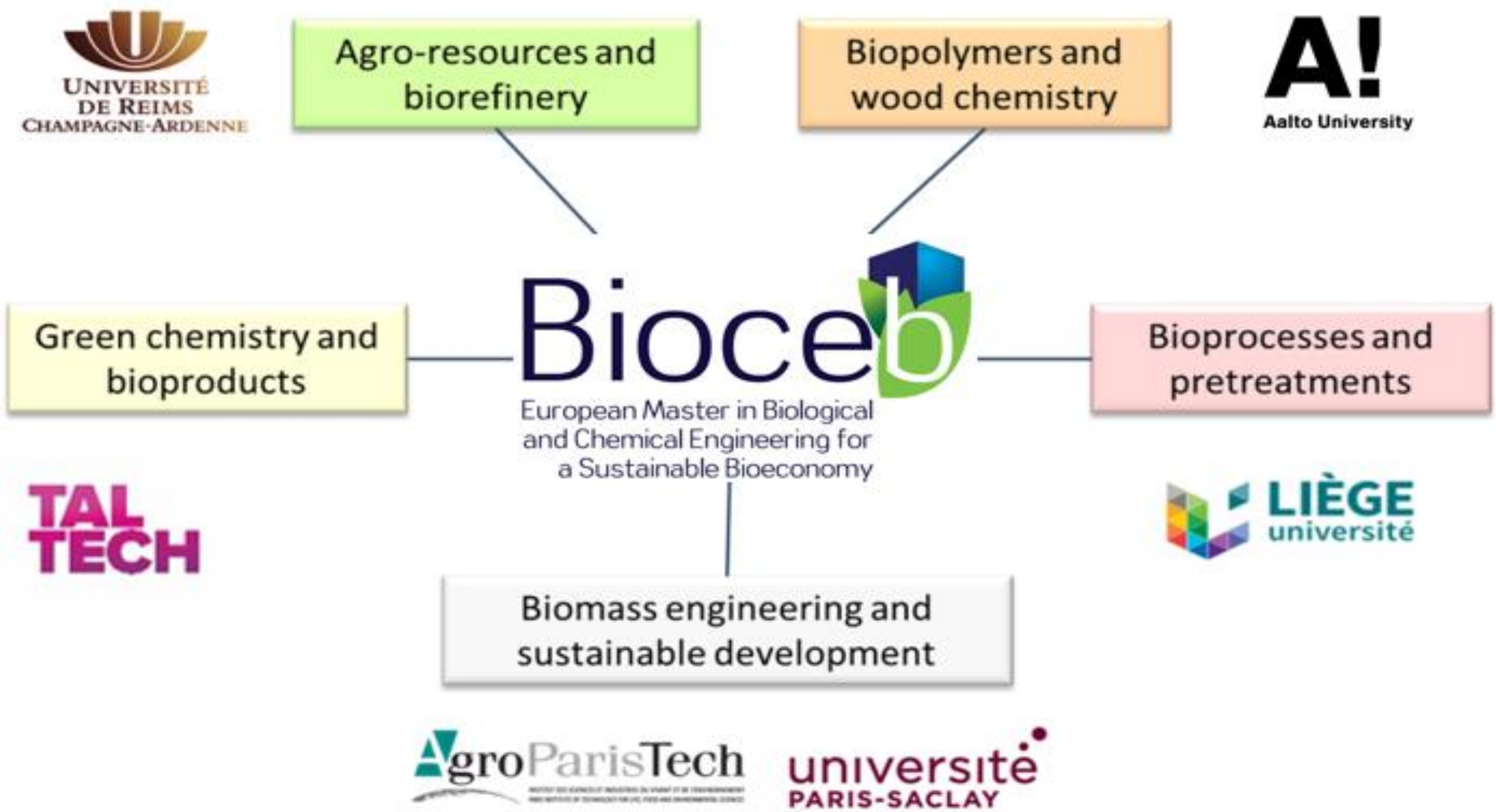


Adaptation to local context and socio-economic demand
&
Integration of global challenges

Education needs: example of Bioceb European EMJMD program

Bioceb
European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy

A consortium with complementary competences



Education needs: example of Bioceb European EMJMD program

Bioceb
European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy

A modular training programme

Induction week
S1 – Agro-sciences and biorefinery (URCA)

S2 – Option 1 (TalTech)
Bioproducts & sustainable chemistry

S2 – Option 2 (AgroParisTech)
Agro-resources & value-chain assessment

Intersectorial joint summer school (TalTech)

S3 – Option 1
(AgroParisTech)
Biomass engineering

S3 – Option 2
(ULiège)
Bioprocesses

S3 – Option 3
(Aalto)
Materials & biopolymers

GREEN LINE PROJECT

S4 – MSc Thesis via internship at international scale (EU or non-EU)

Joint graduation & dissemination event at URCA during induction week
Inter-cohorts (and alumni) meeting

Track 1	Track 2	Track 3	Track 4	Track 5
Université de Reims Champagne-Ardenne	Université de Reims Champagne-Ardenne	Université de Reims Champagne-Ardenne	Université de Reims Champagne-Ardenne	Université de Reims Champagne-Ardenne
TalTech	TalTech	TalTech	AgroParisTech	AgroParisTech
AgroParisTech	Liège université	A! Aalto University	Liège université	A! Aalto University

Education needs: example of Bioceb European EMJMD program

Bioceb
European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy

5 possible tracks related to targeted profesional activities

Modular Track	Targeted scientific and management activities
Track 1: Bioproducts, green chemistry, biomass engineering	Production of tailored plants and microorganisms to increase the sustainability of the value chains (adaptation of plant to climate change, preservation of biodiversity and food resources, etc.)
Track 2: Bioproducts, green chemistry, bioprocesses	Design, optimization and up-scaling of processes for the production of bio-based molecules, combining fermentation and chemistry and taking into account the principle of green chemistry (in particular waste reduction)
Track 3: Bioproducts, green chemistry, materials, polymers	Design and development of bioproducts and biomaterials in particular biodegradable materials, and exploiting the diversity of new structures
Track 4: Agro-resources, value-chain assessment, bioprocesses	Design of new sustainable value chains and processes involving flexible multi-resources and multi-products biorefineries
Track 5: Agro-resources, value-chain assessment, materials, polymers	Design of new sustainable value chains and products for bio-based materials, to substitute fossil-based solutions and create new products

Acknowledgements

- Zelcor and Bioceb projects consortium
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