

Biomass processing for Industrial Biotechnological Applications

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OUTLINE



✓ INTRODUCTION

- ✓ SUSTAINABLE GROWTH: TOWARDS A BIOECONOMY
- ✓ LIGNOCELLULOSIC BIOREFINERIES
- ✓ ENVIROMENTALLY FRIENDLY PRETREATMENTS: AUTOHYDROLYSIS
- ✓ CHALLENGES OF BIOETHANOL FROM LIGNOCELLULOSIC MATERIALS

✓ OUR INTEGRATED APPROACH FOR 2ND GENERATION BIOETHANOL PRODUCTION

- ✓ MAIN RESEARCH LINES ON LIGNOCELLULOSIC BIOREFINERY
- ✓ INTEGRAL VALORIZATION OF VINE PRUNING RESIDUE BY SEQUENTIAL AUTOHYDROLYSIS STAGES
- ✓ BOOSTING ETHANOL PRODUCTION FROM EUCALYPTUS WOOD BY CHEESE WHEY INCORPORATION

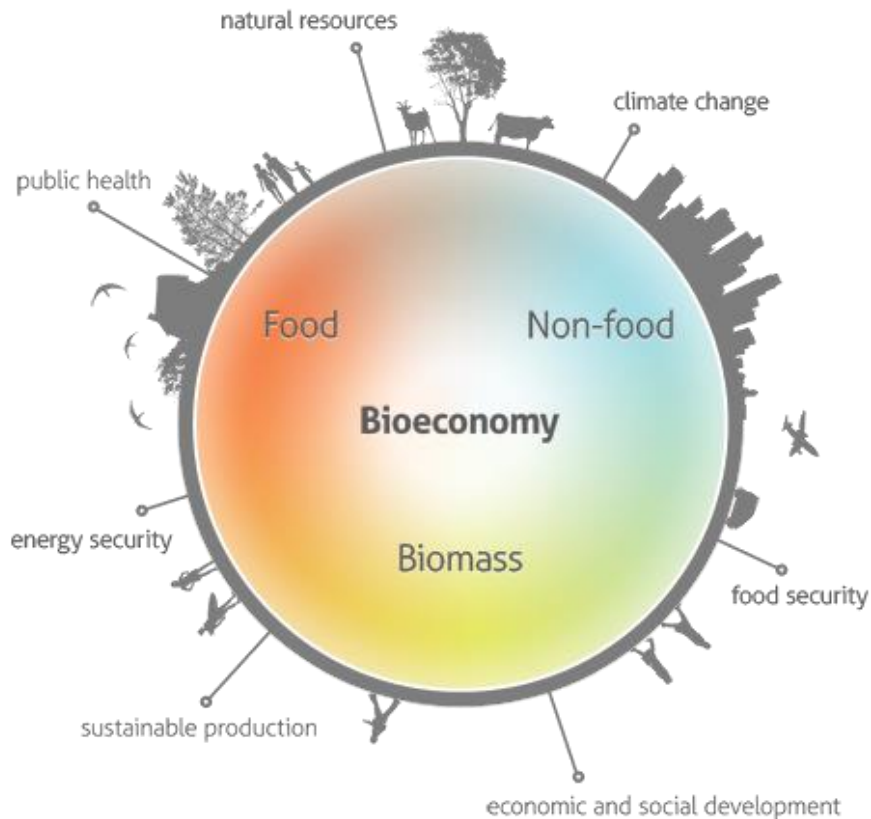


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HOW CAN WE ACHIEVE A SUSTAINABLE GROWTH OF OUR SOCIETY?



SUSTAINABLE GROWTH BASED ON BIOECONOMY

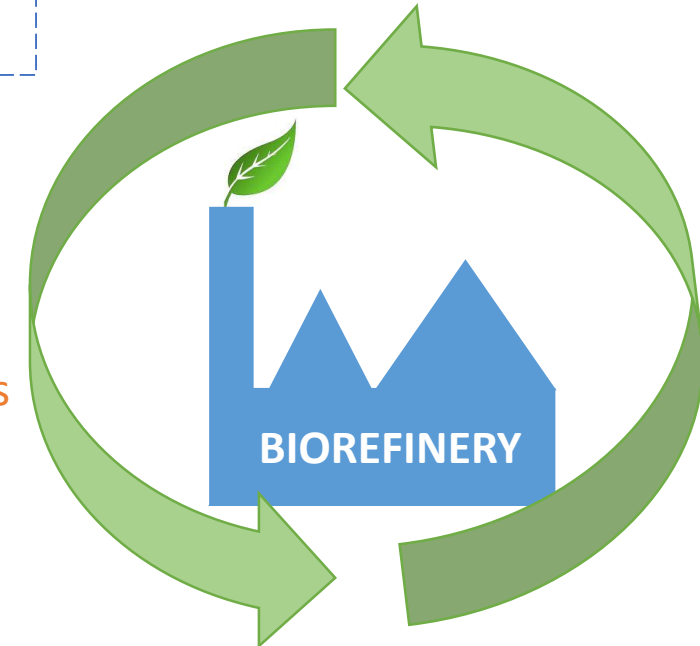


*Bioeconomy encompasses the **production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy** via innovative and efficient technologies, while growing new jobs and industries.*

MAIN DRIVING FORCES

development

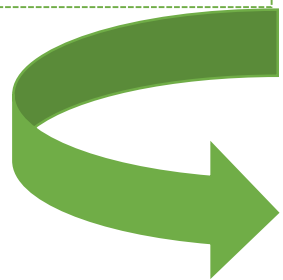
- ✓ Energy security
- ✓ Rural development
- ✓ Environmental concerns





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ALTERNATIVE RENEWABLE RAW MATERIALS



FEEDSTOCK

- **1st Generation: wheat, sugarcane, rice, oil**
- **2nd Generation: lignocellulosic biomass (Wood, non-food crops, forestry residues)**
- **3rd Generation: micro- and macro-algae**

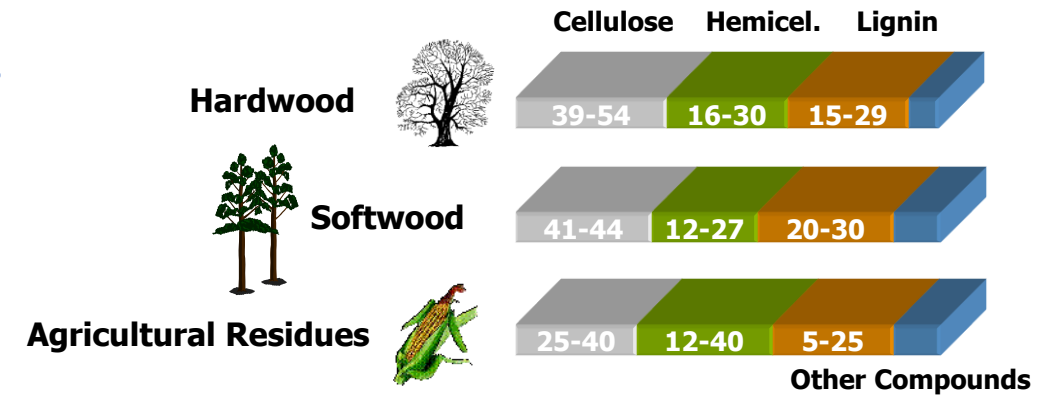
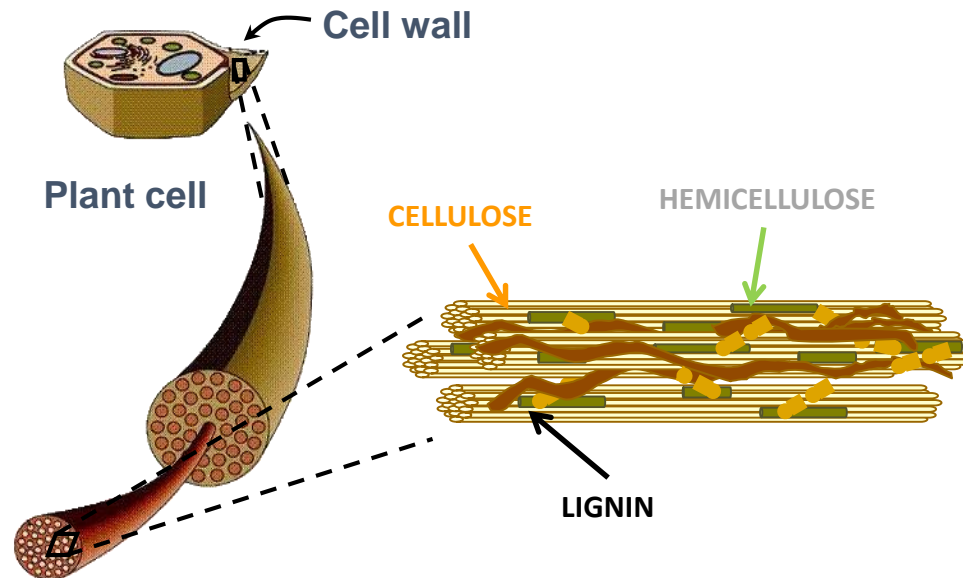


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2ND GENERATION FEEDSTOCK



Lignocellulosic materials are constituted mainly by polysaccharides
(cellulose and hemicelluloses) and lignin

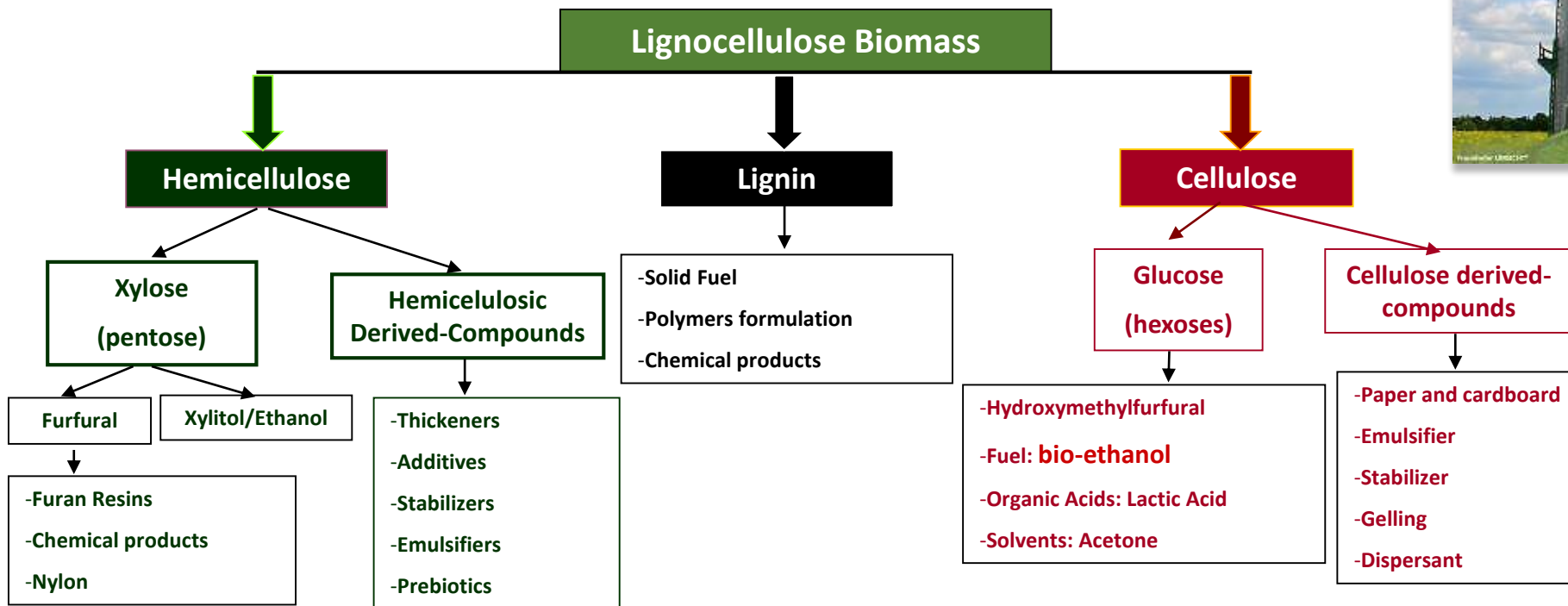


ADVANTAGES	
	<ul style="list-style-type: none">✓ Renewable✓ Largely available✓ Cheap✓ Widespread✓ Production : $2 \cdot 10^{11}$ Tons per year



LIGNOCELLULOSIC BIOREFINERY

«**LIGNOCELLULOSIC REFINERY**» concept: feedstock can be subjected to sequential treatments to obtain the desired fraction(s), almost untouched or as soluble reaction products, in separate streams





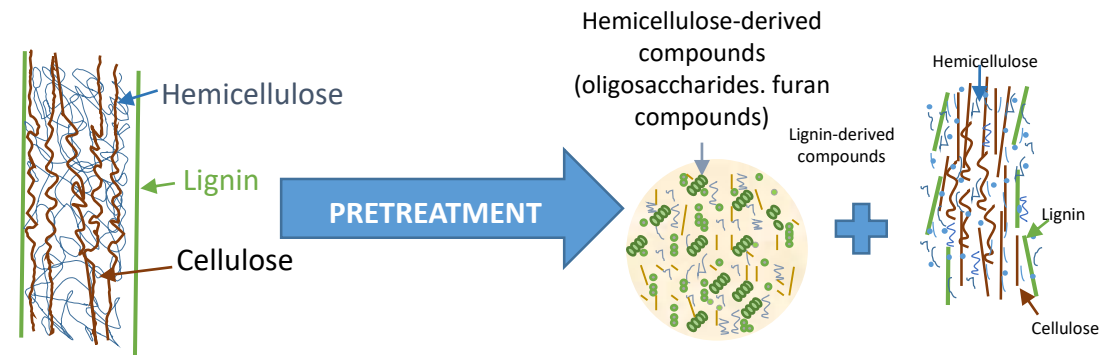
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PRETREATMENT: FIRST STEP IN A BIOREFINERY



IDEAL PRETREATMENT:

- ✓ Simple and economical operation
- ✓ Limited requirements of energy, process water and chemicals
- ✓ Limited corrosion
- ✓ Ability to alter the structure of Lignocellulosic biomass
- ✓ Selectivity towards polysaccharides losses
- ✓ High recovery of valuable hemicellulose-derived products
- ✓ Limited production of undesired degradation products
- ✓ Production of substrates with high cellulose content and susceptibility towards enzymatic hydrolysis
- ✓ Generation of high quality lignin or lignin-derived products
- ✓ Limited generation of wastes





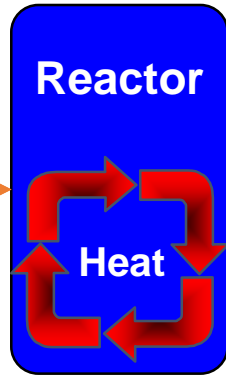
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PRETREATMENT: AUTOHYDROLYSIS



Lignocellulosic
Biomass

Water



Liquid phase

$$R_o = \int_0^t \exp\left(\frac{T(t) - T_{ref}}{\omega}\right) \cdot dt$$

Solid phase

Liquors containing oligosaccharides from
hemicellulose hydrolysis
And degradation compounds: F. HMF. Phenolic
compounds

Solid enriched in
cellulose and lignin

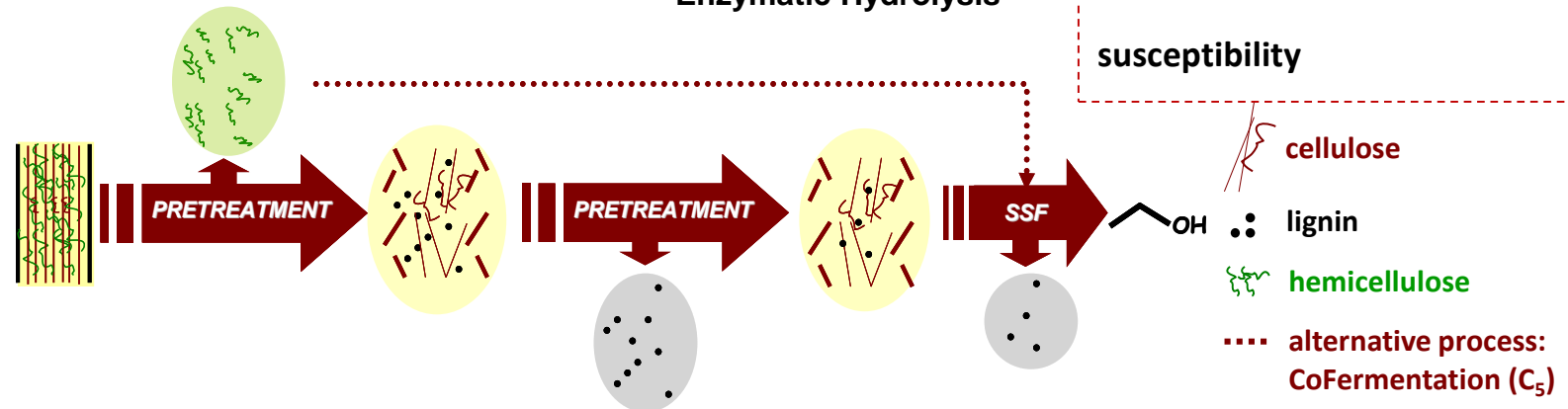
Enzymatic accessibility is
improved

Enzymatic Hydrolysis

Autohydrolysis Limitation → Difficult to
find an optimal condition for high
hemicellulose recovery and high enzymatic
susceptibility

Benefits:

- ✓ No corrosion
- ✓ No sludge
- ✓ No cellulose degradation
- ✓ Low capital and operational costs





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OUR APPROACH FOR 2ND GENERATION BIOETHANOL



Bioethanol from Lignocellulosic Materials

High production costs → bioethanol as transportation biofuel still prohibitively expensive

Advanced processing technologies

✓ Pretreatment

- ✓ High fractionation, high cellulose recovery, low inhibitor compounds, high solubilisation of Hemicellulose fraction

✓ Hydrolysis of cellulose and hemicellulose

- ✓ High solid loadings (15-25%) → high glucose concentration → ethanol 4 %

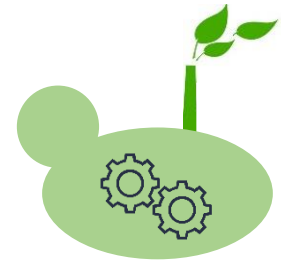
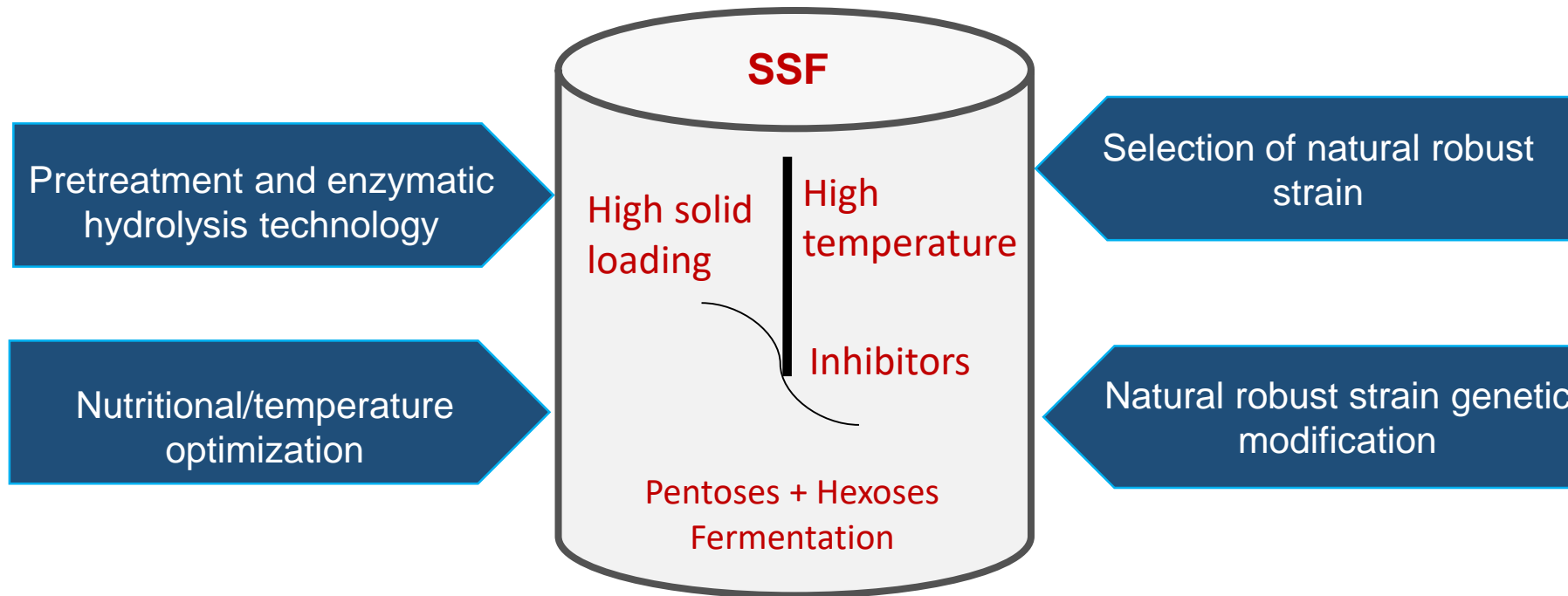
✓ New yeasts development for high productivity fermentations

- ✓ Selection of robust yeast strains → tolerance to high temperatures and inhibitor compounds
- ✓ Nutritional supplementation (low-cost nutrients/residues) → to increase the productivity
- ✓ Genetic engineering for improvement the yeast robustness/fermentation performance



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Integration and intensification of processes for biofuels and bioproducts from Lignocellulosic biomass





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Products
Xylooligosaccharides
Phenolic Compounds

Products

Integration and intensification of processes for biofuels and bioproducts from Lignocellulosic biomass



Raw Materials

Eucalyptus



Corn cob



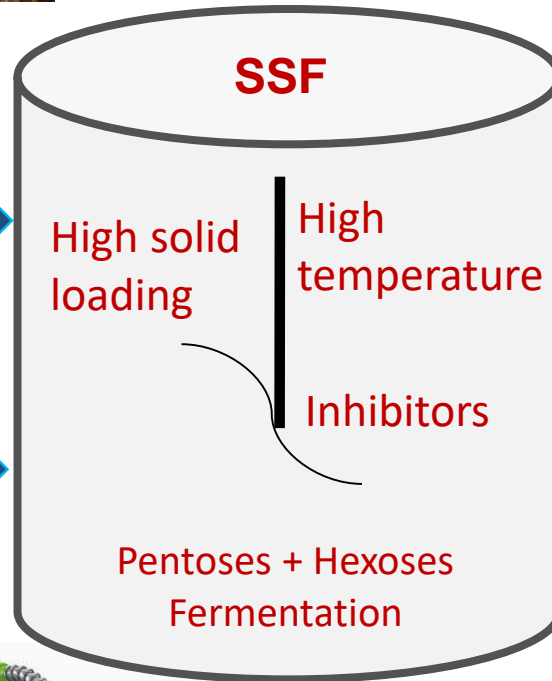
Paulownia



Wheat straw



Vine pruning residues

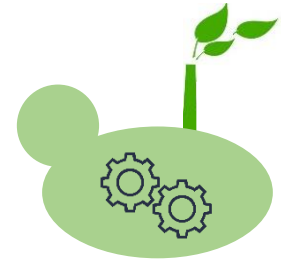


Pretreatment and enzymatic hydrolysis technology

Nutritional/temperature optimization

Selection of natural robust strain

Natural robust strain genetic modification



Products

Word cloud containing: Ethylene, Glucose, Propylene, Glycol, Starch, Cellulose, Lignin, Hemicellulose, Xylose, Mannitol, Sorbitol, and many others.



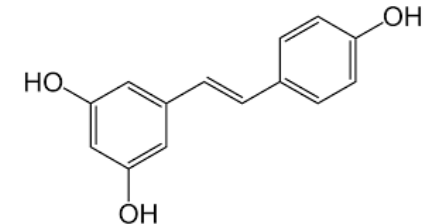
Bioethanol



Xyitol



Furan derivatives



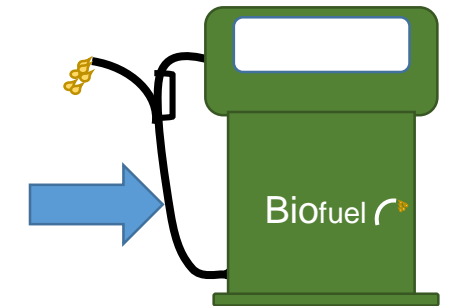
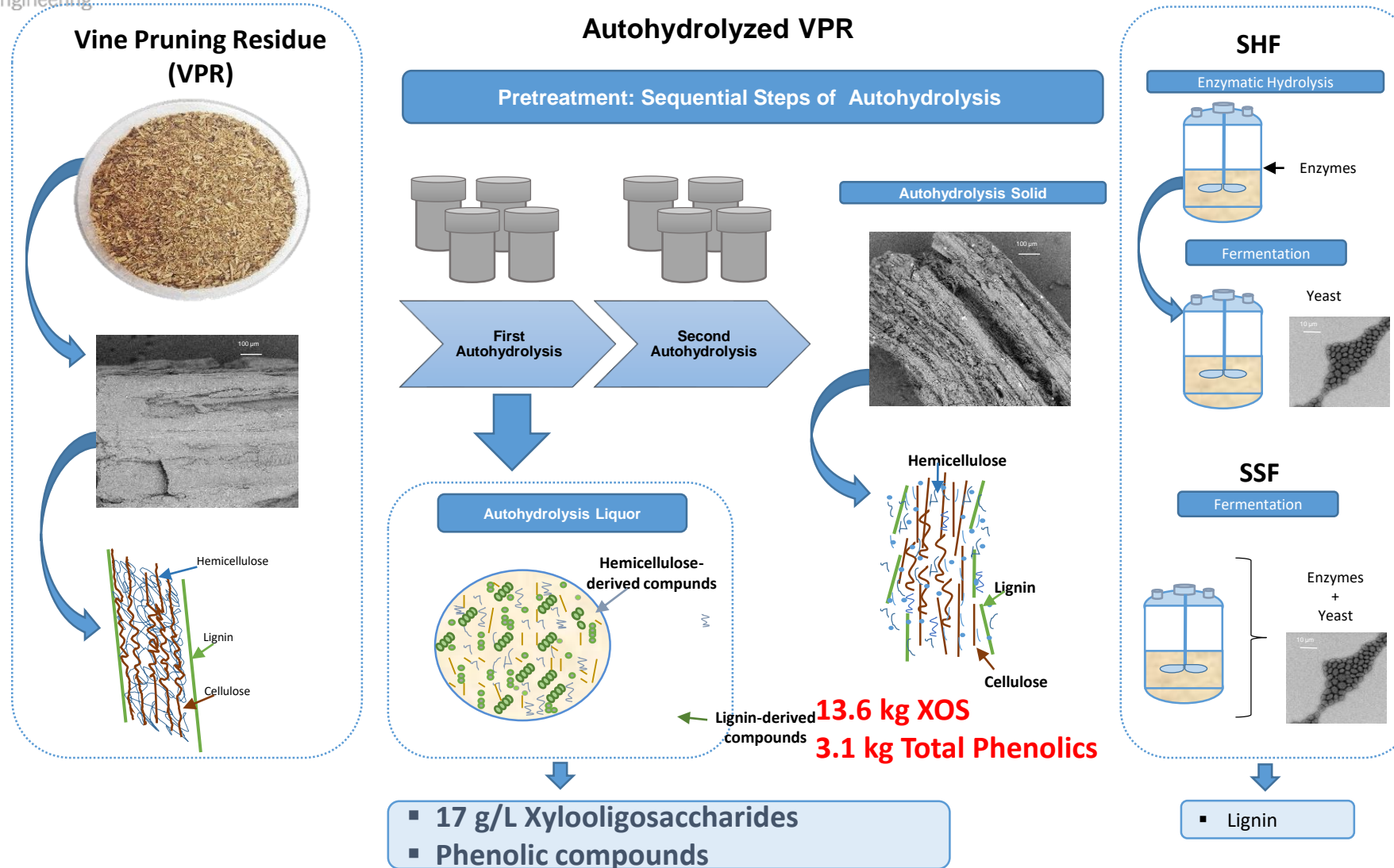
Resveratrol



INTEGRAL VALORIZATION OF VINE PRUNING RESIDUES BY SEQUENTIAL AUTOHYDROLYSIS STAGES

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100 kg



13.1 kg Bioethanol

27 kg Lignin

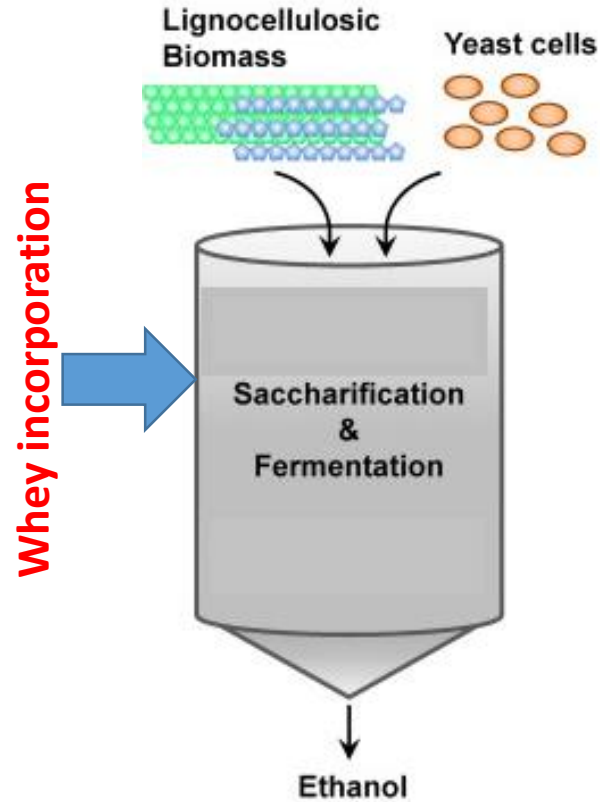
Jesus et al., 2017 Journal of Cleaner Production, 168, 74-86



BOOSTING BIOETHANOL PRODUCTION FROM EUCALYPTUS WOOD BY WHEY INCORPORATION



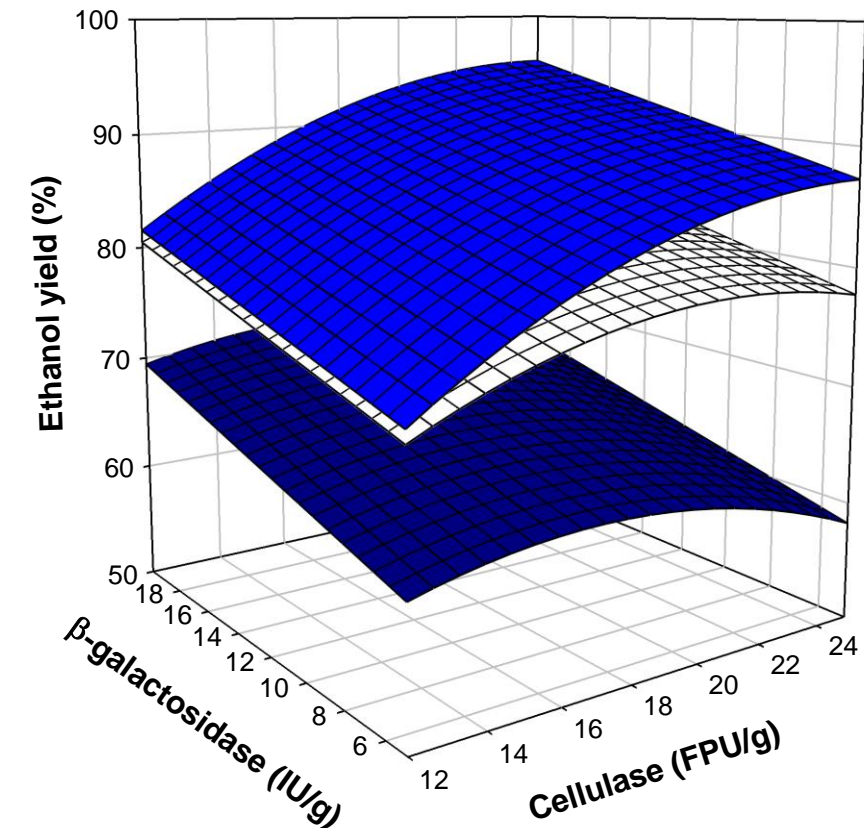
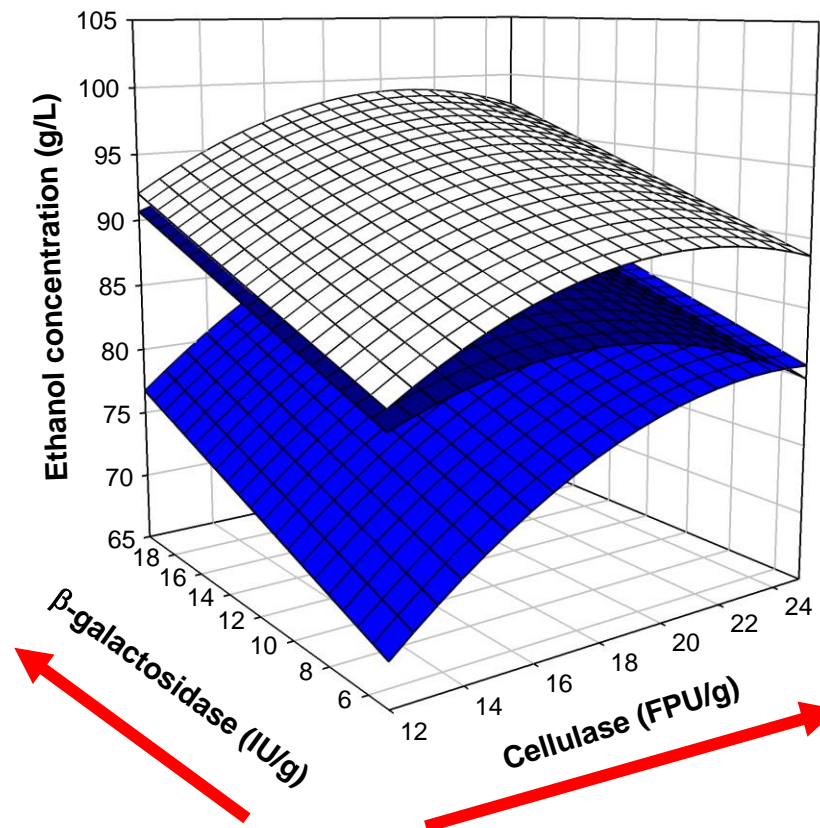
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93 g/L of ethanol
94 % ethanol yield

8.5 % cheese whey
17 % cheese whey
25.5 % cheese whey

Eucalyptus globulus Wood 25%





Linking life and technology to shape the future

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THANK YOU FOR YOUR ATTENTION!!



Lucília Domingues



Carlos Costa



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