

Renewable Resources as Feedstock for the Chemical Industry

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Ongoing Projects on Biorefineries

- „Pilot Project Lignocellulose Biorefinery“
 - FNR-Project
- „Silage as Feedstock for the Chemical Industry“
 - FNR-Project 22027405 (07NR254)
- „SynRg[®] – Systembiotechnological exploitation of renewable raw materials“
 - FNR-Project



Project Features

- Cluster of 15 partners / Research Institutions & Industrial Partners
- Funding Period from 05/2007-05/2009

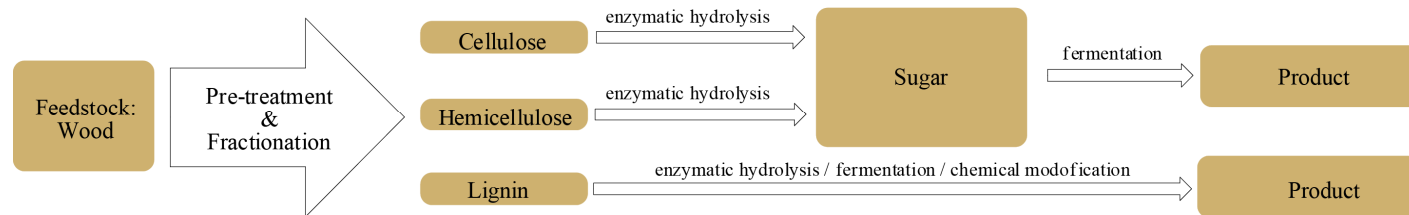
Project Partners



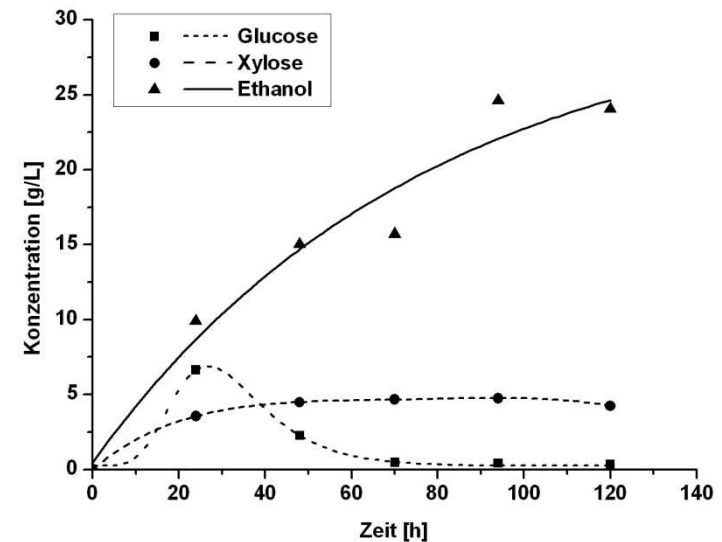
Motivation

- Use of wooden biomass as resource for the production of chemicals and/or fuels
- Similar process scheme as traditional petrochemical refineries
- Three major (biochemical) steps:
 - Disintegration and fractionation of wooden biomass (cellulosic, hemicellulosic and lignin fraction) by thermo-chemical pretreatment (vTI, Hamburg; Fraunhofer ICT)
 - Enzymatic hydrolysis of polymer fractions into the corresponding monomers like glucose (Institute of Bioprocess Engineering, University of Kaiserslautern; Biopos, Teltow)
 - Conversion of the sugars into value added products (Institute of Bioprocess Engineering, University of Kaiserslautern; Bayer Technology Services)

Simplified scheme of a lignocellulose biorefinery



Processintegration of enzymatic hydrolysis and fermentation by simultaneous Saccharification and fermentation (SSF) of crude fiber fraction (100 g/L initial concentration)



Project Features

- Co-operation of the University of Kaiserslautern and the Saarland University
- Funding Period from 2008-2011



Project Partners



Institute of Thermal Process Engineering (Prof. Bart),
University of Kaiserslautern



UNIVERSITÄT
DES
SAARLANDES

Biochemical Engineering (Prof. Heinzle),
Saarland University



TECHNISCHE UNIVERSITÄT
KAISERSLAUTERN

Institute of Bioprocess Engineering (Prof. Ulber),
University of Kaiserslautern

Motivation

- Use of Silage-Ingredients as Feedstock for Biorefineries
 - 598,000 ha are used for production of grass in Germany¹
 - 39 Mt Heyweight => 150 Mt fresh mass²
 - „Green Material“ contains many valuable substances
- Many Drawbacks of the application of fresh material
 - Degradation during storage
 - Available only in summer (Mai to October)
 - Composition changes during the year
- Investigated Feedstocks can be summarized as
 - L-lysine
 - Alcohols (ethanol, 1,2-propanediol)
 - Acids (succinic acid, itaconic acid)

¹ Statistisches Bundesamt, Bodennutzung 2008

² Statistisches Bundesamt, Bodennutzung 2008

Major Goals

- Biochemical Engineering; Saarland University
 - Generation of an L-lysine production strain, capable to grow on silage
- Thermal Process Engineering; University of Kaiserslautern
 - Development of novel extraction techniques for recovery of lactic acid
 - Application of ionic liquids
- Bioprocess Engineering; University of Kaiserslautern
 - Utilization of silage press juice and of hydrolyzed press cake as fermentation medium
 - Development of integrated production routes to alcohols and acids

¹ Statistisches Bundesamt, Bodennutzung 2008

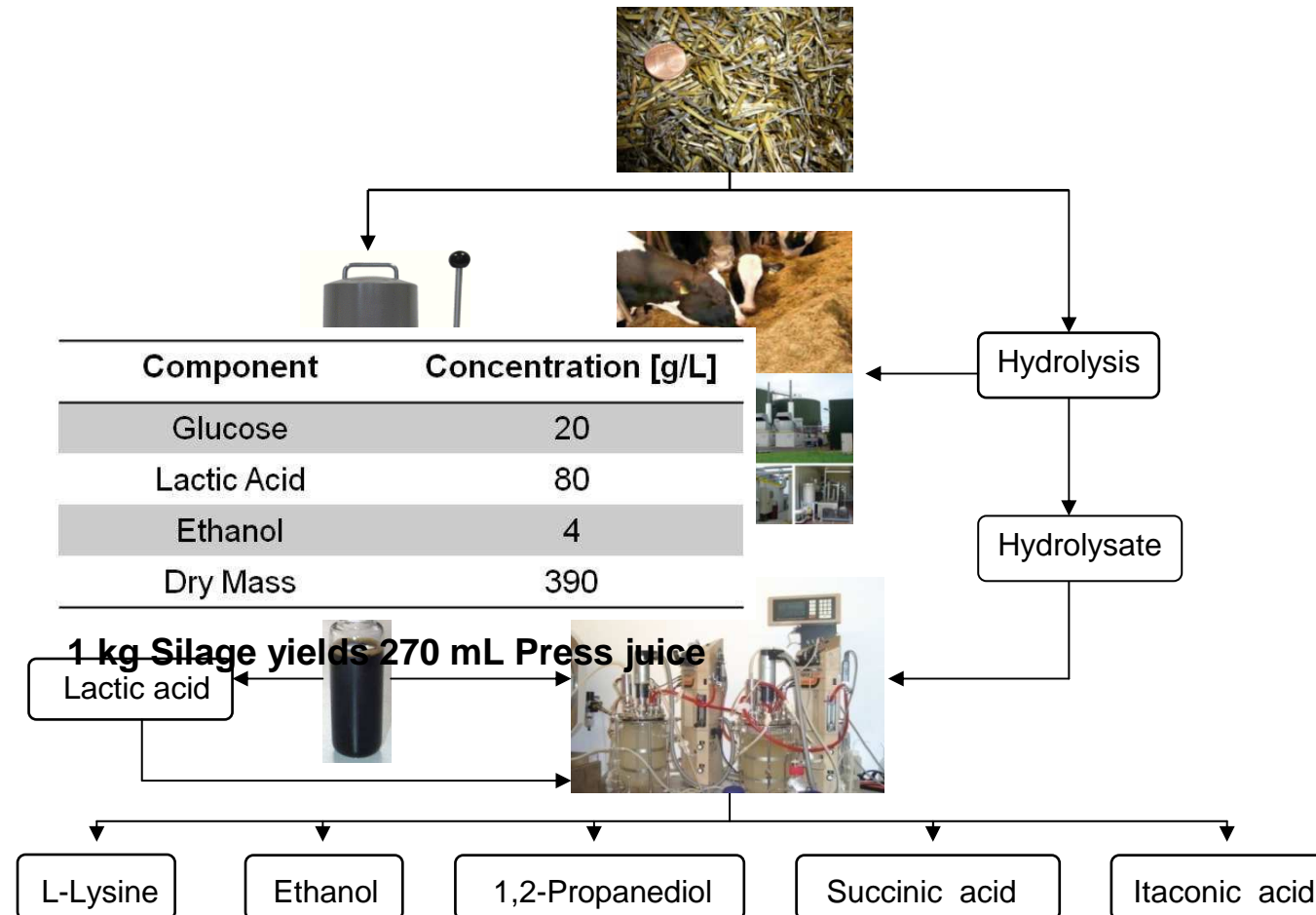
² Statistisches Bundesamt, Bodennutzung 2008

Ensiling Process

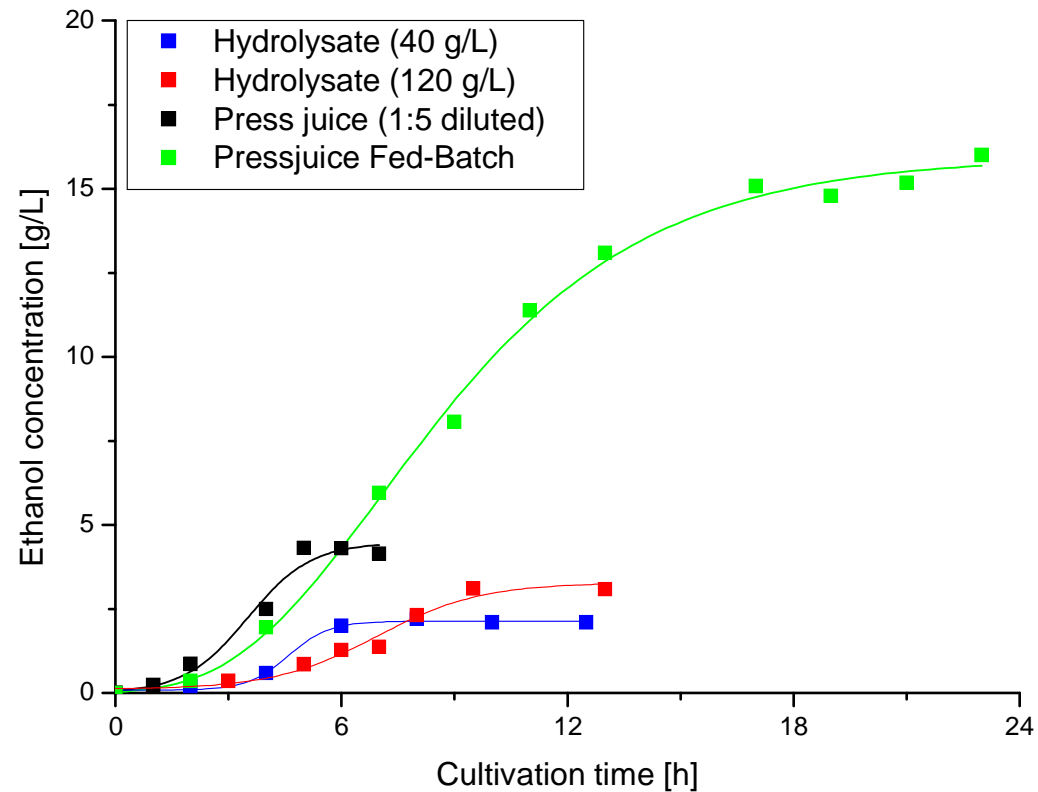
- Traditional agricultural technology
- Gras clip is pressed into silos or bales
- Anaerobic growth of *Lactobacilli*
- Acidification and anaerobic conditions cause conservation of silage
- Organic acids produced during ensiling are valuable components
- Other plant components, as sugars and amino acids are released during ensiling



Process Scheme



Ethanol Production (Model Process)



Current Status

- Ethanol production is possible but not economic (proof of concept)
- Silage press juice has to be applied in a fed batch mode due to high lactic acid content
- Simultaneous utilization of press juice and hydrolysate of press cake is investigated
- Residue of enzymatic hydrolysis (press cake) is investigated for methane generation
- Silage utilization for propanediol and acids production has just started

Project Features

- Cluster of 17 partners / Research Institutions & Industrial Partners
- Funding 3.3 million EUR
- Funding Period from 07/2009-06/2012

Project Partners



Project Goals

- Production of high value commodities/polymers from fatty acids, polyphenols and polyols
- Feedstocks are rape and wheat
- Initialization of a holistic and interdisciplinary approach for utilization of the feedstocks
- Optimization (bio-)synthesis and (agro-)production
- Establishment of sustainable downstream-techniques
- Development of novel methods and processes for exploitation of feedstock material considering the material flux within the value chain

Main Objectives I

- Characterization and extraction of existing plant material
- Application of breeding strategies to increase target compound concentration within corresponding plant organ
- Optimization of compound accessibility
- Build up harvest techniques for preparation, handling and storage of plant material

Main Objectives II

- Development of selective extraction and separation processes
- (Bio-)Transformation of plant material ingredients to high value compounds
- Utilization of the whole plant
- Evaluation of ecological and economic impact of the established processes

Outline of the Project

- Subproject I: Optimization of plant material



- Subproject II: Operations and Processes for harvesting, cell disintegration and downstreaming



- Subproject III: Products and Applications via (bio-)chemical Functionalization and Derivatization



Available Feedstocks

- **Ethanol**
 - “Lignocellulose Biorefinery”
 - “Silage”
- **Acids** (lactic acid, succinic acid, itaconic acid, dicarboxylic acids)
 - “Silage”
 - “SynRg®”
- **Polyols / Polyphenols**
 - “Silage”
 - “SynRg®”
- **Polymers**
 - “SynRg®”
- **Biogas**
 - “Silage”