Green biorefinery research in Austria- an overview

Michael Mandl, Joanneum Research
Stefan Kromus, BiorefSYS

IEA Task 42 Biorefinery Workshop Vienna
Where did we start ......

... looking for a vision for sustainable rural development

... facing the change of agricultural structure

... defining a strategy

Source: BAL Gumpenstein; K. Buchgraber
The Green Biorefinery R&D work was generally performed in three stages:

— fundamental studies,
— technology development and
— optimization of processes.

In summary 7 R&D projects for various aspects have been performed.
Green Biorefinery Austria

Green Biomass
(e.g. Grass, Clover, Lucern,...)

Ensilage Process

Mechanical Fractionation

Press Juice
Press Cake (Fibres)

Amino Acids Separation

Lactic Acid Separation

Fibre Processing

Biogas

Fiberboards, Biocomposites, Insulation Materials,...

Flavours, Chlorophyll, Pigments,...

Electricity, Heat

Amino Acids, Protein Products

Lactic Acid, Ethyl-Lactate,...

Fine Chemicals Separation

ISO 9001 certified
Institute for Sustainable Techniques and Systems

Optimizing processes

- Mechanical fractionation (pressing procedure)

- Processing of juice (LA and AA separation)
State of the Art R&D: Amino Acids

- Silage: hydrolyzed proteins
- ~60% rel. recovery rate of amino acids from Silage
- All essential amino acids are contained
- from nutrition …personal care is feasible
- Complex juice composition!
Lactic acid

- ~85% recovery of lactic acid from silage feedstock
- Application: bulk chemical, solvent, bio-polymer (PLA)
- Combination of separation technologies (patent pending)
- Market perspective for LA promising
Recovery CP / Amino Acids

Recovery Rate Crude Protein (CP)
Percentage of Crude Protein of feed which is transferred into the press juice

- Total, pressing 1+2
- Pressing #1
- Pressing #2

Recovery rate Crude Protein [%]

Clover-Grass Silage
Alfalfa Silage
Absolute Crude Protein (CP) Yield of Press Juice

Yield of Crude Protein [kg/DM feed]

- CP yield feed
- CP total yield juice 1+2
- CP yield juice 1
- CP yield juice 2

Clover-Grass Silage
Alfalfa Silage

1- Klg 2- Klg 3- Klg 4- Klg 5- Klg
6- Luz 7- Luz 8- Luz 9- Luz 10- Luz
Grass fibers utilization

- Press cake is a grass fiber fraction
- Fundamental characterization was done
- Various application have been tested (fiber boards, fleeces, insulation material, building products…)
- Grass fiber products are not known on the market (risky, economic aspects)
- Strategy to use press cake for biogas
Examples Fiber boards

Dichte der Versuchsreihe 3

Querzugfestigkeit 3. Versuchsreihe
Models for Green Biorefinery operation

Biorefinery in the center of a supply area

Possible Integration of surrounding region
“Take home message…”

— Green Biorefinery is a technology concept for using the whole plant

— Logistics will become a part of the process; regional “embedding” of technologies

— Green Biorefinery apply future key-technologies for separating valuable substances

— Green Biorefinery can be easily linked to a biogas digester

— R&D: 5% inspiration; 95% transpiration
Acknowledgement

We kindly acknowledge the support of the funding program

and our scientific partners

University of Natural Resources and Life Science Vienna

Institute for Resource Efficient and Sustainable Systems

Fabrik der Zukunft
Recovery of Crude Protein in Pressjuice

Recovery Rate Crude Protein (CP)
Percentage of Crude Protein of feed which is transferred into the press juice

Absolute recovery rate of 80-120kg AA/ t DM

Institute for Sustainable Techniques and Systems

ISO 9001 certified

BioRefSys®
BioRefinery Systems

INNOVATION aus TRADITION
Recovery of Lactic acid in Pressjuice

Recovery Rate Lactid Acid (LA)
Percentage of Lactic Acid of feed which is transferred into the press juice

Total, pressing 1+2  Preesing #1  Pressing # 2

Absolute recovery rate of 160- 200kg LA/ t DM
Applying process synthesis on Green Biorefinery

— How does a optimal „value chain“ look like?
— Shall all processes taken place in a central plant or are decentral processes an option? (storage, mobile pressing of feedstock)
— Sensitivity of the system to certain parameters (prices)
— How does the system perform generally?
Basic assumptions

- total silage feedstock is 35,500 t/y
- local transport by tractors
  (upto 10 km, max load is 5 t, average speed is 20 km/h)
- central transport by trucks,
  (upto 60 km, max load is 12 t, average speed is 50 km/h)
- time limit for transportation is 2000 h/y for trucks and tractors
- there may be up to 1 “central plant” (biogas + biorefinery)
- there may be up to 5 “local plants” (biogas)
- fractionation of silage either by a mobile press or by presses in the “local” or “central” plants
The „maximal structure“...
Result: optimal synthesis for the base case
Sensitivity analysis: Food sector competition

Fodder pellets as a product

- Central and decentral units
- Split utilisation of silage

Optimal structure with low price fibres (left figure)

Optimal structure with high price fibres (whole figure)
Interesting results...

• **De-central processes are not the rule**
  – Silage (storage + reaction) is de-central
  – No mobile (de-central) press
  – No de-central biorefinery, no de-central biogas unit

• **Fibres are „out“**
  – At current European market price, biogas is more feasible

• **The process is already economically viable**
  – Profits are a healthy 0,6 M€ for 35.000 t/a silage
What is different in processing renewables?

**Conventional chemical processes**
- Raw materials are standardised
- Raw materials are continuously available
- Raw materials have centralised sources
- Logistics play negligible role for process structure

**Renewable resource processes**
- Raw materials differ in quality
- Raw material availability shows strong time dependence
- Raw materials have decentral sources
- Logistics and storage have impact on process structure
...some answers

- Logistics need to be integrated in the process design from the beginning
- Finding the right size for processes is essential economy of scale vrs minimal transport
- Utilizing agricultural wastes and minor quality products to avoid competition for resources
- Local production of renewable resources is important
- Security of raw material supply requires on the long run a sustainable agriculture
What can you expect

— Some basic problems on renewable resources process
— Setup of the Austrian Green Biorefinery
— Applying process synthesis to define a base case
— Optimizing processes
— Summary
The challenges

resource competition

size optimisation

structural optimisation
Renewables involve new questions
Renewables involve new questions

Central vs. decentral

Storage vs. campaign

Processes for renewables
lack of experience; unknown heuristics

Why not bring the process to the raw material?

Adapt the process to the raw material?

Membrane technologies, chromatography, ...

INNOVATION aus TRADITION
Basic logistic problems of renewable resources

...transport density

...short shelf life

...decentral production