Assessing feedstocks variability in biorefineries: use of biocatalysts produced by solid state fermentation

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BIO Conference,
June 2013
Agenda

1. Soufflet presentation

2. The variability of raw materials

3. Solid state fermentation: interest for correcting feedstocks variability

4. Examples
Agro-industrial group, expert in the barley and wheat chains.

One of the largest grain operators in the world.

B to B

Capital owned at 100% by Soufflet family

Founded in 1900

Turnover

4 001 M €

of which non domestic

2 160 M €

Number of employees

3 895

France

2 751

International

1 144
Soufflet Group

- Trading
- Agriculture
- Flour milling
- Ingredients
- Malt production
- Biotechnology division
- Enzyme producer
  - Lyven

5 M T collected
7 M T traded
1 M T wheat flour (+ wheat bran)
2 M T malt (+ rootlets)
Wheat prices from 2003 to 2011

Wheat Euronext (€/T)

Newly cultivated lands have very variable yields.
Price volatility will not decrease.
Feedstock variability

A given feedstock can vary in terms of:
- Dry matter
- Protein content
- Starch content
- Fibre content
- Viscosity
- Microbiology
- Mycotoxins
- Residues

A factory can also change feedstock on a regular basis (wheat – corn).
Feedstock variability

Two solutions:

- Long-term contracts with suppliers and customers for securing prices
- Finding technical solutions to reduce the negative impact of qualitative variability: enzymes
The need for enzymes in agrotechnologies

- Global enzymes market is estimated at 3.5 $ billion in 2013.

- Demand is either for:
  - Pure enzymatic activities, for a very specific catalysis
  - **Enzymatic cocktails**, especially needed when feedstocks variability is high

- Key example: animal nutrition (poultry and swine)
  - Diets (proteins; energy) may vary on a weekly basis
  - Wheat vs corn, rapeseed meal vs soyabean meal
  - Non-Starch Polysaccharides enzymatic cocktails are required, with a mix of xylanases, cellulases, betaglucanases... and even amylases, proteases, etc...
Solid state fermentation

Traditionally used in Asia, solid state fermentation consists in cultivating a micro-organism on a slightly hydrated solid environment. SSF saves both water and energy.

= A way to produce an enzymatic cocktail (biocatalyst) in a single batch, through the use of a complex substratum that can be fully degraded by a non-GM micro-organism.
Solid state fermentation process

**Substrate(s)**
Wheat bran, expeller cake

**Pre-treatment**

**Pre-treated substrate**

**SSF + extraction or drying**

**Biocatalyst**
Solid state fermentation : R&D approach

A biocatalyst is the result of a synergy between three elements (3 “S”).

**S**train

**S**ubstratum

**S**ystem
Solid state fermentation : R&D approach

For a given application, each of the 3 "S" can be optimized:

• Strain : high-throughput screening.

• Substrate : Feedstocks selection is very large, from lab scale to industrial supply (2 origins at least).

• System : All fermentation parameters can be monitored.
Strategy for defining a biocatalyst adapted for a specific application

- Bibliographical analysis: requirements in the application field
- Definition of the enzymatic drivers
- Validation of the enzymatic drivers
- Screening of our banks of biocatalysts / strains
- Upscaling (with application tests at each phase) at 100 g, 10 kg and 1 T
Soufflet’s ambitions in biotechnologies

Our aim:
Create new products from agroresources in order to generate more added value for the whole chain.

→ OSIRIS R&D programme:
77 M€ (2008-2015)
Financial support from OSEO French agency for innovation
Staff of 70 researchers
1 R&D centre (SSF, screening, applications)
1 pilot plant (SSF)
2 factories (SSF)

E85
Biocatalysts have an effect on the liberation of free nitrogen sources:
- Quantitatively
- Qualitatively

Example: lactic acid production (1/3)

Free Amino Nitrogen (FAN) release on wheat

Bacillus
Aspergillus orizae
Aspergillus niger
Example: lactic acid production (2/3)

Comparison of different biocatalysts

- Correlation between FAN release and lactic acid production entered les coefficients FAN et le rendement lactique

Correlation between FAN and lactic acid (wheat)
Biocatalyst can be applied during a classical lactic acid production

Biocatalyst allows to:

- Reduce other constituents
- Degrade polysaccharides
- Increase yields
- Increase fermentation kinetics
- Reduce mash viscosity
- Use complex agro-materials
- Increase DM content (if required)
Example: wheat bioethanol production

- Increase of performances on wheat ethanol production (propagated yeast)
  - Increase of ethanol yield (+3%)
  - Reduction of glycerol production (-20%)
Example: corn bioethanol production

- Increase of performances on corn ethanol production (dry yeast)
  - Increase of ethanol yield (+ 2.5%)
  - Reduction of glycerol production (15 - 20%)
  - Increase of kinetics

Example: corn bioethanol production
Example: poultry feed

A single biocatalyst can improve performances both on wheat-based diets and corn-based diets (-2 to -8 % FCR)

Feed conversion ratio

1.53
1.47
1.4
1.45
1.44
1.3
1.35
1.4
1.45
1.5
1.55
Others

Other applications may include:
- Ruminant feed
- Swine feed
- Yeast production
- Probiotics production
- Ethanol generation 1.5 or 2.0
- ...

Partnerships: the best way to go forward
**SOUFFLET**, a member of IAR

A world class industrial cluster dedicated to **biobased products** and **Biorefinery**

- 210 members
- 40% SMEs
- 135 R&I projects
- Total R&I budget: > 1,2 bn €

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Thank you very much