Cargill Partnership Opportunities for Commercial Fermentations

BIO World Congress - Philadelphia, PA
May 12-15, 2014

Eddyville, Iowa corn wet milling facility front entrance
Cargill’s Vision

Our purpose is to be the global leader in nourishing people.

Our mission is to create distinctive value.

Our approach is to be trustworthy, creative and enterprising.

We are committed to helping people and organizations thrive.
Cargill Biotechnology Overview

• Cargill is well positioned to deliver variety of green sustainable compounds (food, feed and industrial)
  • Access to agricultural feedstocks world wide
  • World wide supply chain infrastructure
• Strong core competency in bioprocess development, scale-up and large scale operations
  • Fermentation
  • Enzymology
  • Separations
  • Engineering
BioCatalysis within Cargill

Feedstocks

Biocatalyst
- Enzymes
- Whole Cells (yeast, bacteria, fungi)

Products
Food:
- Citric Acid, Xanthan, Erythritol, ARA, Ketogulonic Acid, fructose, dextrose, corn syrups

Feed:
- Sweet Bran, RAMP, Empyreal.

Industrial:
- Lactic Acid, Ethanol, Scleroglucan
Development of a Biotech-based Product

Gene discovery
Protein analysis

Molecular Biology

Metabolic Engineering
Directed evolution

Physiology
Host strain selection

Fermentation
Process Development
Scale-up
Novel Yeast (CB1) Identified through Extensive Screening

- Cargill screened ~1200 yeast strains belonging to hundreds of species

- CB1 emerged as a winner and was chosen as a platform biocatalyst

- Key Characteristics of the strain:
  - Tolerant to organic acids at low pH (lactic, acetic, etc.)
  - Fast glycolytic rates
  - Grows and ferments well on a simple defined salts-sugar medium
Biotechnology Partnerships-Licensing of CB1

- Partnering the CB1 Technology with the Other Pieces of the Value Chain for Fuels and Chemical
  > Cellulosic Ethanol
  > Isobutanol (Gevo)
  > Succinate (Bioamber)
- Proven Commercial Strain – Lactic acid
  > Several generations of improved strains
  > Good understanding of scale up - large scale operation
- Yeast Platform
  > No bacteriophage
  > Robust
  > Cellulosic enabled
  > Highly tolerant to acids, temperature, ethanol, and cellulosic hydrolysates
  > Minimal Media – “Clean media”
    > Cost savings on downstream
- Strong IP position
CB1 Ethanol Production Demonstrated in 100% Undetoxified Corn Stover Hydrolysate

Demonstrated:

✓ Fermentation of hexose and pentose sugars
✓ Resistance to feedstock inhibition
✓ High product concentration and yields

The corn stover was pretreated by dilute acid. Pretreatment conditions were 160°C, 10 min residence time, acid loading of 0.8% sulfuric acid dry biomass, and at a 25% total solids loading. Material subsequently hydrolyzed with commercially available enzyme.
Fermentation Development

- Seed Culture Process
- Medium Development
- Fermentation Process Development
- Off-gas mass spectrometer
- Mass Balance

Bench Scale STR and 600L Small Pilot Fermentor

Small Pilot Airlift Fermentors

5,000L Pilot Stirred Tank Fermentor
Downstream Piloting

Downstream Separation & Purification
- Biomass separation
- Evaporation
- Ion Exchange
- Liquid Extraction
- Distillation
- UF/MF

UF Cell Separation Skid

Ion Exchange

Evap & Distillation
Over-the-fence Partnerships

> Ajinomoto
> Heartland Lysine
> Wacker Biochem
> Novozymes
> Evonik
> C.J. America

Ajinomoto North America
Startup 1993
110 employees

Ajinomoto Heartland, Inc.
Startup 1986
Multiple expansions
60 employees
So what is Cargill looking for?

- Value Added Opportunity
- New application with existing Cargill ingredient(s)
- Over-the-fence business
- New product creation
- Cargill creates unique ingredient; customer/partner sells the final product
- Skin in the game – Cargill not a philanthropic organization
- Genetically engineered microbe – license in or out
- Semi-works – limited capability inside Cargill
- Thrive – you will be more successful with Cargill than with anyone else.
THANK YOU

Create, Collaborate, Succeed