BioProtein AS (Limited company)

BioProtein to Replace Conventional Fishmeal Production

By Arild Johannessen
Executive summary

- The BioProtein technology is an alternative method for production of nutritional proteins using fermentation of methane (natural gas). This technology turns standard natural gas into protein having high nutrition value – comparable to fish meal. The technology is protected by a portfolio of patents and new patent applications has been filed based on results from ongoing R&D projects.

- Generally, global demand for proteins is high and increasing. BioProtein can help meet this demand in harmony with the environment and consumer health concerns. Other applications beyond aquaculture have been proven, including both feed to life stock animal and higher value autolysate for industrial use.

- BioProtein can also reduce the dependence on fish meal in fish feed, which is in limited supply while demand is increasing.

- BioProtein Malaysia Sdn Bhd is about to start a feasibility study for the establishment of a commercial production facility in Malaysia.
Agenda

• About the technology
• Motivation
• Current use of high quality proteins like fish meal
• BioProtein as a high quality protein
• Large scale production of BioProtein
• Going forward
BioProtein: using natural gas to produce proteins

BioProtein is made using natural gas...

Methane → [Image of microorganism] → BioProtein
Oxygen → Ammonia → Minerals

The BioProtein technology uses microorganisms that utilize natural gas to produce a protein rich substance.

...in a fermentation process

The process involves:
- Gas
- Recirculated liquid
- UF
- Spraydryer
- Steam
- Centrifuges
- Heat treatment
- BIOPROTEIN

Harvest
Gas Minerals

BioProtein AS
**Methylloccoccus capsulatus**

Gas fixation reactions in Methylloccoci

A) $\text{CH}_4 \xrightarrow{\text{MMO}} \text{CH}_3\text{OH} \xrightarrow{\text{NADH} + \text{O}_2} \text{HCOH} \xrightarrow{\text{O}_2} \text{NH}_3 \xrightarrow{\text{Biomass}} \text{CO}_2$

B) $\text{CH}_2\text{CH}_3 \xrightarrow{\text{MMO}} \text{CH}_2\text{CH}_2\text{OH} \xrightarrow{\text{NADH} + \text{O}_2} \text{CH}_2\text{COOH} \xrightarrow{\text{O}_2} \text{Heterotrophic bacteria} \xrightarrow{\text{Biomass}} \text{CO}_2$
The BioProtein technology has been proven in large scale

- A pilot BioProtein facility has been built by Statoil ASA for the upscale of the BioProtein technology
  - Improvements of the fermenter was performed during the facility operation
  - Full production was achieved, and 10 000 tonnes was produced
  - The product was sold to the Norwegian salmon feed industry
Agenda

• About the technology
• Motivation
• Current use of high quality proteins like fish meal
• BioProtein as a high quality protein
• Large scale production of BioProtein
• Going forward
Future production of food and materials has to utilise new and alternative technologies

Current growth is oil driven...... ..... future will depend upon smart production of biomass
WASHINGTON, April 25, 2012—Global food prices increased by 8 percent from December 2011 to March 2012 due to higher oil prices, adverse weather conditions, and Asia’s strong demand for food imports, according to the World Bank Group’s latest *Food Price Watch*. 
Agenda

- About the technology
- Motivation
- Current use of fish meal as a high quality protein
- BioProtein as a high quality protein
- Large scale production of BioProtein
- Going forward
Consumption of meat is energy consuming especially in terms of the conversion of feed raw materials into final food products.

If handled properly, aquaculture can grow significantly.
Fish meal: from commodity to strategic ingredient

- Fish meal has changed from a commodity to strategic ingredient accompanied by an upwards trend in relative value.
- If price ratio fishmeal/soybean is > 3 fish meal is mainly consumed by aquaculture.
Aquaculture has become the major consumer of fish meal.

- The use of fishmeal in aquaculture is a quarterly divided between:
  - Crustaceans mainly shrimp
  - Marine fishes (sea brass, sea bream, tuna, grouper etc)
  - Salmon and trout
  - Other
Aquaculture is a major source for food supply, with large potential for future growth

- China and Asia accounts for ca. 80% of world aquaculture production
- The same region accounts for 25% of fishmeal
- Aquaculture growth is annually 8% -10%
- Fishmeal production has for decades been stable at 5 – 7 million tonnes per year
- Aquaculture industry is seeking alternative raw materials for feed production
Challenges in the aquaculture industry

Main challenges to run sustainable aquaculture

- Domesticating
  - Control over entire life cycle, breed programs
- Technology
  - Equipment designed for species and environment
- Disease control
  - Prevention and treatment
- Feed
  - Species and environment

Feed is a main challenge

- Sustainable development require access to raw materials
- Less dependency on marine products
  - Fish meal and oil (fish in fish out)
- Development of new raw materials that comply with
  - Sustainability, performance, health and quality
- Increased flexibility in raw materials
Agenda

• About the technology
• Motivation
• Current use of high quality proteins like fish meal
  → BioProtein as a high quality protein
  • Large scale production of BioProtein
  • Going forward
BioProtein is a new protein source that complement current proteins

- It is a high quality protein that complement marine proteins like fish meal for the use in animal feed to
  - Aquaculture
  - Agriculture
- Hypothetically 1% of Norwegian natural gas export can cover the entire use of proteins in the Norwegian salmon industry
- Methane from natural gas or biogas will be available especially as non conventional gas now turns into conventional
BioProtein are particularly attractive for animal feed and industrial fermentation purposes in the food industry.

<table>
<thead>
<tr>
<th>Process</th>
<th>Products</th>
<th>Markets</th>
<th>Applications</th>
<th>Global volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass from Methane (natural gas)</td>
<td>Basic BioProtein</td>
<td>Feed</td>
<td>• Nutritional and functional ingredients in feed for</td>
<td>600 million tonnes*</td>
</tr>
<tr>
<td></td>
<td>Homogenized BioProtein</td>
<td>Pet Food &amp; Animal Feed Ingredients</td>
<td>– Aquaculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Autolysate</td>
<td>Industrial Fermentation</td>
<td>– Pigs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Chicken</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Other animals</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Functional ingredients in wet and dry feed products</td>
<td>20 million tonnes**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Fermentation medium for industrial fermentation processes, e.g.,</td>
<td>A few thousand tonnes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Lactic Acid Bacteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Enzymes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Amino acids</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Secondary metabolites</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• ?</td>
<td></td>
</tr>
</tbody>
</table>

** Pet food only. Source: www.petfoodinstitute.org and www.petfoodindustry.com

Analysis provided by Credo Partners
Performance of BioProtein in selected species

**Life stock animals**  
*Skrede et al. 2003*

**Aquaculture**  
*Aas et al. 2006*
BioProtein – Optimal levels in diets

- 50% of the protein in diets for salmon
- 20-30% of the protein in diets for broiler chicks
- 50% of the protein in diets for pigs
- 40% of the protein in diets for mink

- The effect on taste and appetite could be a limiting factor for some species
Criterias for commercial success

Natural gas...

• The demand of energy is increasing
• Logistics of natural gas often involves processing in order to reach markets
• Unconventional natural gas is being conventional

... vs. Protein demand

• Human population and welfare is increasing
• Marine wild catches are stable
• Need of increased production capacity from new technology, intensified farming, and aquaculture
Agenda

- About the technology
- Motivation
- Current use of high quality proteins like fish meal
- BioProtein as a high quality protein
- Large scale production of BioProtein
- Going forward
Large scale production of BioProtein

- Large scale facilities will produce 40,000 – 100,000 tonnes or more
- Modular design, can be expanded over time as market builds
- Key input variables are natural gas (methane), oxygen and ammonia
- Can be transported over large distances (sea / land) and stored for longer periods (years)
- Production facility utilizes stranded gas or natural gas not commercially viable
- Profitability is dependent upon localisation, natural gas access / price and oxygen price
- There is no production of BioProtein in the world today. This is a new and emerging industry.

- Statoil established a test production facility at Tjeldbergodden, Norway (see picture)
- This plant has already produced more than 10,000 tonnes of BioProtein
- Provides experiences and basis for large scale facilities
- Linde Group AG has prepared a concept design of modular large scale facility
- BioProtein AS ready to start project to build production facility – looking for partners
Site master plan (200x200 m)
Agenda

• About the technology
• Motivation
• Current use of high quality proteins like fish meal
• BioProtein as a high quality protein
• Large scale production of BioProtein
• Going forward
A new commercial potential

- BioProtein Malaysia Sdn Bhd is exploring the possibility to commercialise the BioProtein technology in Malaysia
- Presence of natural gas
- Large and increasing market for food production
- Growing aquaculture sector
- Capital seeking projects within energy and food
- Governmental support and preferential fiscal regimes
Feasibility study will be conducted

- Site localisation
- Commercial agreements
- FEED study
- Market
- Fiscal regimes
- Legal aspects
- Financial setup
The BioProtein hype cycle….

Expectations

- International partner
- Economic model
- Concept study
- Company establishment
- R&D
- Technology trigger
- Searching for venture finance
- Feasibility Study

Time:
- Peak of inflated expectations
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity

...to be continued
BioProtein AS is looking for partners

• Bioprotein AS is looking for partners - investors or / and industrial partners – to build a consortium for large scale production facility for BioProtein and high value products based on BioProtein

• Business case is available

• Bioprotein AS will work with local agents in the process of finding partners

• Bioprotein AS can offer license agreements or joint ventures to industrialize BioProtein

• If you are interested, please contact:
  – General Manager Dr. Arild Johannessen, ajo@bioprotein.no, +47 93 46 52 92
  or
  – Chairman Torkell Gjerstad, Torkell.Gjerstad@iris.no
  – Dr. Bård Johansen, bard.johansen@me.com, +47 91 392455