Progressing Biofuel Production from Microalgae Towards Commercial Success
May 2014

Valerie Harmon, Senior Director R&D
Company Overview
Our Mission

“Cellana, a developer of algae-based bioproducts and biofuels, is focused on using the most productive plants on earth – marine microalgae – to produce nutritional oils, foods, aquaculture and other animal feeds, renewable chemicals, and biofuels, while simultaneously reducing industrial emissions of CO₂.”
Cellana Addresses the Necessity for Development of Sustainable Food, Feed, Nutraceuticals, & Fuels

Increasing Human Populations/ Growing Demand for Food, Feeds and High Value Chemicals

Desire for Sustainable Living

Environmental Concerns/ Climate Change

Enabling Gov’t Policies: Food Security & Energy
Cellana’s Vision of Microalgae

- Untapped resource!
- Efficient harvest of the sun’s energy
- Simultaneous production of:
  - Essential nutrients
  - Essential compounds such as fuels and valuable chemicals
Microalgae
Kona Demonstration Facility

A commercially viable, sustainable business strategy in action!
Intensive, Efficient Algae Production at the Kona Demonstration Facility (KDF) on Hawaii

- 2.5 hectare site in Kona, HI
- $20MM replacement cost; owned free & clear by Cellana
- >750,000 liter large-scale cultivation capacity
- Produced over 13 tons of microalgae since 2010
- Commercially significant biomass/oil yields (over 15 g/m²/day productivity)
- 25 full time employees
Cellana Maintains a Large Private Culture Collection

>100 high-performing strains

Screening criteria mainly emphasize:
1. Omega-3 concentration
2. Biomass yield
3. Amino-acid profile
4. Lipid profile
5. “Ubiquitous” non-GMO strains
Cellana’s ALDUO™ Algae Production Technology: Proprietary, Photosynthetic, & Proven

**Closed System**
Photobioreactors (PBRs)

- Contamination-minimized Monocultures
  - (continuous production; inoculates open ponds)

**Open System**
Open Raceway Ponds

- Consistent Batch Production
  - (fully harvested 3-7 days after inoculation; re-inoculated at end of last day with new batch)

Covered by US Patents 7,770,322 & 5,541,056, Similar Patents/Patents pending in Europe, Australia, South Africa, Brazil, Japan, Mexico
Cellana’s ALDUO™ Algae Production Technology: Cost Effective Commercial Strategy

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Cellana’s ALDUO™ Algae Production Technology: Advantages

• Many kinds of algae for many types of products
• Cost-effective and reliable generation of quality inoculum / biomass
• Successful large scale cultivation of 11 microalgae strains equating to 7 different species cultivated
Cellana’s Biorefinery Business Model:

Omega-3 nutritional oils, foods, high-value aquaculture / animal feed products and fuels are an extension of Cellana’s core competency – producing microalgae.
Cellana’s Biorefinery Business Model: Nothing goes to waste!

We use every component of our biomass

ReNew™ Algae
the planet’s most sustainable™

ReNew® Fuel

ReNew® Omega-3

ReNew® Feed
Commercial-Scale Off-Take Agreement with Neste Oil

- Off-Take Agreement for algae oil announced June 2013
- Neste Oil is the world’s largest refiner of renewable diesel (NExBTL)
- Multi-year off-take agreement
- Commercial-scale quantities of algae oil ("up to tens of thousands of tons")
- Contingencies for Cellana production capacity, sustainability criteria, and other factors
- Non-Exclusive for both parties
- "Samples have shown that Cellana is able to produce algae oil suitable for renewable fuel production by Neste Oil."
- "The off-take agreement with Cellana allows us access to commercial-scale volumes of cost-competitive algae oil in the future."
Kona Demonstration Facility
Large-scale Production of Microalgae using Flue Gas
Successful Flue Gas Utilization at KDF
Supported by DOE/NAABB
Successful Flue Gas Utilization at KDF

- Experiment run with binary ponds and replicated in time
- Flue gas captured from diesel generators that power the site
- Flue gas cooling and soot removal accomplished in a storage tank with water spraying into the tank
- Additional soot removal via an air filter
- Gas injected into algae culture with a sparger
Successful Flue Gas Utilization at KDF

- No significant difference in N consumption or in growth between ponds grown with pure carbon dioxide vs ponds grown with flue gas.
# Heavy Metal Analysis of Biomass Grown on Flue Gas

<table>
<thead>
<tr>
<th>Heavy metals</th>
<th>Biomass grown with pure CO2 (ppm)</th>
<th>Biomass grown with Flue gas (ppm)</th>
<th>IUPAC guideline (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>1.49</td>
<td>1.55</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.011</td>
<td>0.026</td>
<td>N/A</td>
</tr>
<tr>
<td>Lead</td>
<td>0.04</td>
<td>0.096</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Biomass grown on flue gas well within IUPAC (International Union of Pure and Applied Chemistry) guidelines for heavy metals.
Successful Flue Gas Utilization at KDF

- No significant difference in proximate composition of biomass produced or in lipid profiles
Kona Demonstration Facility
Large-scale Production of Microalgae Biomass for Animal Feeds
• Finfish, shellfish, chicken, pigs, cattle – most major sources of meat

• Successful large-scale feed trial for Salmon, Carp, & Shrimp
  - Marine microalgae from biorefinery as a potential feed protein source for Atlantic salmon, common carp and whiteleg shrimp, V. Kiron (Bodo University) et al., published online: Aquaculture Nutrition, 3 APR 2012
    ▪ Cellana’s ReNew Feed was acceptable for the three animals at the maximum levels tested (Salmon 10%, Carp 40%, Shrimp 40%)
    ▪ There were negligible differences in growth and hardly any in the biochemical composition during the study period

• Successful large-scale feed trial for Broiler Chicks
  - Potential and Limitation of a New Defatted Diatom Microalgal Biomass in Replacing Soybean Meal and Corn in Diets for Broiler Chickens, Xin Gen Lei (Cornell) et al., published online: J. Agric. Food Chem., 4 JULY 2013
    ▪ Cellana’s ReNew Feed could substitute for 7.5% of soybean meal alone, or in combination with corn, in diets for broiler chicks when appropriate amino acids are added
Atlantic Salmon

Marine Microalgae 12 Week Feeding Trial

Marine microalgae from biorefinery as a potential feed protein source for Atlantic salmon, common carp and whiteleg shrimp
V. Kiron, W. Phromkunthong, M. Huntley, I. Archibald, G. De Scheemaker
Article first published online: Aquaculture Nutrition, 3 APR 2013
C323 = Nanofrustulum (Bacillariophyceae) C88 = Tetraselmis (Chlorophyceae)
Salmon at the End of the Feeding Trial

“No significant differences in growth or feed performance were observed for algae-based feeds relative to controls, at either the 5% replacement level or at the 10% replacement level.”

Marine microalgae from biorefinery as a potential feed protein source for Atlantic salmon, common carp and whiteleg shrimp

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Common Carp
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Common Carp
Marine Microalgae 12 Week Feeding Trial

“The performance parameters of the groups of common carp that received algae-based feeds did not differ significantly from those of fish that were offered the control fishmeal-based feed…”

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Whiteleg Shrimp
Marine Microalgae 12 Week Feeding Trial

Shrimp Survival (%)  Shrimp Weight Gain (%)

Control (CO)  369%  86%
C323 (25%, L3)  398%  91%
C323 (40%, H3)  385%  91%
C88 (25%, L8)  374%  91%
C88 (40%, H8)  387%  86%

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Whiteleg Shrimp: Successful 12-Week Feeding Trial

Whiteleg shrimp accepted all the test feeds readily, demonstrating the palatability of the new ingredients. Shrimp that were fed algae-based feeds did not differ from the control fishmeal-fed group in terms of their growth and feed performance…"

“The shrimp growth and feed performance data did not reveal any statistically significant differences during the entire period. However, body protein was lower (P < 0.05) at higher inclusion level of MAP8 compared to those of the control shrimp and L3.”

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Conclusions from the Successful Feed Trials

• The algal replacements were acceptable for the three animals at the maximum levels tested
  - Salmon 10%, Carp 40%, Shrimp 40%
• There were negligible differences in growth and hardly any in the biochemical composition during the study period
• Other feed trials with chickens and pigs equally successful
Summary
Cellana is the Choice to Commercialize Algae-Based Omega-3s and Proteins

- Most Sustainable Feedstock on the Plant
  - Low carbon footprint
  - Low fresh water footprint
    - Especially when compared to fermentation-based products or terrestrial-crop-based products
    - Salt- and brackish-water strains with just a rinse step at the end
  - Low/no arable land footprint
  - Non-GMO algae
- Patented ALDUO™ Production Technology
- Flexible and Economic Algae Biorefinery Model
- Demonstrated Viability of Cellana’s ReNew™ Feed through Trials
  - Over 6 tons of ReNew™ Feed supplied for trials, 2008-Present
- Demonstrated Viability of Cellana’s ReNew™ Fuel via off-take with Neste
- Validated, Modular, Commercial-Ready Platform
  - Over $100MM invested in R&D, facilities, strains, IP
Proud Member of ATP³ Consortium
Thank You to the staff of Cellana and the agencies that fund our research.

For further information please visit www.cellana.com

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