An overview of PROPLEX T in aquafeeds

A high-quality protein source from dried fermentation biomass
Alternative Proteins
Poised to accelerate

- Concerns over price, supply, and sustainability of fish meal and oil is driving research for alternative proteins

- Increasing global population and per capita consumption of seafood highlights the need for alternative proteins

- To meet the demand of feed production, alternative proteins will need to fill the void in formulation.

- Emerging alternative proteins include single cell proteins (e.g., SCP; algae, fungi, yeast, and bacteria), animal byproducts, fishery byproducts, and plant proteins (e.g., fermented SBM and DDGS).

Source of figures: FAO The State of World Fisheries and Aquaculture 2016
PROPLEX T - Dried Fermentation Biomass

Overview

- Co-product of threonine manufacturing process
- Fermentation process uses a strain of bacteria with a carbohydrate sugar
- The bacteria is separated from the threonine to create the biomass
- Bacteria - higher protein than other SCP sources such as algae, fungi, and yeast
- Excellent amino acid profile & digestibility
- No animal proteins
- No known anti-nutritional factors

Typical Nutrient Composition

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4.5%</td>
</tr>
<tr>
<td>Crude protein</td>
<td>74.0%</td>
</tr>
<tr>
<td>Crude fat</td>
<td>6.6%</td>
</tr>
<tr>
<td>Ash</td>
<td>2.5%</td>
</tr>
<tr>
<td>Gross energy</td>
<td>5,701 kcal/kg</td>
</tr>
</tbody>
</table>
Threonine Manufacturing Process Overview

1. Fermentation Media
2. Fermentation
3. Screening / Filtration
4. Purification
5. Evaporation
6. Purification
7. Biomass
8. Drying
9. Oil
10. Packaging
11. Bulk L-Threonine
12. Amino Acid Distribution
13. PROPLEX® T Distribution
What Products Does PROPLEX T Replace?

<table>
<thead>
<tr>
<th>Animal Proteins</th>
<th>Plant Proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fish meal</td>
<td>• Soybean meal</td>
</tr>
<tr>
<td>• Blood meal</td>
<td>• Canola meal</td>
</tr>
<tr>
<td>• Meat and bone meal</td>
<td>• Corn gluten meal</td>
</tr>
<tr>
<td>• Shrimp meal</td>
<td>• Fermented products</td>
</tr>
<tr>
<td>• Squid meal</td>
<td>• Protein isolates</td>
</tr>
<tr>
<td>• Poultry by-product meal</td>
<td>• Protein concentrates</td>
</tr>
<tr>
<td>• Feather meal</td>
<td></td>
</tr>
</tbody>
</table>
PROPLEX T
A high-quality protein source

6 Source: Almeida et al. 2014
## Digestibility Coefficients (%) of PROPLEX T Across Species

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Fish meal, Menhaden Select&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Aquaculture</th>
<th>Poultry</th>
<th>Swine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arginine</td>
<td>75.5</td>
<td>95.7</td>
<td>98.6</td>
<td>94.9</td>
</tr>
<tr>
<td>Histidine</td>
<td>65.5</td>
<td>93.1</td>
<td>95.7</td>
<td>91.8</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>70.4</td>
<td>93.6</td>
<td>98.4</td>
<td>92.5</td>
</tr>
<tr>
<td>Leucine</td>
<td>71.6</td>
<td>94.3</td>
<td>98.7</td>
<td>92.0</td>
</tr>
<tr>
<td>Lysine</td>
<td>70.3</td>
<td>93.6</td>
<td>95.8</td>
<td>92.7</td>
</tr>
<tr>
<td>Methionine</td>
<td>80.5</td>
<td>95.5</td>
<td>98.5</td>
<td>92.0</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>67.3</td>
<td>92.4</td>
<td>98.1</td>
<td>91.2</td>
</tr>
<tr>
<td>Threonine</td>
<td>64.5</td>
<td>92.4</td>
<td>97.9</td>
<td>93.9</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>NT&lt;sup&gt;2&lt;/sup&gt;</td>
<td>NT</td>
<td>97.9</td>
<td>95.0</td>
</tr>
<tr>
<td>Valine</td>
<td>70.4</td>
<td>89.4</td>
<td>97.4</td>
<td>90.8</td>
</tr>
</tbody>
</table>

<sup>1</sup> Digestibility coefficients based on rainbow trout trials

<sup>2</sup> Not Tested
PROPLEX T in Catfish Diets: Substitute SBM

- Juveniles (~14 g)
- 15 fish/tank
- 4 tanks/treatment
- Trial length: 8 weeks

RESULT

- Better growth rate up to 12% inclusion rate compared to SBM
- No significant difference in FCR (1.36-1.73) or survival (81.7-100%)

Source: ADM Research Trial (D. Allen Davis, Auburn University)
PROPLEX T in Practical Shrimp Diets

- Juveniles (~2.3 g)
- 10 shrimp/tank
- 4 tanks/treatment
- Trial length: 6 weeks

**RESULT**

- No significant difference in weight gain (316.9-359.3 g), survival (84-88%), FCR (1.53-1.70), or Protein Retention Efficiency (31.1-35.9)
- PROPLEX T can be included up to 12% in practical diets

Source: X Qiu and A. Davis, in process
Pompano using PROPLEX T to Reduce FM

- Juveniles (~8.1 g)
- 20 fish/tank
- 3 tanks per treatment
- Trial length: 10 weeks

**RESULT**

- There was no significant difference in final weight (64.5g-79.5 g), survival (81.7%-96.7%), percent weight gain (711.6%-879.0%), or FCR (2.1-2.0).
- PROPLEX T can be included up to 12.8% in practical diets and higher levels should be evaluated.

### Ingredient\(^1\)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Control (0)</th>
<th>PROPLEX T (4)</th>
<th>PROPLEX T (8)</th>
<th>PROPLEX T (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROPLEX T</td>
<td>0.0</td>
<td>4.3</td>
<td>8.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Menhaden fish meal</td>
<td>15.0</td>
<td>10.0</td>
<td>5.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Poultry byproduct meal</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>34.0</td>
<td>34.0</td>
<td>34.0</td>
<td>34.0</td>
</tr>
</tbody>
</table>

\(^1\)Other ingredients include: menhaden fish oil, corn starch, whole wheat, vitamin and mineral premixes, choline chloride, Stay C, CaP-dibasic, lecithin, and amino acids

PROPLEX T in Practical Red Fish Diets

- Juveniles (~8.0 g)
- 20 fish/tank
- 3 tanks per treatment
- Trial length: 8 weeks

**RESULT**

- No significant difference in weight gain (632-702 g), feed efficiency (0.90-0.96), or survival (95-98.3%)
- PROPLEX T can be included up to 13.5% (30% of CP) in practical diets and higher levels should be evaluated

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Control (0)</th>
<th>PROPLEX T (4)</th>
<th>PROPLEX T (9)</th>
<th>PROPLEX T (14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROPLEX T</td>
<td>0.0</td>
<td>4.5</td>
<td>9.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Menhaden fish meal</td>
<td>28.5</td>
<td>25.7</td>
<td>22.8</td>
<td>20.0</td>
</tr>
<tr>
<td>Dex starch</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>38.4</td>
<td>34.5</td>
<td>30.7</td>
<td>26.9</td>
</tr>
</tbody>
</table>

1Other ingredients include: menhaden fish oil, vitamin and mineral premixes, CMC, amino acids, and Celufil

PROPLEX T – Dried Fermentation Biomass
Research Recap

**Wide Acceptance**
- Accepted by a variety of species
  - Additional trials in progress (e.g., Atlantic salmon)

**5-10% Inclusion**
- Best growth performance appears to be around 5-10% inclusion level for most species
  - Higher inclusion levels accepted by some species

**Palatability Concerns**
- Palatability issues at high inclusion levels (>15%) for some species

**Suitable Alternative**
- Suitable alternative to FM and other protein sources (e.g., SBM, concentrates, and isolates) in practical formulations
PROPLEX T – Dried Fermentation Biomass

Summary

- Excellent amino acid profile
- Highly digestible
- 74% crude protein
- Consistent high-quality protein source
- Added flexibility to formulation
- Viable alternative

Aquaculture: recommended inclusion level of 5%