Introductions

• Who is Zeigler Bros., Inc.?
• Review of Florida pompano nutrition.
• Overview of feed manufacturing.
• Introduction to texturized feed manufacturing.
• Founded in 1935 by brothers Ty and LeRoy as a local producer of poultry and livestock feeds.

• Dr. Tom Zeigler (son of LeRoy) assumed leadership in 1967 and changed the strategic direction towards R&D of specialty animal and aquatic feeds.

• Today, as Zeigler embarks on its 3rd generation of family leadership the company continues to develop new and innovative technologies for specialty markets.

• With just under 100 employees globally, Zeigler exports hatchery products to 50 countries and is responsible for about 80,000 MT of aquafeed production in five countries.
Zeigler
nutrition through innovation

nutrition through innovation

Shrimp Aquaculture
Finfish Aquaculture
Pet & Zoo
Health & Research
Feed Mill Technology

Zeigler
nutrition through innovation
Our VISION

To serve as the global beacon for nutritional innovation, bringing value to the lives of our customers, employees, and communities.
Company Profile

2013
Matt and Tim Zeigler assume Company Leadership

2014
Dr. Craig Browdy becomes the new Director of Research and Development

2015
Dr. Leandro Castro becomes Project Manager at ZBI-RD

2016
Peter VanWyck becomes the ZARC manager – Full Technical Staff for Conducting Trials

2017
New Website
• www.zeiglerfeed.com
• Focus on Customer
• Updated Product Information

2018
R&D / Nutrition Efforts Supported by:
• 4 Ph.D. Scientists
• 10 Technicians
• 2 In-House R&D Facilities

2018
Nutrition Department Expands
• Christa Rice – Nutrition Assistant
• Dr. Scott Snyder – Nutritional Technology Manager

• Zeigler maintains highly diverse ingredient stocks.
• Zeigler manages a sales portfolio of over 300 product SKU’s; 80% of which are aqua products.
Florida Pompano Nutrition

• Protein
• Fat
• Carbohydrates
• Vitamins and Minerals
• Specialty Additives
Determining Nutrient Requirements

- Comparative gut physiology is useful in determining basic dietary tolerances.
- Digestive System A is representative of a carnivorous species like salmonids.
- System B represents an omnivore species with carnivore preference like a catfish.
- System C represents omnivore species with herbivore preference like tilapia.
- System D represents herbivore species like carp.
Pompano Digestive System

- Pompano have a carnivorous digestive system.
- Indicates the need for high protein levels and low tolerance for carbohydrates.
- Indicates a preference animal-derived proteins and fats.
- Feeds must be composed of highly digestible ingredients.
- This basic understanding of the digestive system and early gross protein and energy requirement studies identified that a pompano diet should be relatively high in crude protein (40-50%) and contain moderate levels of fat (10-15%).

Gothreaux, 2008
Protein Requirement

• We are referring to amino acid requirements.
• Experimental feeds designed to mimic the amino acid profile of the Florida pompano have led to a better understanding of dietary amino acid requirements for this species.
• Several labs have made requirement estimates for key amino acids methionine, lysine, arginine and taurine.
• The use of the ideal protein concept has allowed rapid development of highly digestible feeds.
• However, there is much more to determine.
Lysine Requirement

\[ Y = \frac{-1.1625 + 0.0788 \times 10^{1.09}}{0.375 + 10^{1.09}} \]

Requirement = 1.57%
## Nutrient Requirements – Amino Acids

### Freshwater Fish Requirements, AA

<table>
<thead>
<tr>
<th>% protein</th>
<th>Channel Catfish</th>
<th>Rainbow trout</th>
<th>Pacific salmon</th>
<th>Common Carp</th>
<th>Tilapia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arginine</td>
<td>1.20 1.20</td>
<td>1.50 1.50</td>
<td>2.04 2.20</td>
<td>1.31 1.70</td>
<td>1.38 1.20</td>
</tr>
<tr>
<td>Histidine</td>
<td>0.42 0.60</td>
<td>0.70 0.80</td>
<td>0.61 0.70</td>
<td>0.64 0.50</td>
<td>0.48 1.00</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>0.73 0.80</td>
<td>0.90 1.10</td>
<td>0.75 1.00</td>
<td>0.76 1.00</td>
<td>0.87 1.00</td>
</tr>
<tr>
<td>Leucine</td>
<td>0.96 1.30</td>
<td>1.40 1.50</td>
<td>1.33 1.60</td>
<td>1.00 1.40</td>
<td>0.95 1.90</td>
</tr>
<tr>
<td>Lysine</td>
<td>1.43 1.60</td>
<td>1.80 2.40</td>
<td>1.70 2.20</td>
<td>1.74 2.20</td>
<td>1.43 1.60</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.60 0.70</td>
<td>0.70 0.70</td>
<td>0.70 0.70</td>
<td>1.00 0.90</td>
<td>1.00 0.90</td>
</tr>
<tr>
<td>Methionine, cystine</td>
<td>0.64 0.90</td>
<td>1.00 1.10</td>
<td>1.36 1.10</td>
<td>0.94 1.00</td>
<td>0.90 1.00</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>0.07 0.90</td>
<td>0.90 1.30</td>
<td>1.30 1.30</td>
<td>1.10 1.10</td>
<td></td>
</tr>
<tr>
<td>Phenylalanine, tyrosine</td>
<td>1.40 1.60</td>
<td>1.80 1.80</td>
<td>1.73 1.80</td>
<td>1.98 2.00</td>
<td>1.55 1.60</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.56 0.70</td>
<td>0.80 1.10</td>
<td>0.75 1.10</td>
<td>1.19 1.50</td>
<td>1.05 1.10</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.14 0.20</td>
<td>0.20 0.30</td>
<td>0.17 0.30</td>
<td>0.24 0.30</td>
<td>0.28 0.30</td>
</tr>
<tr>
<td>Valine</td>
<td>0.84 0.80</td>
<td>1.20 1.20</td>
<td>1.09 1.20</td>
<td>1.10 1.40</td>
<td>0.78 1.50</td>
</tr>
</tbody>
</table>
Nutrient Requirements - Vitamins

Table 10. Dietary vitamin requirements for rainbow trout, channel catfish and common carp (mg/kg dry diet unless specified)

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Rainbow trout</th>
<th>Channel catfish</th>
<th>Common carp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (IU)</td>
<td>2000-15000</td>
<td>5500</td>
<td>1000-20000</td>
</tr>
<tr>
<td>Vitamin D (IU)</td>
<td>2400</td>
<td>500-4000</td>
<td>NR</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>30-50</td>
<td>50-100</td>
<td>80-300</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>10</td>
<td>10</td>
<td>NR</td>
</tr>
<tr>
<td>Thiamine</td>
<td>1-12</td>
<td>1-20</td>
<td>NR</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>3-30</td>
<td>9-20</td>
<td>4-10</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>1-15</td>
<td>3-20</td>
<td>4</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>10-50</td>
<td>10-50</td>
<td>25</td>
</tr>
<tr>
<td>Niacin</td>
<td>1-150</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Folic acid</td>
<td>5-10</td>
<td>NR or 5</td>
<td>NR</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>0.02</td>
<td>0.02</td>
<td>NR</td>
</tr>
<tr>
<td>Choline</td>
<td>50-3000</td>
<td>400</td>
<td>500-4000</td>
</tr>
<tr>
<td>Inositol</td>
<td>200-500</td>
<td>NR</td>
<td>200-440</td>
</tr>
<tr>
<td>Biotin*</td>
<td>0.8</td>
<td>0.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>100-500</td>
<td>NR or 100</td>
<td>R</td>
</tr>
</tbody>
</table>

NR = Not required;
R = Required
Source: Lall (1991); *After Hepher (1990)
Commercial Formulation

• Identify what is known.
• Use the numerous resources to fill in the unknown with data from species as similar as possible.
• Strike a balance between manageable requirements and cost.
• Formulation is the practice of constructing a finished feed recipe that both nourishes the animal and satisfies the requirements of the farmer in terms of cost, and overall objectives.
Commercial Formulation

• Responsibility to customer.
• Responsibility to animal.
• Limitations of culture system.
  • Digestibility and waste characteristics.
• Overall customer objectives.
  • Animal performance.
  • Sustainability.
  • Certification scheme.
Practical Feedstuffs for Pompano

Gonzalez-Felix et al., 2010

Table 3 Mean (±SD) water quality parameters in each of four replicated systems used to determine digestibility coefficients for select feed ingredients fed to Florida pompano, Trachinotus carolinus held at 3 g L⁻¹ and 28 g L⁻¹

<table>
<thead>
<tr>
<th>Parameter</th>
<th>System 1</th>
<th>System 2</th>
<th>System 3</th>
<th>System 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen (mg L⁻¹)</td>
<td>5.84 ± 0.14</td>
<td>4.93 ± 0.37</td>
<td>4.40 ± 0.49</td>
<td>5.52 ± 0.36</td>
</tr>
<tr>
<td>Salinity (g L⁻¹)</td>
<td>2.7 ± 0.3</td>
<td>3.10 ± 0.8</td>
<td>3.04 ± 0.8</td>
<td>2.9 ± 0.3</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>27.5 ± 0.3</td>
<td>27.1 ± 0.4</td>
<td>27.4 ± 0.5</td>
<td>27.5 ± 0.6</td>
</tr>
<tr>
<td>Ammonia-N (mg L⁻¹)</td>
<td>0.22 ± 0.20</td>
<td>0.28 ± 0.17</td>
<td>0.21 ± 0.12</td>
<td>0.18 ± 0.12</td>
</tr>
<tr>
<td>Nitrite (mg L⁻¹)</td>
<td>0.41 ± 0.25</td>
<td>1.41 ± 0.63</td>
<td>1.78 ± 1.00</td>
<td>1.16 ± 0.58</td>
</tr>
<tr>
<td>pH</td>
<td>8.1 ± 0.2</td>
<td>7.8 ± 0.3</td>
<td>7.8 ± 0.3</td>
<td>8.4 ± 0.3</td>
</tr>
<tr>
<td>Alkalinity (ppm CaCO₃)</td>
<td>170 ± 62</td>
<td>182 ± 49</td>
<td>186 ± 49</td>
<td>179 ± 43</td>
</tr>
</tbody>
</table>

Riche et al., 2017
Feed Formulation

Process of selecting and blending ingredients into a product that meets the nutritional requirements of the animal and can be manufactured in a utilizable form cost effectively.
# Finished Formula

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Reference diet</th>
<th>Test diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal, menhaden</td>
<td>379.4</td>
<td>265.6</td>
</tr>
<tr>
<td>Soybean meal (49% CP)</td>
<td>250.0</td>
<td>175.0</td>
</tr>
<tr>
<td>Soy protein concentrate</td>
<td>100.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>153.3</td>
<td>107.3</td>
</tr>
<tr>
<td>Oil, menhaden</td>
<td>65.0</td>
<td>45.5</td>
</tr>
<tr>
<td>Soy lecithin</td>
<td>10.0</td>
<td>7.0</td>
</tr>
<tr>
<td>CMC₁</td>
<td>20.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Vitamin mix²</td>
<td>5.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Mineral mix³</td>
<td>2.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Stay-C³</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Chronic oxide</td>
<td>10.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Ethoxyquin</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>4.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Test ingredient⁴</td>
<td></td>
<td>300.0</td>
</tr>
</tbody>
</table>

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1. Carboxymethylcellulose, sodium salt.
2. Per kg diet: vitamin A, 6000 IU; vitamin D, 1000 IU; vitamin E, 0.1 g; biotin, 0.2 g; folic acid, 9 mg; niacin, 0.2 g; pantothenic acid, 0.1 g; vitamin B-6, 25 mg; riboflavin, 40 mg; thiamin, 40 mg; vitamin B-12, 20 mg.
3. Per kg diet: iron, 0.1 g; manganese, 25 mg; copper, 10 mg; zinc, 0.1 g; iodine, 4.5 mg; cobalt, 50 mcg; selenium, 0.5 mg.
4. Stay-C stabilized vitamin C (L-ascorbyl-2-polyphosphate), 35% ascorbic acid activity.
5. Canola meal, corn gluten meal, or distillers dried grains with solubles.

Lech & Reigh, 2012
Pompano-specific Formulation

• Today, there is adequate data available to construct high-quality pompano-specific feeds.

• There are still numerous nutrient requirements to determine.

• If the formulator considers the rearing environment and the producer’s objectives, superior profitability can be achieved over general marine feeds.
Good Nutrition

Success

Nutrients  Feed  Feeding

Problems

Nutrients  Feeds  Feeding Methods
Feed Physical Characteristics

- Particle size and uniformity depend on fish size and uniformity
- Freshness – check labels for manufacture dates
- Packaged to retain quality, shelf life and palatability
- Water stability adequate to retain nutrients
- Shape and texture as preferred by the animal
- Proper storage
Aquafeed Processing

• Traditional dry extrusion review.
Traditional Extrusion
Traditional Extrusion

• Primary Objectives
  • Starch-based pellet binding.
  • Aquafeed industry standard.
  • Process and ingredient combinations are vast.
  • Efficient and low-cost operations
  • Consistent final product physical characteristics.
  • Predictable.
Texturized Extrusion

Extruded meat analogues with enhanced nutritional value were produced by incorporating microalgae to its formulation. However, to achieve appropriate fibrillar structure, moisture contents were optimized.
Texturized Extrusion

• **Primary objectives**
  • Offer a feed with natural mouth-feel.
  • Offer a feed with incredible water stability.
  • Increased performance over traditional extrusion.
  • Increased use of alternative ingredients.
Texturized Extrusion
Texturized Extrusion
Complete Feed Program

- Formulation
- Manufacturing
- Feeding Methods

Success

Nutrients
Feed
Feeding
Conclusions

• Current state is that the texturized extrusion is costly.

• Texturized extrusion did not result in improved FCR.

• There is much more to learn about this species in terms of nutrition, feeds, and feeding.
“The ability to learn faster than your competition may be the only sustainable competitive advantage.”