Indirect criteria to select the trout lines to enhance the feed efficiency of plant based diet

Kimia Kajbaf and Vikas Kumar

Aquaculture Research Institute
Department of Animal and Veterinary Sciences
Sustainable feed

- >60% of total production costs goes to fish feed
- Traditionally: Fish meal was major source for protein
- Currently: Plant protein is the number one ingredient in aquafeed

Global Fish Meal and Fish Oil Supply

Hyben, 2017
Rainbow Trout Selection for Plant Protein Utilization (UI-ARI and USDA)
Selection of trout reared on high soy diet

- Initial Average weight = 30 ± 1.6 g
- 5 month feeding trial

**Plant-based diet:** 23% SPC, 25% soybean meal, 10% corn protein concentrate

Unpublished data from ARI/USDA
Enteritic effect of high soy diet

- Selected-Plant meal
  - Lamina Propria
  - supranuclear vacuoles
  - Submucosal layer

- Nonselected-Plant meal
  - mucous cell hyperplasia
  - lymphocytes

STOMACH
PYLORIC CECA
DISTAL INTESTINE
MI
Growth performance results of the selected line

**Final body weight**

<table>
<thead>
<tr>
<th></th>
<th>FM-NS</th>
<th>FM-SE</th>
<th>PM-NS</th>
<th>PM-SE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (g)</strong></td>
<td>63.2</td>
<td>62.6</td>
<td>61.9</td>
<td>64.7</td>
</tr>
</tbody>
</table>

**Specific Growth Rate (SGR, %/day)**

<table>
<thead>
<tr>
<th></th>
<th>FM-NS</th>
<th>FM-SE</th>
<th>PM-NS</th>
<th>PM-SE</th>
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</thead>
<tbody>
<tr>
<td><strong>SGR</strong></td>
<td>3.65</td>
<td>3.50</td>
<td>3.20</td>
<td>3.70</td>
</tr>
</tbody>
</table>

Unpublished data from ARI/USDA

FM=Fish Meal
PM= Plant Meal
NS= Non-selected
SE=Selected
Growth vs. feed efficiency?
Research design

Phase I
- Fertilization
- PIT Tag implantation
- 1st Feeding challenge
- (6 months)

Phase II
- Acclimatization
- RFI records
- 2nd feeding challenge
- (8 months)

Phase III
- Selection for lines
- Challenging with the same diet
- (4 months)
Sample collection: 3 fish per tank
- Liver
- Muscle
- Digesta
- Distal intestine

Weighing fish individually (~1600 fish) and sample collection
Fish response to compensatory feeding regime

- Fish shows variation in weight gain and loss in response to FD and RF

![Graph showing fish response to FD and RF](image)

- 399 fish in FD+/RF+
- 369 fish in FD+/RF-
- 310 fish in FD-/RF-
- 253 fish (14% of initial population) in FD-/RF+
Residual Feed Intake (RFI): RFI = actual feed intake - expected feed intake

Acclimatization

1 month

RFI measurement every 2 week

3 month

Feed Deprivation

1 month

Refeeding

1 month

Feed Deprivation

1 month

Refeeding

1 month

* Weighing fish individually (~1000 fish) and sample collection

Phase II

Phase I

Phase II

Phase III

Helland et al., 1996
Fish response to compensatory feeding regime was re-evaluated

Fish selection after 2\textsuperscript{nd} challenge

Distribution of individuals across the groups from different families

<table>
<thead>
<tr>
<th>Families</th>
<th>Number of Fish</th>
<th>FD\textsuperscript{+}/RF\textsuperscript{+}</th>
<th>FD\textsuperscript{-}/RF\textsuperscript{+}</th>
<th>FD\textsuperscript{+}/RF\textsuperscript{-}</th>
<th>FD\textsuperscript{-}/RF\textsuperscript{-}</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>46 fish</td>
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<tr>
<td></td>
<td>23 fish</td>
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<td>43 fish</td>
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</tr>
<tr>
<td></td>
<td>30 fish</td>
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<tr>
<td></td>
<td>FD\textsuperscript{+}/RF\textsuperscript{-}</td>
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</tr>
<tr>
<td></td>
<td>FD\textsuperscript{-}/RF\textsuperscript{-}</td>
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</tbody>
</table>
Phase III

Phase I
- Selection

Phase II
- Rearing progeny

Phase III
- Challenging with same diet
- Studying performance
Expected outcomes and Benefits

• Genetic improvement of rainbow trout for efficient high soy diet utilization
• 10-20% increase in feed efficiency
• Lower the cost of production
• Sustainable aquaculture
• Can be applied for other commercial fish
Thank you!