DIETARY REQUIREMENTS OF ORGANIC AND INORGANIC ZINC IN DIPLOID AND TRIPLOID RAINBOW TROUT (*Oncorhynchus mykiss*)

KRISTEN A. MEILER AND VIKAS KUMAR
AQUACULTURE RESEARCH INSTITUTE
DEPARTMENT OF ANIMAL AND VETERINARY SCIENCE
AQUACULTURE

• Fastest growing food sector
• Provides > 50% fish/shellfish consumed by humans
• Feed: 60-70% of total operational cost

Feed Conversion Ratio
Pounds of feed to produce one pound of animal protein

Source: http://www.earth-policy.org/books/pb2/pb2ch9_ss4
VARIABLES

Zn: Essential trace mineral
• Present in all organs, tissues and fluids
• Produce deficiency symptoms when removed

Organic: Chelated with other ingredients
• More bioavailable
• Organic = 15% Zn, Inorganic = 75-80% Zn

Triploids:
• Sterile
• Potential for faster growth
• May have different nutrient requirements
GOAL AND OBJECTIVES

To determine Zn requirements in a commercial strain of rainbow trout.

1. Organic vs. inorganic zinc
2. 2X vs. 3X ("Genetically similar")
MATERIALS AND METHODS

FEED FORMULATION

- Basal diet 33 mg/kg Zn
- 43% crude protein [isonitrogenous]
- 20% lipid [isolipidic]
- Incremental organic (Alltech)/inorganic (ZnSO₄) Zinc

<table>
<thead>
<tr>
<th>Basal</th>
<th>Inorganic</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Zn₃₃</td>
<td>Zn₆₃</td>
<td>Zn₉₃</td>
</tr>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Zn₁₂₃</td>
<td>Zn₁₅₃</td>
<td>Zn₁₈₃</td>
</tr>
<tr>
<td>G</td>
<td>H</td>
<td>I</td>
</tr>
<tr>
<td>Zn₆₃</td>
<td>Zn₉₃</td>
<td>Zn₁₂₃</td>
</tr>
<tr>
<td>J</td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>Zn₁₅₃</td>
<td>Zn₁₈₃</td>
<td></td>
</tr>
</tbody>
</table>
MATERIALS AND METHODS

SAMPLING

11 fish
  3 fish
  9 fish
  9 fish
  9 fish

- Standard/total/fork length and K
- Whole body proximate

11 fish
  3 fish
  9 fish

- Caudal blood drawn for analysis of zinc dependent enzymes
- Tissues removed for liver, vertebrae, and whole-body zinc analysis
- Tissues removed for RNA extraction
- Distal intestine histology

11 fish
  3 fish
  9 fish

- Cataract formation and lens histology
RESULTS

**Triploid Lipid Retention**

Box plots showing the distribution of lipid retention in triploid organisms with different inorganic and organic conditions. The plots indicate a significant difference (*p* < 0.05) in lipid retention between inorganic and organic conditions, with inorganic conditions generally showing higher lipid retention.
DISTAL INTESTINE HISTOLOGY

6a: Diploid control
6b: Triploid control
6c: Diploid organic Zn\textsubscript{183}
6d: Triploid organic Zn\textsubscript{183}

Intestinal morphology are labeled as follows:
A: Serosa
B: Muscularis
C: Submucosa
D: Lamina propria
E: Goblet cell
F: Absorptive vacuoles
G: Epithelial layer
CONCLUSIONS

1. Zinc requirements for fish tended to be higher in the inorganic diets when compared with organic diets.
2. No significant growth differences were seen between treatments for zinc type, amount, or ploidy.
3. Organic diets yielded significantly higher lipid retention and whole-body protein content.
4. Skeletal and operculum deformities varied between treatments, more deformities were observed in triploids.
5. No significant differences were seen in cataract formation or lens histology.
6. No significant differences were seen in distal intestine histology.
ONGOING ANALYSES AND FUTURE RESEARCH

Ongoing analyses:

- Mineral analysis
- Fatty acid analysis
- Gene expression
  - Oxidative stress related
  - Bone development
  - Growth
- Determination of antioxidant enzyme activity
- Bone density (X-ray)

Future research:

- Digestibility study
- Increase genetic variability
- Fillet quality
ACKNOWLEDGEMENTS

1 ARI staff
1 Dr. Seunghan Lee
1 Dr. Erin Scott, Texas A&M University
1 Dr. Nicholas Romano, University of Arkansas at Pine Bluff
1 Scott Williams and Daniel Korbel