Effects of rearing conditions on low-temperature tolerance of Nile tilapia, *Oreochromis niloticus*, juveniles

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Background information

- Global expansion of tilapia farming constrained by sensitivity to low temperature
- Optimal growth temperature: 25-28°C
- Over-wintering mortalities common
- Cold tolerance in fish dependent on
  - Environment
  - Health and nutrition
  - Genetic effects
- Selection for growth in low input environments at Abbasa, Egypt
- Improvement of trait important for extension of grow-out period
Objectives

- Investigate the effect of age, genotype and body size on cold tolerance (Experiment 1)
- Investigate effect of diet on cold tolerance (Experiment 2)
- Determine low lethal temperature for *O. niloticus* reared under low-input environments (Experiment 1 and 2)
- Determine the effect of acclimatization on cold tolerance (Experiment 1 and 2)
Experiment 1

- Fry families produced and grown in separate 2x3 m hapas in pond until tagging
- Pond received 50kg/ha chicken manure per day
- Carried out in summer
- 10 fry/ family from 80 families tagged
- Age range from 41-90 days
- Weight: 1-20g
Cold tolerance test

- Experiment in cold room and 5 aquaria
- Water temperature lowered from 16 °C at the rate of 1°C/day
- Fry not fed
- Hourly measurements of temperature and mortality
- Trait description: Temperature at Death (TAD) or Cooling Degree hours (CDH)
Experiment 2

- Carried out in Fall
- 20 full-sib families produced using brooders in first experiment
- Each family divided in two groups of 30 swim-up fry
- Assigned to two treatments: pellet and natural-fed
- Reared for 42 days
- 10 fish per treatment per family tagged for cold tolerance
- Cold tolerance measured as in experiment 1
Data analysis

- Genotype, aquarium, age, size analyzed in experiment 1

- Model 1:
  - \[ Y_{ijkl} = \mu + a_i + \beta_1 \text{AGE}_{ijkl} + \beta_2 \ln(w)_{ijkl} + s_j + d_k(s_j) + e_{ijkl} \]

- Effect of diet, genotype, aquarium, specific growth rate, condition factor and genotype X diet effects analyzed in second experiment

- Correlation of size and cold tolerance
Results

Fish that lost balance (arrows) considered dead
Results

- Mortality in experiment 1 from 13.6°C to 8.6 °C
- Experiment 2: from 11.7 °C to 7.5 °C
# Size and cold tolerance parameters of pellet and natural-fed tilapia fry

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Diet</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pellet-fed</td>
<td>Natural-fed</td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>0.045 (0.03)</td>
<td>0.045 (0.03)</td>
</tr>
<tr>
<td>Final weight (g)</td>
<td>1.97 (0.65)</td>
<td>1.92 (0.61)</td>
</tr>
<tr>
<td>Standard length (mm)</td>
<td>38.05 (3.99)</td>
<td>37.58 (3.81)</td>
</tr>
<tr>
<td>Specific growth rate (%/day)</td>
<td>9.37 (1.21)</td>
<td>9.34 (1.29)</td>
</tr>
<tr>
<td>Condition factor</td>
<td>3.86 (0.40)</td>
<td>3.71 (0.37)</td>
</tr>
<tr>
<td>Temperature at death (°C)</td>
<td>8.9 (0.67)</td>
<td>9.0 (0.64)</td>
</tr>
<tr>
<td>Cooling degree hours</td>
<td>551.66 (104.53)</td>
<td>530.56 (99.80)</td>
</tr>
</tbody>
</table>
Tendency for smaller fish to have lower cold tolerance

\[ y = 86.662 \ln(x) + 165.31 \]

\[ R^2 = 0.3365 \]
Presence of genotype environment interaction
Results and Discussion

- Significant effect of aquarium, genotype, fish size in both experiments
- Age does not affect tolerance
- Pellet-fed fish significantly more cold tolerant than natural (phytoplankton) fed fish
- Fish reared in autumn more cold tolerant
  - Acclimatization effect?
Acclimatization

- Mortality in experiment 1 from 13.6°C to 8.6 °C
- Experiment 2: from 11.7 °C to 7.5 °C
Temperature regimes during fry rearing in the two experiments

(a) Min. Experiment 1
Min. Experiment 2

(b) Max. Experiment 1
Max. Experiment 2

Time (days)
Conclusions

- Smaller (<5g) fish are less tolerant to lower temperatures

- Potential for manipulation of environment and diet for improved cold tolerance

- Genotype x diet interactions should be further studied
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Thank You All!