Bio-flocs technology application in over-wintering of tilapia

Roselien Crab, Malik Kochva, Willy Verstraete and Yoram Avnimelech
The Problem

- One of the problems of growing tilapia in temperate regions is over-wintering. You need the whole year to complete the growing cycle of tilapia, yet, tilapia is sensitive to cold temperature and below ~13°C mortality starts.

- In Israel, normally it is possible to hold juveniles in ponds without catastrophes, but if cold spells occur, mortality takes place and next year there are much less tilapia in the market.

- Similar situation was report from China, where production declined by ~80% due to the cold winter 2008
Potential solution

- It is possible to keep juveniles and market size fish in green houses or similar structures during the winter, usually using solar heating, but in cases geothermal water.

- These structures are expensive. A dense biomass has to be held, in order to justify the investment. In case of dense biomass, metabolites, especially ammonium may accumulate and endanger the fish population.

- Water replacement is not a reasonable option, since you loose heat by releasing the warm water.
Use of biofloc technology as an option?
Materials and methods

- Experimental design
  - Winter period 2008 (13th of January till 4th March)
  - 10 circular concrete ponds (1 m deep, 50 m²)
  - Paddlewheel + upward flow aerator
  - 50 and 100 g tilapia hybrid fingerlings (Oreochromis niloticus x Oreochromis aureus)
  - 16 kg fish/m³ pond water (could be raised!)
  - Water exchange: 25% → 10% → 0%
Materials and methods

- Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Feed protein (% DW)</th>
<th>Feed added (kg/day)</th>
<th>Starch added (kg/day)</th>
<th>C/N</th>
<th>Pond No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% P</td>
<td>30</td>
<td>5</td>
<td>0</td>
<td>10.8</td>
<td>1</td>
</tr>
<tr>
<td>30% P + STARCH</td>
<td>30</td>
<td>5</td>
<td>4.5</td>
<td>20.4</td>
<td>3, 5, 8</td>
</tr>
<tr>
<td>23% P</td>
<td>23</td>
<td>6.5</td>
<td>0</td>
<td>14.0</td>
<td>2, 9</td>
</tr>
<tr>
<td>23% P + STARCH</td>
<td>23</td>
<td>6.5</td>
<td>3</td>
<td>20.5</td>
<td>4, 6, 7, 10</td>
</tr>
</tbody>
</table>

- Daily measurement water quality (nitrogen) with 0% water exchange during 5 days

- More detailed nitrogen dynamics during 24 hr
Results

- Temperature and oxygen control
  - Dissolved oxygen: 9 – 10 mg O₂/L
  - Average temperature: 18°C
5 days of zero water exchange

Results (1)

- Nitrogen dynamics – Total nitrogen
Results (2)

○ Nitrogen dynamics – Inorganic nitrogen
Results (3)

- Nitrogen dynamics - Suspended nitrogen

![Graph showing suspended nitrogen dynamics over time for different conditions.](image)
24 hours nitrogen balance

Results (1)

- Inorganic nitrogen dynamics – Ammonium nitrogen
Results (2)

- Inorganic nitrogen dynamics - Nitrite nitrogen
Results (3)

- Inorganic nitrogen dynamics - Nitrate nitrogen
Results (4)

- Inorganic, organic and total nitrogen dynamics
**Fish survival, growth and condition factor.**

- **Fish survival**
  - 50 g fish: 80 ± 4%
  - 100 g fish: 97 ± 6%

- **Fish growth**
  - 50 g fish: 0.27 ± 0.02 g/fish.day
  - 100 g fish: 0.29 ± 0.03 g/fish.day

- **Condition factor**
  - CF = 100 \( \frac{W}{L^3} \)
    - CF < 1.8 poor conditions
    - CF > 2 good physiological state
  - 50 g fish: 2.17 ± 0.06
  - 100 g fish: 2.19 ± 0.07
Conclusions

- Greenhouse ponds + Bio-flocs technology =
  - Temperature control
    Collect and preserve solar heating with minimization of water exchange
  - Water quality control
    Proper C/N ratio: inorganic nitrogen $\rightarrow$ organic nitrogen
  - Fish survival
    Excellent (vs mass mortality)
  - Fish growth
    High (vs no growth)
  - Fish condition
    Excellent

Many thanks to the team of the Genosar Experimental Intensive Fish Production Station