BIOFILTRATION OF AQUACULTURE EFFLUENTS: NUTRIENT STRIPPING EFFICIENCIES IN FOUR SEAWEED SPECIES

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INTRODUCTION

SUSTAINABILITY CHALLENGES OF AQUACULTURE

Land-based production

Sea cages production

Increase Interactions with the Environment
As consumers, we influence the landscapes and lives of those who live near the extraction, manufacturing, disposal, and other impacts of the products we use every day.
Aquafeed inputs

Eutrophication, oxygen depletion, biodiversity modifications, ...
Requirements of algal biofilter

- High production
- Ease to cultivate
- Resistance to epiphytes
- Grow well in high nutrient concentrations
- Economically viable
- Local species

Few successfully tested species

Neori 2004
OBJECTIVES
• Evaluate the growth of free floating macroalgae with water biofiltration capacities

• Determine the biofiltration and production capacity of cultured macroalgae

• Optimize the nutrient capture process by macroalgae in a land-based aquaculture production facility
MATERIAL & METHODS
Macroalgal selected
Culture conditions

90 l tanks, 10 renovations / day

Seaweeds:
- Harvested
- Blot dried
- Weighed

Growth rate

$$\mu = \frac{100 \ln \left( \frac{P_t}{P_0} \right)}{t} = \%$$

Production rate

$$P = \frac{\frac{N_t - N_0}{PH} \times PS}{A} = gPSm^{-2}d^{-1}$$

3 replicates for 3 Weeks
Ammonia biofiltration capacity

Water samples

Entrance

Exit

Weekly

Colorimetric method by Parsons *et al.*, 1984

NITROGEN UPTAKE EFFICIENCY = %

NITROGEN UPTAKE RATE = \( m \text{ mol m}^{-2} \text{ h}^{-1} \)

STATISTICAL ANALYSIS = PERMANOVA
RESULTS
Growth Rates

**Ulva rigida**

- Week 1: 15.93%
- Week 2: 11.80%
- Week 3: 5.37%
- Average: 11.03%

**Colpomenia sinuosa**

- Week 1: -5.01%
- Week 2: -7.44%
- Week 3: -5.83%
- Average: -6.09%

**Schizymenia dubyi**

- Week 1: 2.32%
- Week 2: 1.60%
- Week 3: 0.83%
- Average: 1.58%

**Valonia utricularis**

- Week 1: 3.76%
- Week 2: 0.59%
- Week 3: -0.12%
- Average: 1.31%
Production Rates

*Ulva rigida*

*Colpomenia sinuosa*

*Schizymenia dubyi*

*Valonia utricularis*
## Nitrogen Uptake

<table>
<thead>
<tr>
<th></th>
<th>U. rigida</th>
<th>C. sinuosa</th>
<th>S. dubyi</th>
<th>V. utricularis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUE</strong></td>
<td>90.19 ± 13.87a</td>
<td>87.59 ± 10.27a</td>
<td>73.90 ± 3.15b</td>
<td>63.85 ± 11.02a</td>
</tr>
<tr>
<td><strong>NUR</strong></td>
<td>0.73 ± 0.49a</td>
<td>0.64 ± 0.38a</td>
<td>0.94 ± 0.25a</td>
<td>0.61 ± 0.36a</td>
</tr>
<tr>
<td><strong>Growth rate (%)</strong></td>
<td>11.03 ± 4.34a</td>
<td>-4.28 ± 0.65b</td>
<td>1.58 ± 0.61c</td>
<td>1.30 ± 1.54c</td>
</tr>
<tr>
<td><strong>Production rate</strong></td>
<td>35.91 ± 17.33a</td>
<td>-52.23 ± 8.66b</td>
<td>3.27 ± 1.01c</td>
<td>1.76 ± 2.05c</td>
</tr>
</tbody>
</table>

*C. sinuosa* did not resist free floating culture conditions

*U. rigida* similar results to other studies

*S. dubyi* comparable to *Hydropuntia cornea* in other studies
Biofiltration ability (NUR) in relation to algal biomass

<table>
<thead>
<tr>
<th>Algal Species</th>
<th>Biofiltration (mmol NH$_4^+$ m$^{-2}$ h$^{-1}$ kg$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulva rigida</td>
<td>4.05</td>
</tr>
<tr>
<td>Colpomenia sinuosa</td>
<td>1.19</td>
</tr>
<tr>
<td>Schizymenia dubyi</td>
<td>3.93</td>
</tr>
<tr>
<td>Valonia utricularis</td>
<td>1.48</td>
</tr>
</tbody>
</table>
Summary

- *Ulva rigida* showed the best growth, production rates and biofiltration efficiency followed closely by *Schizymentia dubyi*.

- *Valonia utricularis* presented an acceptable growth and production rates but NUE and NUR were not high enough to be considered as a good biofiltering species.

- *C. sinuosa* also presented a high NUE, but it may be overestimated because of the epiphytes and bacteria that grew with it.

- *Colpomenia sinuosa* did not resist the free floating conditions, which makes this species not suitable for biofiltration and production systems.
In an era of increasing resource scarcity, integrated aquaculture systems have a role to play.

However, the biggest problem in scaling up these types of systems is that they are very knowledge intensive and difficult to manage ... adding species and production systems greatly increases the complexity ...

WORLD RESOURCE INSTITUTE: Improving ... Aquaculture. Waiter et al., 2014
INTERNATIONAL CONFERENCE 25-29th January 2016
Challenges in the Environmental Management of Coastal and Marine Areas

Scientific Sessions:
✓ Ecosystem Conservation and Aquaculture
✓ Responsible use of Coastal & Marine Resources
✓ Integrated Management of Coastal & Marine Areas

Scientific Contributions Deadline: 30 October

SUMMER SCHOOL 13-17th June 2016
Advances in the Culture of Marine Algae: Techniques, Uses and New Developments

State of the Art for Micro- and Macroalgal species

For more information check the website: www.ecoaqua.eu