Tolerance comparison of Chlorella sp. [ACW1] and Brassica chinensis to human urine

Lindsay Iglesias

University of Florida
Bioenergy Research Lab
Problem Definition

- Urine is a unavoidable human “waste” with resource potential
  - Fertilizer
  - Medium for algal culture

- Health and environmental problems
  - Algal blooms and odors when left untreated
  - Health concerns when combined with solid waste and untreated

- Objective: This study aims to show that algae can tolerate high urine concentrations for the purpose of urine remediation
Experimental Design

- Collect urine sample representative of random small household
- Test the tolerance of alga *Chlorella sp. [ACW1]* and crop *Brassica chinensis* to urine
- Qualitatively evaluate adult plant species tolerance to urine
- Investigate ideas for phycoremediation and algae harvesting
Urine composition

- **Main components**
  - Urea
  - Chloride
  - Sodium
  - Potassium
  - Creatinine
  - Phosphorus

- **Urea**
  - Hydrolysis by urease to NH$_3$ (aq)
    - O$_2$ - NH$_3$ (g)
    - H$_2$O – NH$_4^+$

**Urine Sample Data**

<table>
<thead>
<tr>
<th>Stock Dilution</th>
<th>Mg NH$_4$ – N/L</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
<td>0.065</td>
<td>5.19</td>
</tr>
<tr>
<td>10 %</td>
<td>17.365</td>
<td>6.71</td>
</tr>
<tr>
<td>25 %</td>
<td>48.369</td>
<td>6.77</td>
</tr>
<tr>
<td>50 %</td>
<td>102.564</td>
<td>6.78</td>
</tr>
<tr>
<td>75 %</td>
<td>151.493</td>
<td>6.78</td>
</tr>
<tr>
<td>100 %</td>
<td>196.756</td>
<td>6.78</td>
</tr>
</tbody>
</table>
Chlorella sp. [ACW1]

- Autotrophic, unicellular green alga
- Chlorella genus grows rapidly, high photosynthetic efficiency of 34% (Lee 1980)
- Thrive in high nutrient environments such as landfill leachate, sewage (Abeliovich & Azov 1975)
- ACW1 discovered thriving on dairy manure
Chlorella sp. [ACW1] tolerance tests

Cell count $13.2 \times 10^6$ cells/ml

Multi-well tray for algae urine tests

Algae ACW1 stock solution

Low inoculum

High inoculum
Fluorescence for 10 uL
Fluorescence for 100 µL

Fluorescence for 100 uL [ACW1]

Urine Concentration (% of 2.2mL)
Brassica chinensis germination tests

- **B. chinensis** (Chinese Cabbage Michihili)
  - Wide climate range
  - Fast germination rate
  - High N requirement

Petri dishes for germination tests
Germination Test Results

Germination of *B. chinensis*

- Germinated
- Cotyledon Emergence
- Root Tip Burn

Urine Concentration (% of 4 mL)

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Seeded Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

0% | 10% | 25% | 50% | 75% | 100%
Adult Leaf tolerance evaluation

- Qualitative analysis
  - Leaf “browning”
  - Fluorescence
Implications

- *B. chinensis* showed evidence of urine toxicity at 25% concentration
- ACW1 grew prolifically and survived in 100% urine which place it as a candidate for urine remediation

- Implications are that less water would be required for urine dilution, there is a potential to treat human urine, and the possibility of harvesting a slow-release algal fertilizer.
Future research

Phycoremediation

Harvesting

Distillation and solar heating


Questions?