Characterization of *P. aeruginosa* Growth Patterns Under Varying Gravitational Conditions

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**BACKGROUND**

- **Pseudomonas aeruginosa**\(^3,5\)
  - Responsible for over 11% of all nosocomial infections
  - Found in normal gut flora
  - Isolated from Apollo 13 and 17 astronauts

**OBJECTIVES**

OBJECTIVE 1. Demonstrate planktonic *P. aeruginosa* growth in varying gravitational regimes via colony forming units (CFU) and biomass growth curves over time.

OBJECTIVE 2. Demonstrate *P. aeruginosa* biofilm growth on silicone at varying gravitational regimes via biomass, mean thickness, substratum coverage, and roughness.

**METHODS**

Planktonic samples were analyzed for cell count and biomass via optical density readings, and silicone samples were analyzed for biofilm biomass, mean thickness, roughness, and substratum coverage via MATLAB and COMSTAT.\(^*\) A Brown-Forsythe and one-way ANOVA were used to test for significant differences between the regimes. A post-hoc analysis was conducted to determine significance between each regime individually.

**QUANTITATIVE ANALYSIS**

<table>
<thead>
<tr>
<th>Substratum Coverage (%)</th>
<th>Mean Thickness µm</th>
<th>Biomass (µm^3/µm^2)</th>
<th>Roughness Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth 1g</td>
<td>65.1%</td>
<td>1.53</td>
<td>0.65</td>
</tr>
<tr>
<td>1/6g – SIMULATED LUNAR GRAVITY</td>
<td>67.8%</td>
<td>1.53</td>
<td>0.66</td>
</tr>
<tr>
<td>1/6g – SIMULATED MARTIAN GRAVITY</td>
<td>64.1%</td>
<td>1.53</td>
<td>0.67</td>
</tr>
<tr>
<td>1/3g – SIMULATED MARTIAN GRAVITY</td>
<td>63.1%</td>
<td>1.53</td>
<td>0.68</td>
</tr>
<tr>
<td>1/3g – SIMULATED OUTER SPACE</td>
<td>62.6%</td>
<td>1.53</td>
<td>0.69</td>
</tr>
</tbody>
</table>

**CONCLUSIONS**

- *P. aeruginosa* proliferated with greater capacity in both simulated Lunar and Martian environments, but the simulated microgravity environment was by far the worst with final cell concentrations increasing by over 72% compared to 1g controls.
- Gravitational regime plays a role in the formation of *P. aeruginosa* biofilms and altering architectural characteristics. Most notably, the loss of microcolonies - indicated by decreasing roughness coefficients and increasing substratum coverage – was observed as simulated gravity was reduced.
- Silicone loses its biofilm resistive capacities with decreasing simulated gravity.
- Further studies are needed to elucidate the underlying mechanisms of these changes and determine if any of these changes may have detrimental effects to long-term space flight missions and eventual Lunar and Martian colonies.

**ACKNOWLEDGEMENTS**

I would like to thank the MSMHA program and BioServe Space Technologies for providing me the opportunity and resources necessary to pursue this project. Furthermore, I would like to personally thank Zeena Sadaf Nazar, University of Colorado Boulder candidate for B.S. ’19’, for helping me with this project. Finally, I would like to thank my peers and my committee members Dr. Salcedo and Dr. Finger for providing the moral support and advice necessary to get me to the finish line. This material is based upon work supported by the National Aeronautics and Space Administration under Grant No. NNX09AI93G.

**REFERENCES**

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\(*\) Complete list of references available in written manuscript.

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**3D BIOFILM ANALYSIS**

- **P. aeruginosa** demonstrates significant growth under decreasing gravitational conditions. Soft Colonies Circular plot of cells within biofilm with larger colonies indicating areas of greater cell density. Wider Colonies Demonstrate of biomass thickness within with larger biomass thickness. High Colonies Biofilm-encrusted render demonstrating approximate substratum coverage and roughness.