Optimizing sterilization and nutrient delivery techniques for sugar kelp (*Saccharina latissima*) in Dalhousie's Aquatron

Tessa Schaeffer, supervised by Dr. Carly Buchwald
Dalhousie University

Introduction

- Sugar kelp (*Saccharina latissima*) is farmed commercially for seafood, biofuel, medicine, and makeup products.[1]
- Farming involves an in-lab **hatchery phase** and an at-sea phase.[2]
- Young kelp sporophytes are often outcompeted by **biological contaminants** like diatoms, ectoprocts, and other algae in the hatchery phase.[3]
- Contamination may be affected by the level of **nutrients** introduced into tanks.
- Water **sterilization techniques** are necessary to remove contaminants from the hatchery.
- Different kelp hatcheries have access to different equipment, seawater, and environmental conditions, and **site-specific techniques** must be developed for each hatchery.[4]

Figure 1 Healthy spool (left), image taken by Tessa Schaeffer. Diatom-contaminated spool (middle), image from GreenWave. Cyanobacteria-contaminated spool (right), image from GreenWave.

Research questions

- Which combination of nutrient delivery and sterilization techniques **(a)** optimizes kelp growth while **(b)** minimizes contamination?
- Which combination of techniques are optimal for Dalhousie's Aquatron?

Hypotheses

- Tanks with high nutrient addition and no extra sterilization will show the highest level of contamination.
- Tanks with low nutrient addition and 0.35-µm filtration will show the lowest level of contamination.
- Tanks with addition of germanium dioxide will show the lowest kelp growth.

Methodology

Kelp was selected for spawning from Mahone Bay, Nova Scotia, on October 23rd, 2023 by snorkelers. GreenWave spawning protocols were followed to process sorus tissue, seed spools, and monitor growth throughout the hatchery phrase.[5]

	Low nutrients (1.5 mL solution)	High nutrients (4.4 mL solution)
No extra sterilization	■ ■ ■	■ ■ ■
Addition of germanium dioxide (17 mL)	■ ■ ■	■ ■ ■
0.35-µm filtration	■ ■ ■	■ ■ ■

Figure 2 Experimental design matrix demonstrating the combinations of nutrient delivery and water sterilization techniques. Seawater pumped into Aquatron was already filtered through a coarse sand filter and treated with UV radiation. 17 mL of GeO_2 was added weekly post-water change.

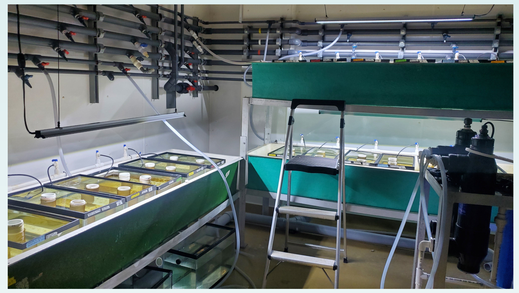

Figure 3 Layout of hatchery created for this experiment in Dalhousie University's Aquatron. Each raceway contained 6 tanks and was outfitted with an LED light strip. Each tank contained two spools. Lines pumping seawater directly from the Northwest Arm are pictured at the top of the image. 0.35-µm filtering device pictured on the right.

Preliminary results

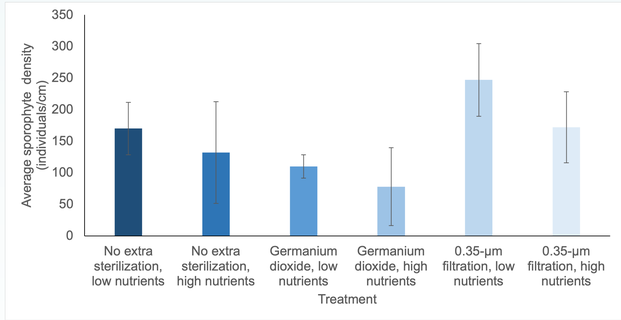

Figure 4 Average sporophyte density (individuals/cm) per treatment. Data collected and analyzed by Tessa Schaeffer, 2023.

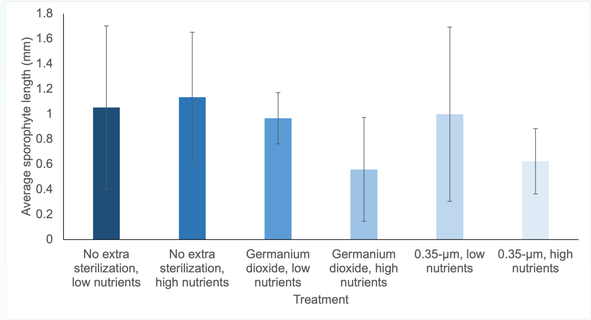

Figure 5 Average sporophyte length (mm) per treatment. Data collected and analyzed by Tessa Schaeffer, 2023.

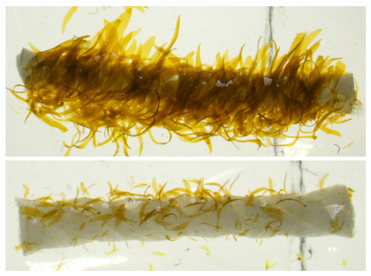

Figure 6 1-cm cuts of twine under the microscope. Sporophytes on the top are dense and long (treatment: 0.35-µm filtering, low nutrients) and sporophytes on the bottom are sparse and short (treatment: no extra sterilization, high nutrients). Images taken by Tessa Schaeffer.

Figure 7 Post-experiment contamination (cloudy water, green coloring) resulting from increased nutrients and missed water changes. Picture by Carly Buchwald.

Discussion

- High sporophyte densities, weekly water changes, and relatively low nutrients likely led to **negligible contamination** on the spools throughout the experiment.
- Tanks treated with **GeO_2 and high nutrients** demonstrated the **lowest kelp growth**, likely because of its effect on later sporophyte growth stages.[6]
- **Low nutrient** treatments generally produced **higher growth** than high nutrient treatments (maybe due to interactions with organisms in the water).
- Imperfect placement of LED light bars likely had a negative effect on kelp growing in top raceway.

Conclusions

1. *S. latissima* grew best under low nutrient (1.5 mL solution) conditions.
2. No extra sterilization is needed for *S. latissima* in Dalhousie's Aquatron, as long as sporophyte densities are high.

Future work:

- Follow-up data collection on outplanted seedlings to determine success in at-sea environment.
- Repeat experiment with further optimization: better light conditions, lower nutrient concentrations, lower spore densities.

References

[1] Breton et al. 2018. Phycologia. 57(1):32-40.
[2] Flavin et al. 2013. Kelp farming manual.
[3] Visch et al. 2023. Applied Phycology. 4(1):44-53.
[4] Redmond et al. 2014. Seaweed culture handbook.
[5] Greenwave. Starting a hatchery.
[6] Shea et al. 2007. Applied Phycology. 19(1):27-32.

Acknowledgements

I would like to acknowledge my supervisor Dr. Carly Buchwald for guiding me throughout this project, my project partner Lara Mitchell for sharing this kelp hatchery with me, my labmates Ainhoa and Mikey for helping me set up the hatchery, the folks at the Ecology Action Centre and Peter Darnell for outplanting the kelp and giving advice when needed, and the Aquatron staff for providing technical support.