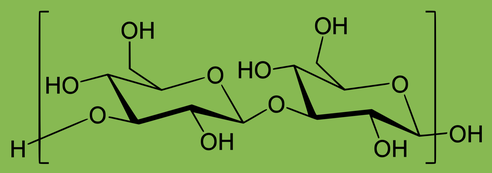
Novel Nutraceuticals from Algae

Nicholas Morgan, Zachary Peever, Hunter Marcelo, Marc Vincent Raranggor, Elvis Yu
Schulich School of Engineering, University of Calgary

***Project Goal: Design a facility to produce paramylon from the microalgae species* Euglena gracilis.**

Paramylon (β-1,3 glucan)



•Molar weight: 472.4 g/mol

•Powder apparent density: ~0.1 g/cm^3

•**Health benefits include:** LDL cholesterol reduction, immunostimulation, and anticancer properties

•Carbohydrate, appears as a fine white powder

•FDA-approved, vegan, and dairy-free substance

•Typically sold in pill capsules, but can be added to food products

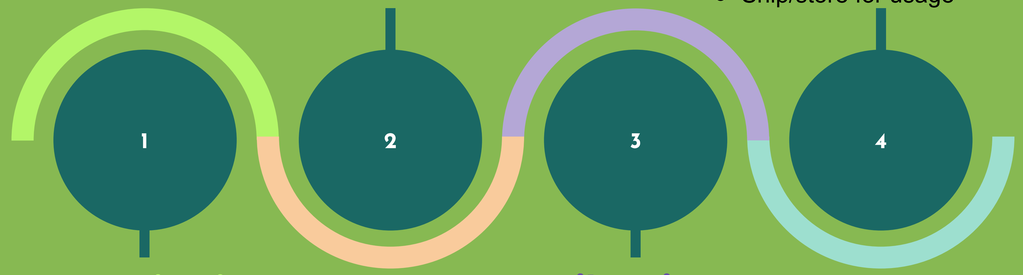
Paramylon is currently sold in pill capsules, but there may be more accessible ways.

Our vision: Incorporate paramylon into a common, accessible food product, i.e., ice cream.

•Paramylon can be used as a thickening agent, replacement for cream
•Health benefits, dairy-free, vegan

Is a pilot-scale *E. gracilis* growth & processing facility feasible?

Our Process



Bioreactor

- Grows Algae from initial culture using growth medium
- Operates at pH of 3.6 and 30° C
- Reaction time of approximately 5 days
- 1500L stainless steel stirred tank jacketed reactor

Pasteurization

- Reduce bacterial contaminants in the feedstock
- Facilitate thermal death of unwanted organisms

Filtration

- To filter out impurities from the algal soup and concentrate the solution
- Uses microfiltration with a cross-flow geometry
- Membranes made of polyethersulfone with pore diameter of 0.45µm
- Consists of two filters in series with a water stream in between to prevent algal gelation

Extraction & Purification

- Burst algae open with surfactants and extract paramylon
- Separate paramylon from liquids
- Wash off remaining chemicals on paramylon
- Dry paramylon
- Ship/store for usage

Vegan Ice Cream Process Requirements
• 15 kg/day of paramylon required
•Ideal ice cream base viscosity: 75-125 cP
• Theoretical amount needed per 500 mL of ice cream: 2 grams
•Produce CAD$27 million worth of ice cream, with a 60% gross profit margin

Project Drivers

•**Novel Technology:** Paramylon extraction is a relatively new process

• **Reduced Emissions:** the dairy industry in the United States emitted 99,000 ± 8480 Gg of CO2 in 2019. Algae-based substrates in food could reduce the strain on the farming industry due to the growing global population. Furthermore, the algae consumes CO2 during growth for potential carbon capture benefits.

• **Repurpose Waste:** Algae reactors can use industrial byproducts such as corn steep liquor as a feedstock

Design Considerations

• **Economic analysis**
• Net present value (NPV) of ~$ 600,000 USD
• Total capital investment (TCI) of $3,700,000 USD
• Payback period of 8.8 years
• Discounted rate of return of 10%
• Plant life of 15 years

• **Environmental analysis**
• Sodium dodecyl sulphate (SDS) and substance disposal
• Recycling streams
• High water usage

• **Social analysis**
• Calgary-based plant, requires ~5000 ft^2
• Industrial noise

• **Safety analysis**
• Contamination
• Operating conditions
• Protection and protocols