DULSE PROTEIN EXTRACTION PLANT DESIGN:

A sustainable protein to meet the world's growing demands.

INTRODUCTION

Develeara mollis (Pacific Dulse)

Background

As the world population and demand for dietary protein have grown, seaweeds have emerged as a sustainable alternative to animal proteins. In particular, red seaweeds have a promising potential to be the leading plant-based protein due to their high protein content and rapid growth rates. Traditional crops such as soybeans require significant arable land resources and freshwater irrigation, whereas seaweed can grow in tanks supplied with nutrient-rich tidal seawater.

Founded by OSU business professor Chuck Toombs, Oregon Seaweed is a company that aims to meet the demand for protein by supplying it from dulse seaweed. The company currently owns farms in Bandon and Garibaldi, OR.

Project Goals

Literature on the *Develeara mollis* strain of dulse is limited, so the following target objectives were formed:

- Create a preliminary plant design for the extraction of proteins from raw dulse seaweed based on similar species
- Perform cost analysis and determine the feasibility of several protein extraction methods
- Produce a detailed roadmap for future laboratory-scale testing

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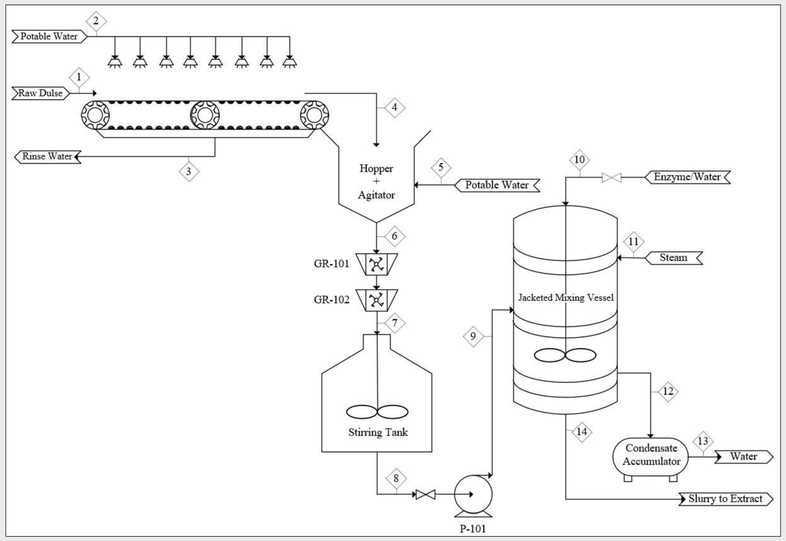
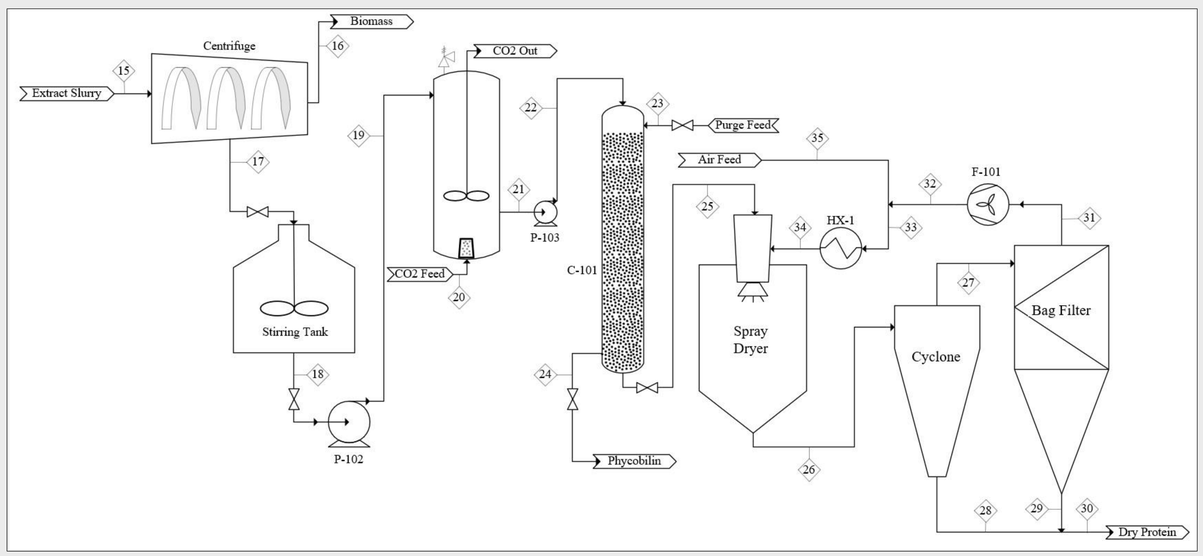


PRE-PROCESSING

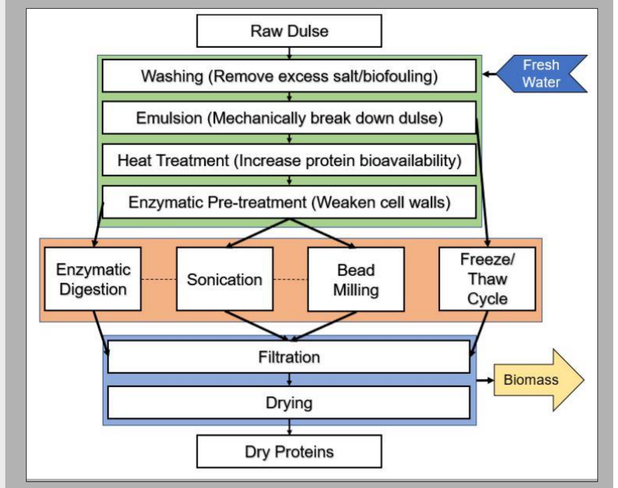
Pre-processing the dulse requires a rinsing stage to remove biofouling and salt before grinding it into small particulates suspended in water. To increase digestibility of the proteins, the dulse slurry is heat-treated and then incubated with enzymes to break down the cell walls. This allows the some of the proteins to exit the cells and solubilize. With the cell walls partially digested and some protein released, the dulse slurry heads to the primary extraction phase to remove the remaining protein. To lower the carbon footprint of this process, the thermal energy for pre-processing will ideally be supplied from the excess heat generated by pyrolysis of the waste biomass.

POST-PROCESSING

Post-processing the dulse involves many unit operations to arrive at a final dry protein product. Initially, the slurry must be centrifuged to separate the dissolved proteins from the residual biomass. This biomass has potential to be used as biochar, a soil amendment and secondary product that was investigated by the other dulse teams. The protein solution is then sent through a carbon dioxide aeration column to increase pH and cause the protein to precipitate out of solution. A more dilute solution of protein can then be passed through an ion exchange column to separate the two proteins of interest, phycobilin and RuBisCo by their charge affinities. The solution of phycobilin then exits the system to be sold as a side product to be purified further. The RuBisCo and other excess proteins can be spray dried into a fine powder, to be sold for use in plant-based protein food products.



SUMMARY



Protein Extraction

1. Enzymatic Digestion – Enzymes break down cell walls of the dulse, releasing proteins within
2. Sonication – Ultrasound mechanically destroys cells
3. Bead Milling – Beads are used to grind the dulse apart
4. Freeze/Thaw Cycle – Water expansion when freezing is exploited, also allowing for long-term storage of the dulse

Conclusions

An industrial plant for protein extraction from dulse was designed and four primary methods of protein extraction were identified for producing large amounts of plant-based proteins from dulse seaweed. A preliminary cost analysis was performed. To verify if the extraction methods work at full-scale, laboratory tests are required.

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