PURDUE UNIVERSITY

CAPSTONE/DESIGN EXPERIENCE 2016

CHITIN EXTRACTION THROUGH BACTERIA FERMENTATION

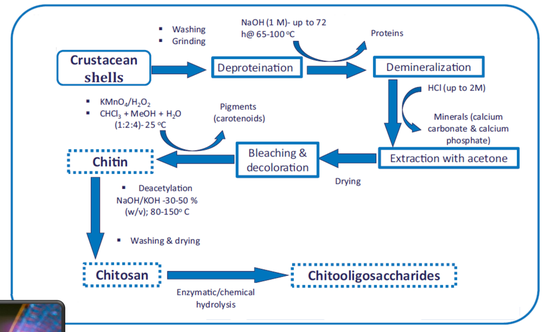
Yiqun Chen (BE), Fang Yuan (BE), Xinchen Zhang (BE)

Agricultural & Biological ENGINEERING

Introduction and Objective

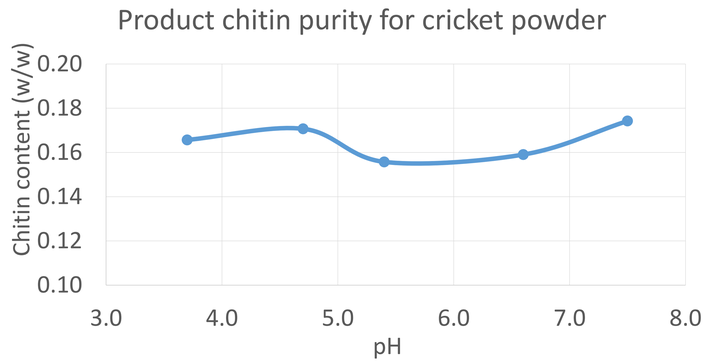
Chitin is the second most abundant biopolymer produced in nature, normally found in crustaceans, insects and microorganisms. Chitin and its derivative chitosan has been widely used in a variety of fields including pharmaceutical, food and agricultural industry. Recent Biological methods takes advantage of the metabolic nature of bacteria to achieve similar similar effect of acid and alkali used in traditional extraction, rendering the process more environmental-friendly and cost-efficient. The goal of this study is to scale-up the current lab-scale-limited process and design a student-run business.

Chemical Method



Experimental Results

- Lab fermentations are conducted under different pH conditions to determine the correlation between fermentation environment pH and extraction performance
- Result shown low correlation between pH condition and product purity



Design Alternatives

- Alternative bacteria for fermentation

  Species considered: Lactic-acid producing bacteria (e.g. Pediococcus, probiotics), co-fermentation of different bacteria

  Factors considered: Price; accessibility; culture stability
- Alternate fermentation culture

  Alternatives considered: Selective(MRS), non-selective (L-29), minimal media

  Factors considered: Bacteria growth; cost; equipment maintenance

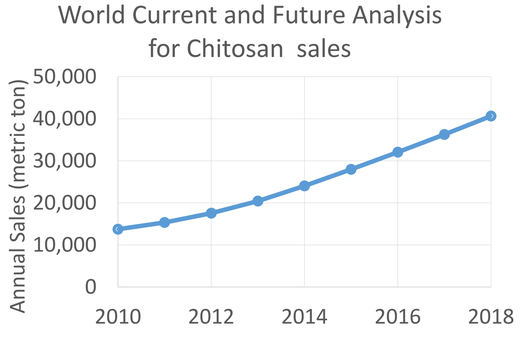
Financial Plan

Equipment	Est. Cost
Crusher	$ 2,000.00
Fermenter	$ 31,598.00
Filter	$ 12,858.00
Dryer	$ 17,025.00
Centrifuge	$ 34,027.00
Total equipment cost	$ 97,508.00
Total capital Investment	$ 511,676.00

- 10-year project lifetime
- Maximal annual sale = 296.5 tons/year
- Estimated unit sale price: $4.375/kg
- Annual profit after tax: ≈ $98k
- Annual rate of return = 13.9%

Market Analysis

- Annual sale of chitin and derivatives continue to increase around the world
- %CAGR (Compound Annual Growth Rate) of chitosan market size estimated 14.5%

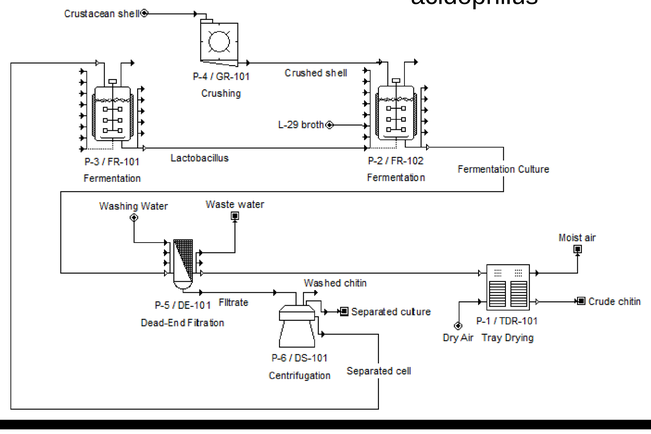


Plant Design

Design objectives:

- Production rate: 812kg / day
- Product Purity: 59%

- **Material**: Crustacean shell chitin concentration: ~25%
- **Culture**: Lactobacillus acidophilus



Unit Operations:

- Crusher

  Reduce material size to facilitate reaction
- Fermentation tank

  Lactobacilus culture fermented with material in agitated tank for 24hrs
- Filtration

  Separate product from culture
- Drying

  Dry in tray dryers to reduce product moisture to <5%
- Centrifugation

  Disc bowl centrifuge separates bacteria cell from waste for recycling

Social Impact and Sustainability

- Material-wise sustainable design using organic waste as material
- Introduce environmental friendly design to current market
- Draw student attention to the biological material processing industry
- Create student employment opportunity on campus

Sponsor:

Technical Advisor:

Instructors:
Dr. Martin Okos

Acknowledgements:
Dr. Amanda Deering's Lab
Dr. Thomas Walter

PURDUE AGRICULTURE
PURDUE UNIVERSITY

PURDUE ENGINEERING
Think impact.