Optimal Extraction of Chitin from Underutilized Sources

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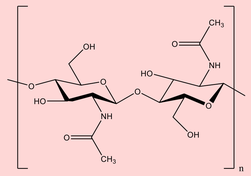
Introduction

Chitin is an extremely abundant natural polymer used commercially in many applications but mainly obtained from fungi and shrimp.



Chitin is already used in the agriculture, medical, cosmetic and water treatment industries.[1] In the field of biomedicine, chitin has been found to be able to clot blood, and it is non-toxic. Even though it is used commercially in a wide range of applications, most chitin is obtained from just a few sources.

Underutilized Sources of Chitin

Louisiana crawfish production was 81.9 million lbs in 2005 and the outer shells were discarded as waste[2]

Over 120 million pounds of lobster were caught in Maine in 2013[3]

As many at 300 cicadas have been observed per meter over large areas[4]

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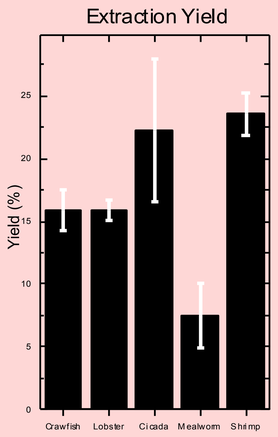
The Extraction Process

- The extraction process was based on existing literature for the extraction of chitin from shrimp[5]
- Start with unmodified source material
- Wash and dry
- Rough grind to reduce particle size
- Agitate at 100°C in NaOH
- Drain by vacuum filtration
- Agitate at room temperature in HCl
- Drain by vacuum filtration
- Rinse with acetone for crawfish, shrimp, and lobster
- Agitate at room temperature in bleach
- Drain by vacuum filtration
- Desiccate for 48 hours
- Weigh final product
- Characterize

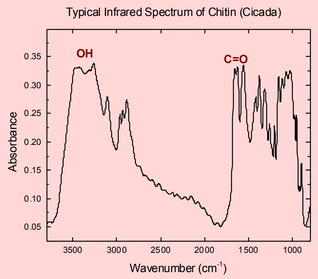
Results - Yield

- The final chitin yield was calculated based on the initial dry weight of the source material
- The extraction yield (right) was based on all samples that showed little or no residual protein
- Cicada sloughs showed an unusually high chitin with a high error due to the collection environment
- All other samples have yields that correspond well to their know chitin compositions



Results – Degree of Acetylation

- Degree of acetylation was determined by comparing OH and C=O peaks in IR[6]
- For most samples, increasing the NaOH concentration decreased the degree of acetylation (see table below)
- The HCl concentration, reaction order, and source material concentration showed little or no effect

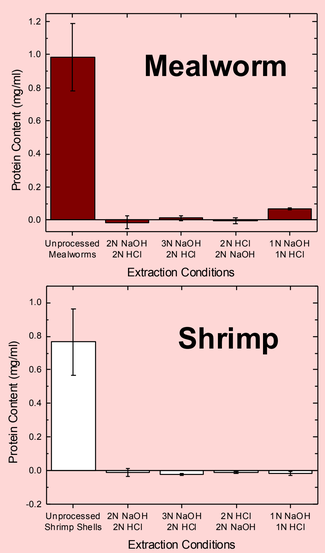


	Crawfish		Lobster		Cicada		Mealworm		Shrimp	
NaOH (N)	DA (%)	Error (%)	DA (%)	Error (%)	DA (%)	Error (%)	DA (%)	Error (%)	DA (%)	Error (%)
1	92.1	3.2	66.2	5.7	80.2	8.9	92.2	11.3	79.3	8.1
2	90.9	11.6	62.6	5.5	89.8	5.8	88.1	16.5	78.9	4.3
3	87.0	8.1	76.5	3.5	75.2	0.9	86.1	8.0	67.6	7.8

Results – Protein Studies

- Bradford Protein Assay was used to determine amount of protein left in the chitin samples
- The HCl concentration, reaction order, and source material concentration showed little or no effect
- Only low NaOH concentrations and short reaction times showed an increase in protein concentration on some samples (mealworms and lobster shells)

Bradford Protein Assay with unmodified mealworm (left), extracted chitin (middle), and blank (right)

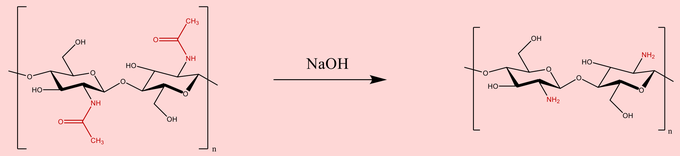


Conclusions

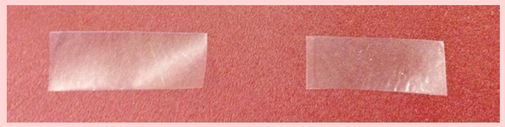
- Chitin extracted from crawfish, lobster, mealworms, and cicada appears functionally similar to chitin extracted from traditional sources
- Varying the concentration of base and/or acid in the extraction process has little effect on the final product
- Some sources (mealworms and cicadas) have inherent difficulties due to the low amount of chitin per individual

Future Work

- Most current commercial applications utilize the completely deacetylated version of chitin, chitosan[7]



- Take our ideal reaction conditions and deacetylate to form chitosan
- Utilize the mechanical strength of chitin and chitosan to make composite with other plastics
- Below is a test sample with poly(vinyl alcohol) (PVA) on the left and a PVA sample with 3% cicada chitosan on the right



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