



UCD Institute of
Food and Health

Chitosan-SDS coacervates for encapsulating amyloglucosidase: a study on structured capsule formation and enzymatic performance

4th International Electronic Conference on Foods

Focus on Sustainable Food Systems: Current Trends and Advances

15 to 30 October 2023

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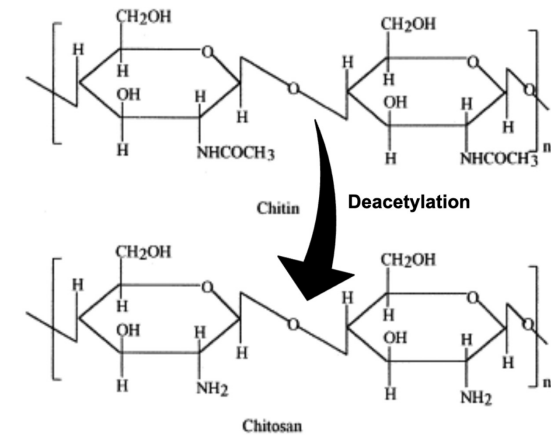
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Introduction

Chitosan:

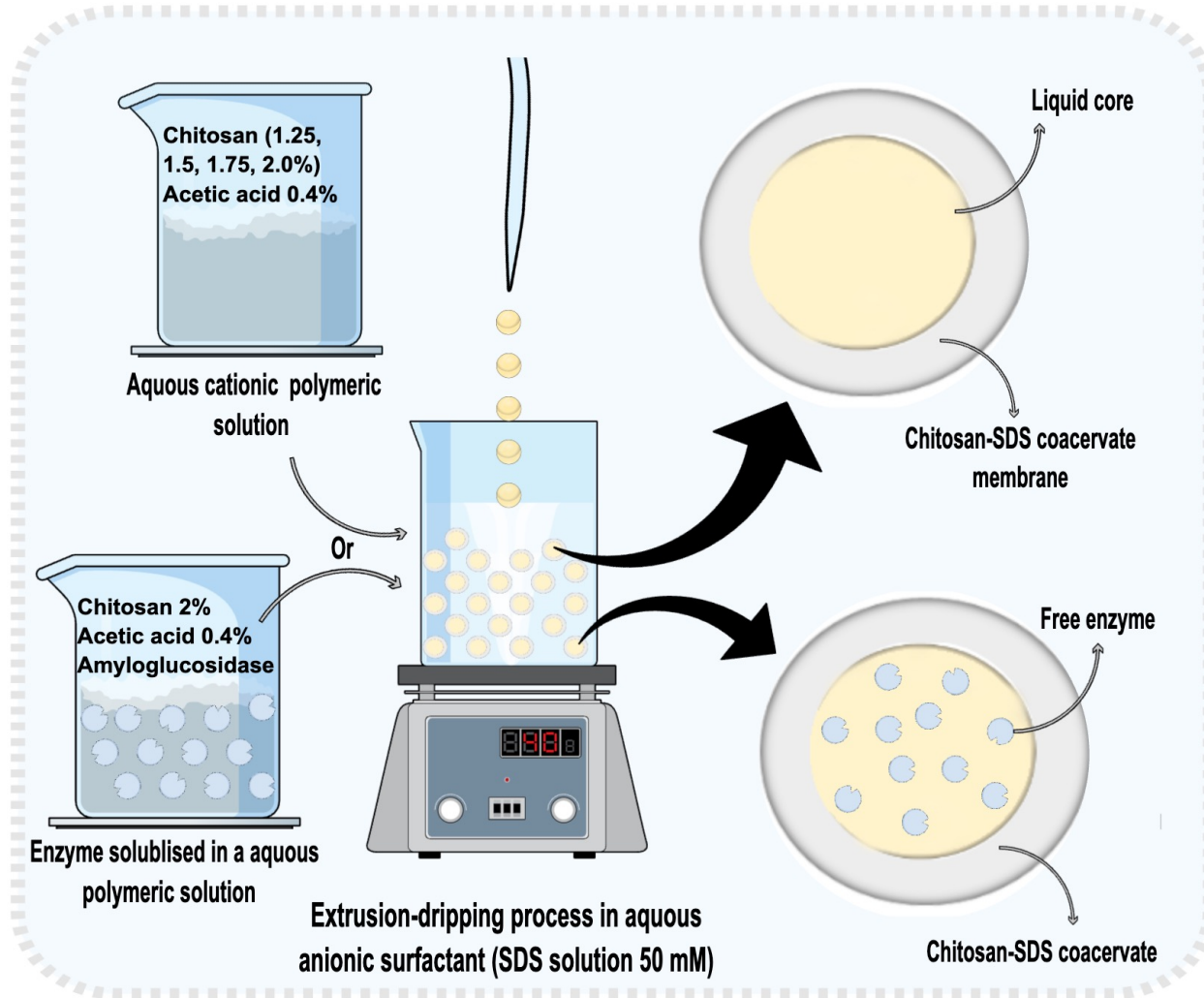
- A cationic polymer from crustaceans and fungi chitin;
- Bio-degradable, biocompatible, and modifiable in aqueous acidic solution;
- Widely used in food application, and enzyme immobilisation;
- Hydrogel beads formed via alkaline precipitation.



Chitosan-SDS coacervates:

- An alternative for the low mechanical strength and acid stability of chitosan beads (alkaline precipitation);
- Attractive for drug delivery, cosmetics, water treatment and food application;
- Coacervates stabilised by electrostatic attraction between oppositely charged molecules.

Material and Methods



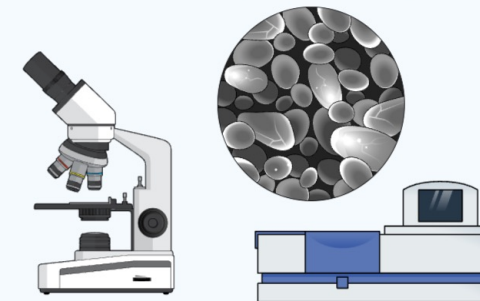
Chitosan-SDS coacervates characterisation

Various concentration of chitosan (1.25, 1.50, 1.75 and 2.0% w/v):

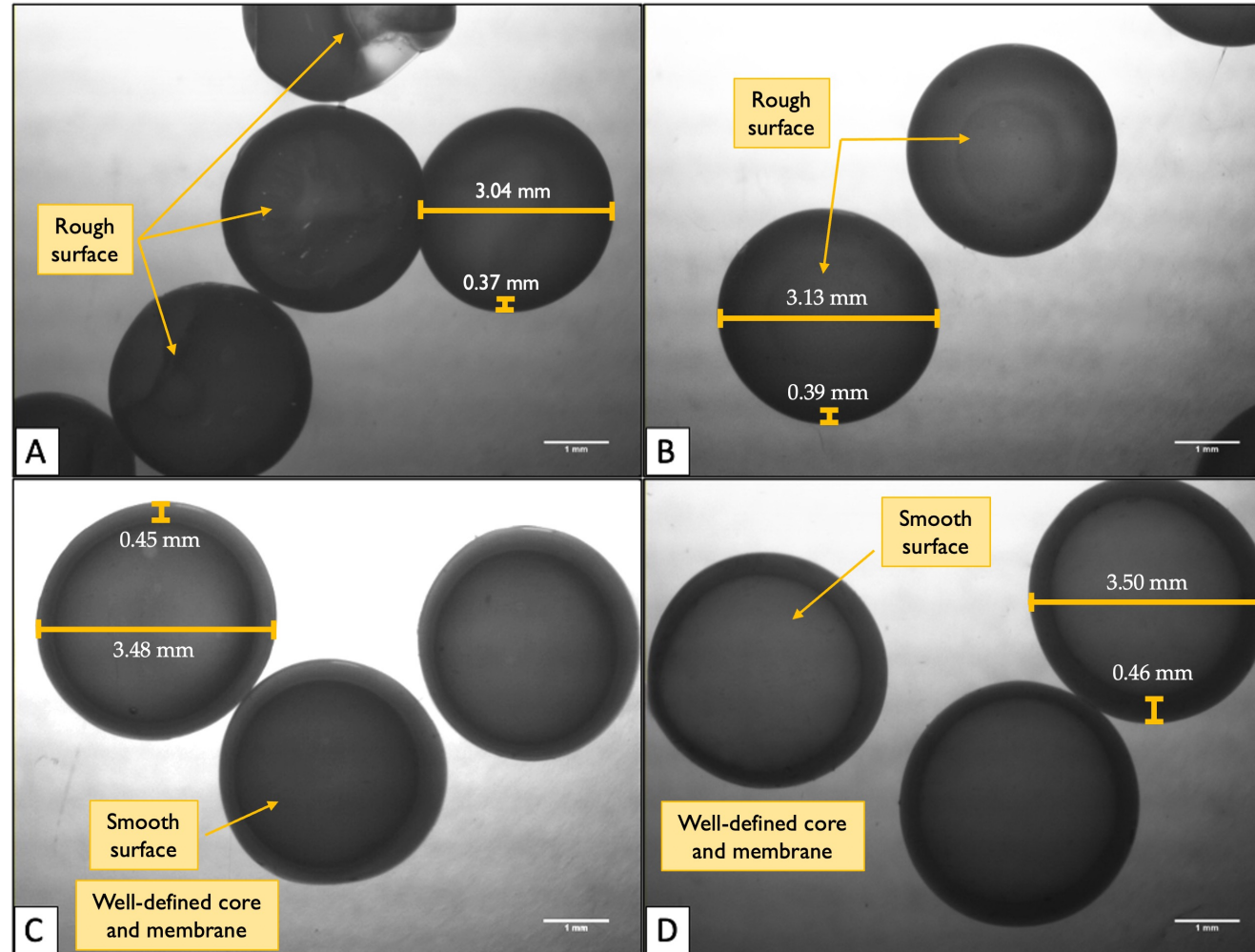
- Morphology
- Particle Size
- Shrinkage or swelling degree

Chitosan concentration at 2%:

- Yield of encapsulation
- Conversion Rate
- Curve of glucose production (free, released and encapsulated enzyme)

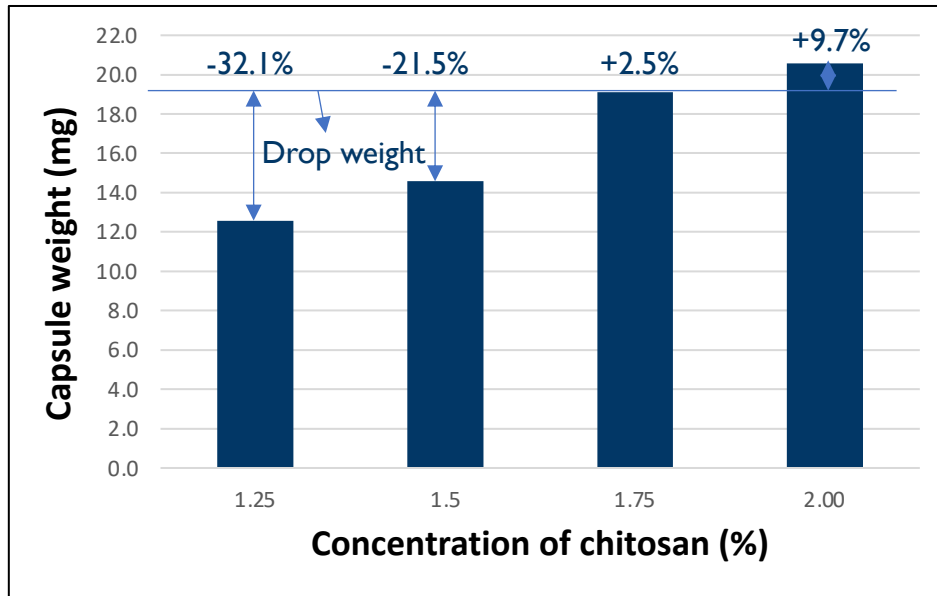


Results – Morphological characteristic



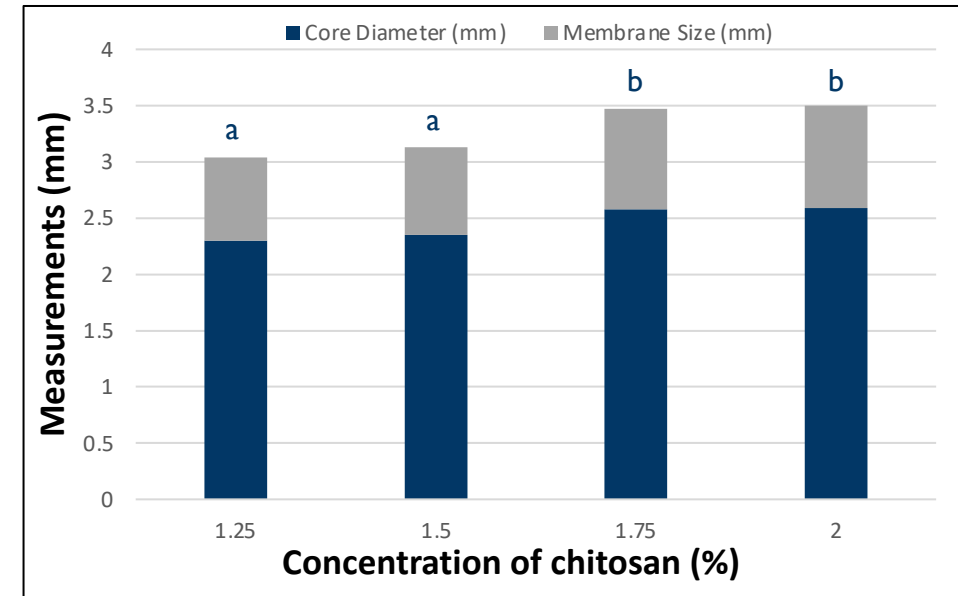
Images of chitosan-SDS coacervate capsules obtained from stereo microscope zoom x7 and obtained from 1.25% (A), 1.5% (B), 1.75% (C) and 2% (D) chitosan solutions.

Results – Morphological characteristic



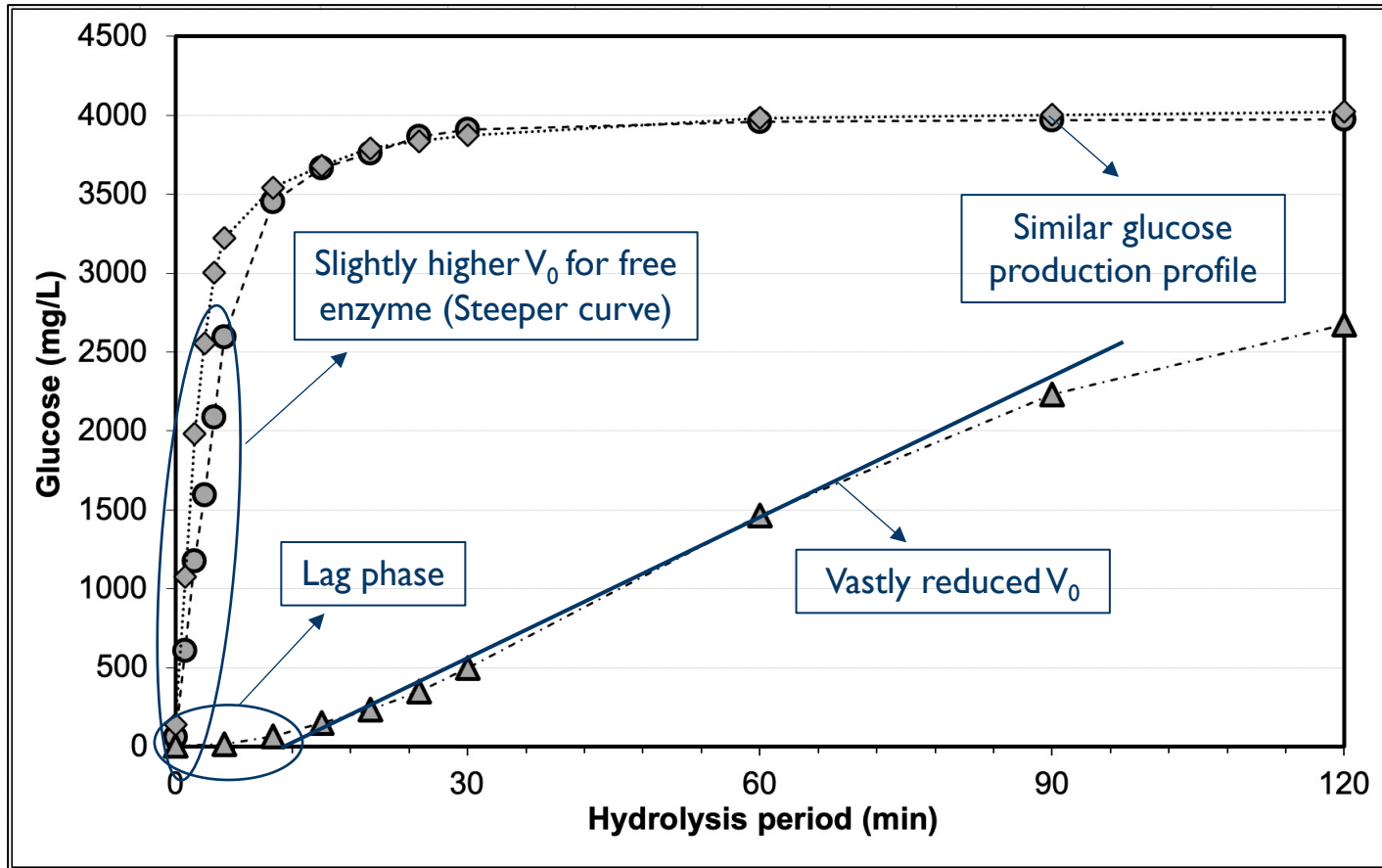
Capsule weight as a function of the chitosan concentration and their respective shrinkage/swelling degree.

$$\text{Shrinkage/swelling degree (\%)} = \frac{(\text{Capsule weight} - \text{Drop weight})}{\text{Drop weight}} \times 100$$



Representation of chitosan-SDS coacervates sizes through the core diameter and membrane size as a function of chitosan concentration. Different lowercase letters present significant differences by Tukey posthoc test at the 5% significance level, in terms of capsule and core diameter, as well as membrane size.

Results – Enzymatic performance



Glucose production during gelatinised corn starch hydrolysis carried out at 60 °C for 120 minutes with free (◊), released (○) and encapsulated (Δ) amyloglucosidase.

Immobilisation Yield and conversion rate.

Immobilisation Yield	71% ± 2.6%
Conversion rate	81% ± 0.4%

$$\text{Immobilisation yield (\%)} = \frac{\text{Activity released enzyme}}{\text{Activity free enzyme}}$$

$$\text{Conversion rate (\%)} = \frac{\text{Total amount glucose produced (g)}}{\text{Amount of initial substrate (g)}}$$

Discussion & Conclusion

- ↑ Chitosan concentration → Spherical and self-supporting capsules, larger size, well-defined membrane, and smooth surfaces (more effective and improved ionic interaction);
- ↓ Chitosan concentrations → shrunk and weak capsules (electrostatic force not strong enough to form well-structured gel capsules);
- 3 mm Coacervate size → facilitates enzyme recovery (simple separation step), enzymatic reaction control and termination;
- Chitosan-SDS coacervates → an innovative technique for encapsulating diverse enzymes (improved stability, high substrate-product conversion rate, and broader applicability by enabling precise product release control).