

# Biological Design Doctoral Defense

## The Properties and Longevity of Crude Urease Extract for Biocementation

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### Abstract

Urease, an amidohydrolase, is an essential ingredient in the emerging engineering techniques of biocementation. This technique utilizes the urease enzyme to catalyze the hydrolysis of urea in an aqueous solution, causing alkalinity changes and forming carbonate ions that leads to calcium carbonate precipitation in presence of calcium ions. A common method of carbonate precipitation is based on agriculturally derived free urease enzyme as the source of urease, a process referred to as enzyme induced carbonate precipitation (EICP). Enzyme used to precipitate calcium carbonate in engineering applications has typically been commercially available urease, however, the cost of urease enzyme has been a barrier to adoption of EICP in engineering applications. The objective of this study was to develop a simple and inexpensive EICP technique using agricultural resources to facilitate enzyme production for practical engineering applications. The specific objectives of this study were (i) to develop a simple extraction process in the laboratory to obtain urease extracts of varying levels of purity from four plant sources (sword jack bean, jack bean meal, soybean, and watermelon seeds), (ii) to further reduce the cost of enzyme production by eliminating the use of buffer, centrifugation, and dehusking during the extraction process, (iii) to reduce the extracted urease aqueous solution to a powder using freeze drying and investigate its stability compared with the crude extract solution and the commercial enzymes, and (iv) to study the kinetics of the extracted enzyme including to gain further insight of chemical reactions rate that was catalyzed by enzymes. The results of this study suggested that inexpensive crude extracts of urease from agricultural products, including jack beans, soybeans, and watermelon seeds, is effective at catalyzing urea hydrolysis for carbonate precipitation. It was also found that the lyophilized crude extract maintained its activity during storage more effectively than either the crude extract solution or the rehydrated commercial urease. In particular, a crude extract of urease from jack beans can be stored after production followed by lyophilization for periods in excess of one year without a significant loss of activity. These results offer the potential for a significant reduction in the cost of applying enzyme induced carbonate precipitation, or EICP, in engineering practice by mass production of the enzyme.



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Zoom Link: <https://asu.zoom.us/j/83466532577>