

Combination Efficiencies of Allyl Isothiocyanate and Triacetylate – β Cyclodextrin

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Scope

There are many new technologies evolving in the world of film manufacturing. Often this entails additives that impart or enhance certain qualities in a film structure. One common use for film is for the protection and preservation of food. Allyl isothiocyanate (AITC), is a naturally occurring oil that can inhibit the growth of bacteria that cause food spoilage. Embedding this compound into a film could reduce spoilage.

AITC needs to be able to be embedded into a film structure and its release rate controlled. Cyclodextrins can be used to encapsulate AITC and protect and control its release. This research focuses on evaluating encapsulation methods and will explore the release rate under different conditions.

Background

Allyl isothiocyanate (AITC) is a natural pungent flavor compound that is derived from the cruciferous plant family. AITC has been found to inhibit the growth of bacteria that cause food spoilage. The use of AITC in food systems is limited because of its strong odor and the reaction that occurs between AITC and water. These challenges can be overcome if AITC can be protected and released slowly.

Cyclodextrins (CDs) are small (0.57 nm to 0.95 nm) molecules that form a truncated conical structure that is open in the center. This opening allows for the encapsulation process to occur. CDs, which are produced by the bacterial digestion of cellulose, are used in many areas including pharmaceuticals, cosmetics and food products.

Triacetylate – β Cyclodextrin (TA β CD) is β Cyclodextrin that the OH groups located on the ends of the molecule have been replaced with OCOCH₃. Cyclodextrin in this form will be able to be integrated into extruded polyethylene film without significantly decreasing the film's mechanical strength and barrier properties.

Research Questions

1. TA β CD is not soluble in water and will require a different approach to encapsulate the AITC. Which encapsulation method between solvents mixtures and physical mixtures provide the maximum AITC encapsulation efficacy for TA β CD?
2. How do the various solvents affect the efficacy of AITC encapsulation in TA β CD?
3. How will the physical mixing time affect the efficacy of AITC encapsulation in TA β CD?

Methodology

Solvent Encapsulation process for β -Cyclodextrin (β CD)

10 g of β CD was mixed with 100 ml of deionized water by stirring at ambient temperature. 1.3 ml of AITC was dissolved in 5 ml of ethanol and added to the aqueous suspension. This was stirred for 3 hours at 60°C. The suspension was then left in a refrigerator for 12 hours. The precipitant was then collected and spread on a glass plate, and dried using a convection oven.

Physical Encapsulation process for Tri-Acetyl- β -Cyclodextrin (TA β CD)

In the physical encapsulation process, 5 g of TA β CD was mixed with 0.5 ml AITC and 14ml of different solvents (isopropyl alcohol, acetone and chloroform) and 1ml of water. The mixture was kneaded and ground using a mortar and pestle. After 8, 16 and 24 minutes of manual mixing, the sample was placed on a glass plate and dried in a convection oven.

Determination of AITC in Tri-Acetyl- β -Cyclodextrin (TA β CD)

The dry powders were ground to a fine powder in a mortar and pestle and 1g of the complex was mixed into a solution of 29 ml of hexane and 1 ml of water. These samples were mixed for 40 minutes under ultrasonic conditions. The samples were then placed in a centrifuge for 10 minutes, before a sample was taken from the top. The sample was then tested by a UV-spectrophotometry at the 266 nm wavelength.



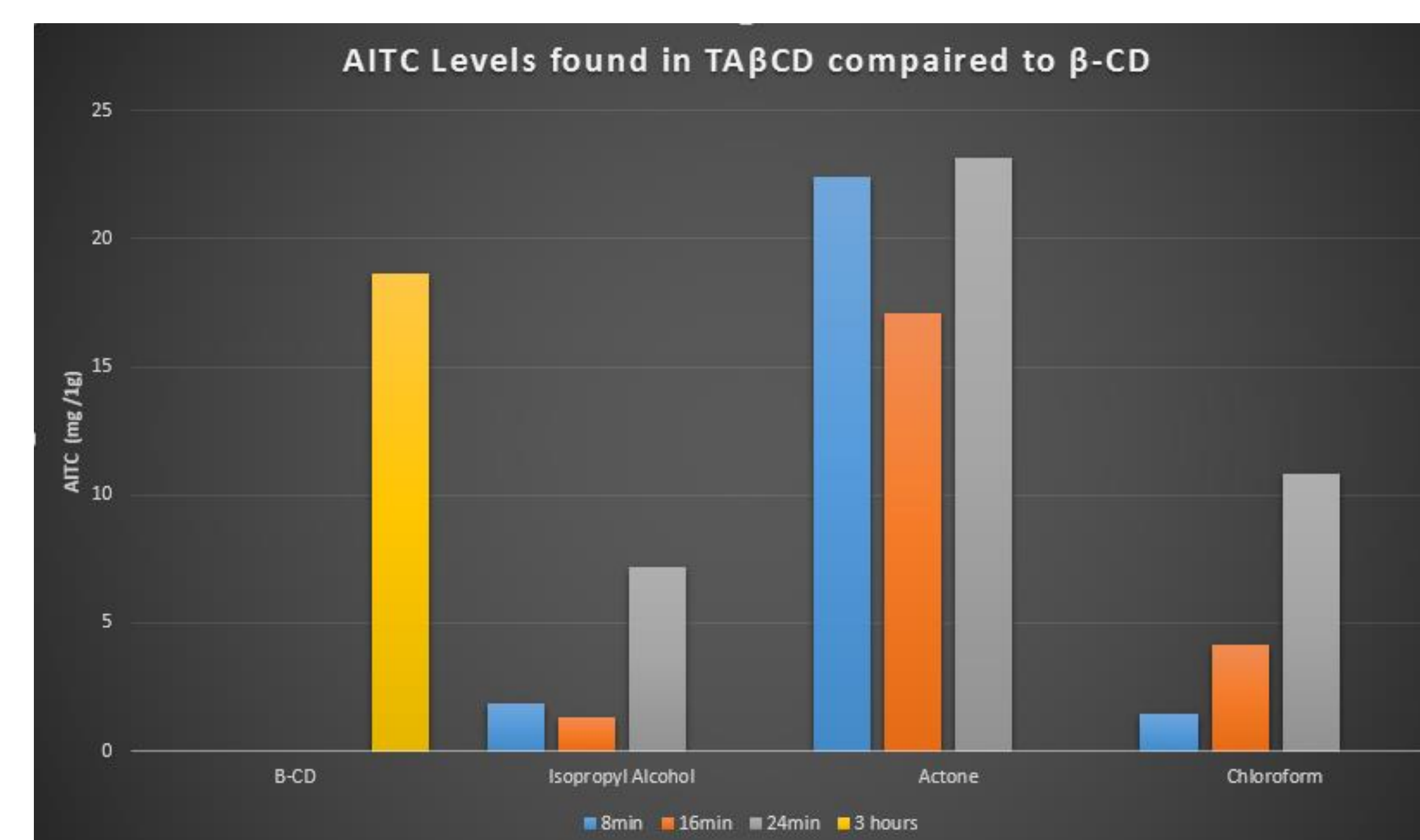
Manually encapsulate AITC in TA β CD (left) Encapsulating AITC in TA β CD by stirring (right)



Sonicated samples (left) Testing a sample in the UV spectrometer (right)

Results

TA β CD can encapsulate AITC better than β CD when physically encapsulated in the presence of acetone. The encapsulation process of AITC in TA β CD, in acetone is non linear in nature as shown in the graph below. This test was repeated and similar results were found.



Conclusion

From these results we can conclude that acetone may be the best solvent to encapsulate AITC in TA β CD. Using this solvent may produce results similar to the encapsulation of AITC in β CD. The encapsulation time seems to influence the encapsulation process when chloroform is used as a solvent.

These results will be confirmed with additional samples that will further the accuracy of the data. The release characteristics at different relative humidities will also be explored in the coming months.

Future Study

- Investigating the effect of relative humidity (0-100% RH) on the AITC aroma release (out of TA β CD complex).
- Investigating the effectiveness of the AITC-TA β CD complex against common spoilage and pathogenic microorganisms.

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