Encapsulation of essential oils of Rosemary, Cinnamon, Oregano and Thyme in *Saccharomyces cerevisiae* to enhance their antimicrobial activity in selected foods

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INTRODUCTION AND AIM

The biocompatible and biodegradable yeast cells can be exploited to microencapsulate a range of active compounds. The aim of the present study was to investigate the encapsulation of essential oils (EO) of rosemary, cinnamon, oregano, and thyme in *Saccharomyces cerevisiae* cells (SCC) and determine its application as a natural antimicrobial preservative in foods. In independent trials, the EOs was encapsulated into non-autolysed and autolysed SCC and the physicochemical characteristic of the loaded cells were examined.

METHODS

Preparation of cell material by Autolysis method


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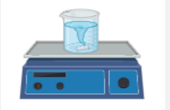

Dry yeast → Deionised water → Stirred for 20 min

Yeast suspension

Autolysed (AU)
SCC was encapsulated in a water bath at 52°C under agitation (170 rpm) for 24 hours, followed by centrifugation for 20 and then lyophilization (-54°C for 48 hours)

Non-autolysed
SCC directly was centrifuged for 20 min and then lyophilized (-54°C for 48 hours)

Loading Essential oil in yeast cell

Incubation lyophilized cell with each four EOs (separately) and water , ethanol at shaker water bath (170 rpm) for 15 min at 45 °C

After withdrawing the samples, centrifuged them for 20 min , discarding the supernatant washed the pallets with deionised water and then lyophilization at -54°C for 48 hours

Determination of total EOs content

50 mg encapsulated EOs mixed with 500µl deionised water and 4.5 ml ethanol

Then suspension centrifuged and supernatant filtered and injected to GC-MS chromatography

Determination of antimicrobial properties of free and autolysed encapsulated EOs against *E.coli* using

- ✓ Well diffusion method for free EOs
- ✓ Agar overlay assay for autolysed encapsulated EOs

Antibacterial activity in food models

1. Add MIC of autolyzed encapsulated and free EOs to each portion of ham.
2. Then, add 100 µL of 0.5 McFarland *E. coli* to each portion.
3. Store the samples under vacuum and non-vacuum sealing for 6 days at two different temperatures: 10°C and 23°C

SCAN ME

RESULT

Determination of encapsulation loaded of each EOs

- The results show that the encapsulation load of cinnamon EO in autolyzed SCC was 15.53% higher than in non-autolyzed SCC. A similar trend was observed for autolyzed encapsulated oregano, thyme, and rosemary EOs, with increases of 9.28%, 9.69%, and 9.76%, respectively, compared to non-autolyzed samples.

Determination of antimicrobial effect of free and autolysed encapsulated three EOs against *E. coli*

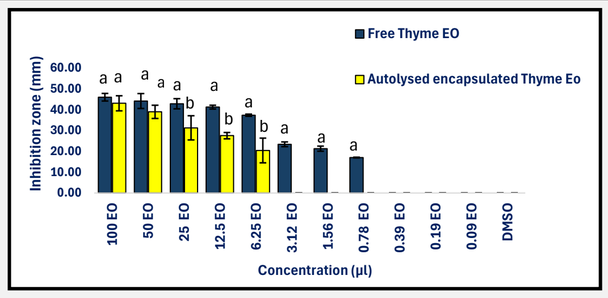

Fig 1: Antibacterial effects of Free and AU- Encapsulated thyme EO against *E. coli*

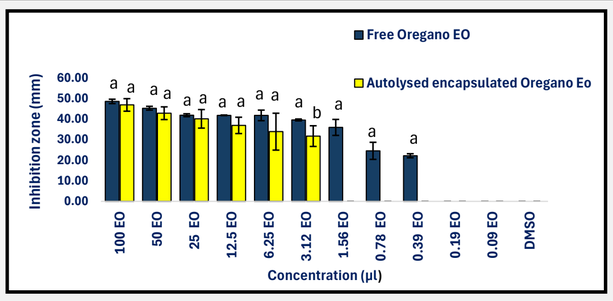

Fig 2:Antibacterial effects of Free and AU- Encapsulated oregano EO against *E. coli*

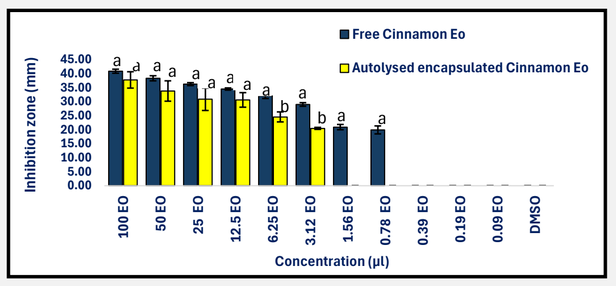

Fig 3:Antibacterial effects of Free and AU- Encapsulated cinnamon EO against *E. coli*

- ✓ The MIC of encapsulated cinnamon, oregano, and thyme were found to be 8.41 mg (3.12µl), 8.54 mg (3.12µl), and 23.06 mg (6.25µl), respectively, against *E. coli*.
- ✓ Both free and AU-encapsulated Rosemary EO did not show any antibacterial effects against *E. coli*.

Antibacterial activity in food model

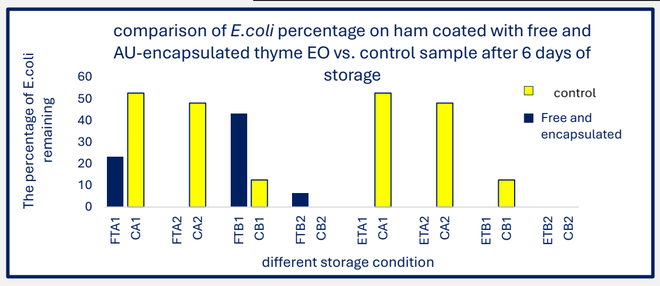

Fig4: Percentage of remaining E. coli on the 6th days of storage in ham under different conditions with comparing the effects of the MIC of AU-encapsulated thyme EO with the same amount of free thyme EO vs control sample against E. coli. The conditions are labeled as follows: F (free EOs), E (encapsulated EO), T (thyme), C (control, without free EOs or AU-encapsulated Eos), A (vacuum), B (sealing), with 1 indicating storage at 10°C and 2 at 23°C.

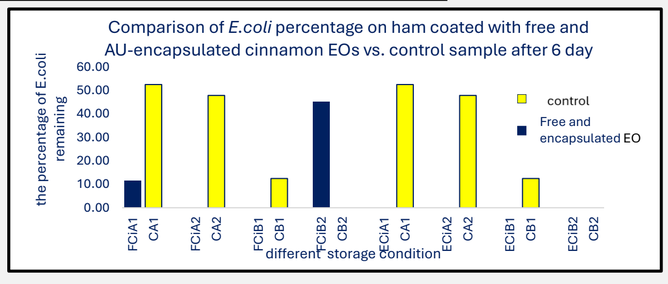

Fig5: Percentage of remaining E. coli on the 6th days of storage in ham under different conditions with comparing the effects of the MIC of AU-encapsulated cinnamon EO with the same amount of free cinnamon EO vs control sample against E. coli. The conditions are labeled as follows: F (free EOs), E (encapsulated EO), Ci (cinnamon), C (control, without free EOs or AU-encapsulated Eos, A (vacuum), B (sealing), with 1 indicating storage at 10°C and 2 at 23°C.

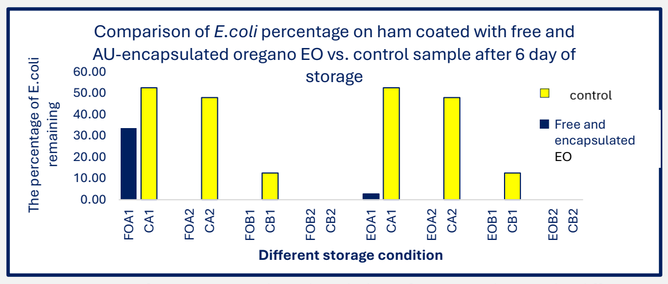

Fig7: Percentage of remaining E. coli on the 6th days of storage in ham under different conditions with comparing the effects of the MIC of AU-encapsulated oregano EO with the same amount of free oregano EO vs control sample against E. coli. The conditions are labeled as follows: F (free EOs), E (encapsulated EO), O (oregano), C (control, without free EOs or AU-encapsulated Eos), A (vacuum), B (sealing), with 1 indicating storage at 10°C and 2 at 23°C.

- ✓ Bacteriological tests revealed that AU-encapsulated EOs significantly reduced E. coli in inoculated ham compared to control samples (which had no added free or encapsulated EOs) under the same storage conditions and duration.

CONCLUSION

This study shows the successful encapsulation of thyme, oregano, cinnamon, and rosemary EOs in SSC. Autolysis pretreatment significantly improved the encapsulation efficiency by enhancing yeast cell permeability. The encapsulated EOs retained strong antibacterial effects, particularly against E. coli, with thyme, oregano, and cinnamon. Encapsulation also allowed for a controlled release, improving the antibacterial effectiveness of the oils in food preservation, particularly in ham samples. This method holds promise for broader applications, including food safety and pharmaceutical preservation, by offering a stable, biodegradable delivery system for essential oils