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EMULSION CHARACTERISTICS EXPLAINING THE EFFECT OF TWEEN-80 ON THE ANTIMICROBIAL ACTIVITY OF ESSENTIAL OIL COMPOUNDS

Introduction

Essential oils (EO) have a low solubility in water (Wishart et al., 2013). Therefore, emulsifiers are needed to apply EO as antimicrobials in the food industry, as a lot of food matrices that are prone to microbial spoilage and contamination have a high water activity. Tween-80 is often used for this purpose because it is a well-known and food-grade emulsifier. However, Tween-80 can influence the antimicrobial activity of EO compounds (Van de Vel et al., 2017). Different hypotheses have been formulated about the mechanism behind this interaction (Van de Vel et al., 2017). To our knowledge, these hypotheses have not been confirmed yet. We investigated the characteristics of emulsions of individual EO compounds with different Tween-80 concentrations to link them to their antimicrobial activity.

Tested hypotheses:

- **H1**: The antimicrobial activity of EO compound emulsions is linked to its droplet size.
- **H2**: The antimicrobial activity of EO compound emulsions is linked the dissolved concentration of the compound.

$$X_{dissolved} \overset{\text{Solubility}_{compound}\ C_{tween\text{-}80}?}{\rightleftharpoons} X_{solubilized} \overset{C_{compound}\ C_{tween\text{-}80}}{\rightleftharpoons} X_{emulsified}$$

Droplet size of EO emulsions (H1)

Set-up:

Mixture preparation

↓

1' vortex (max. speed)

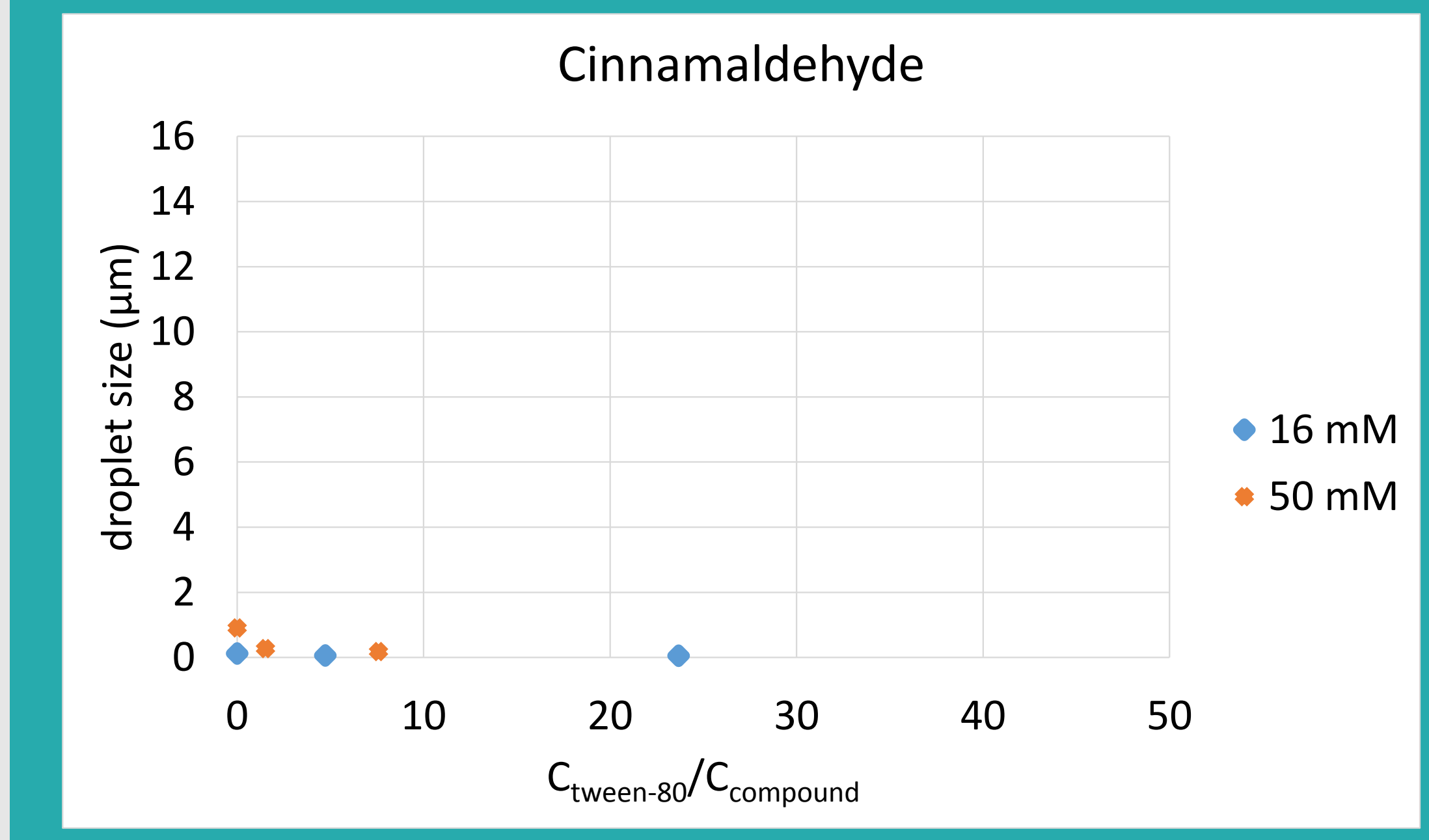
↓

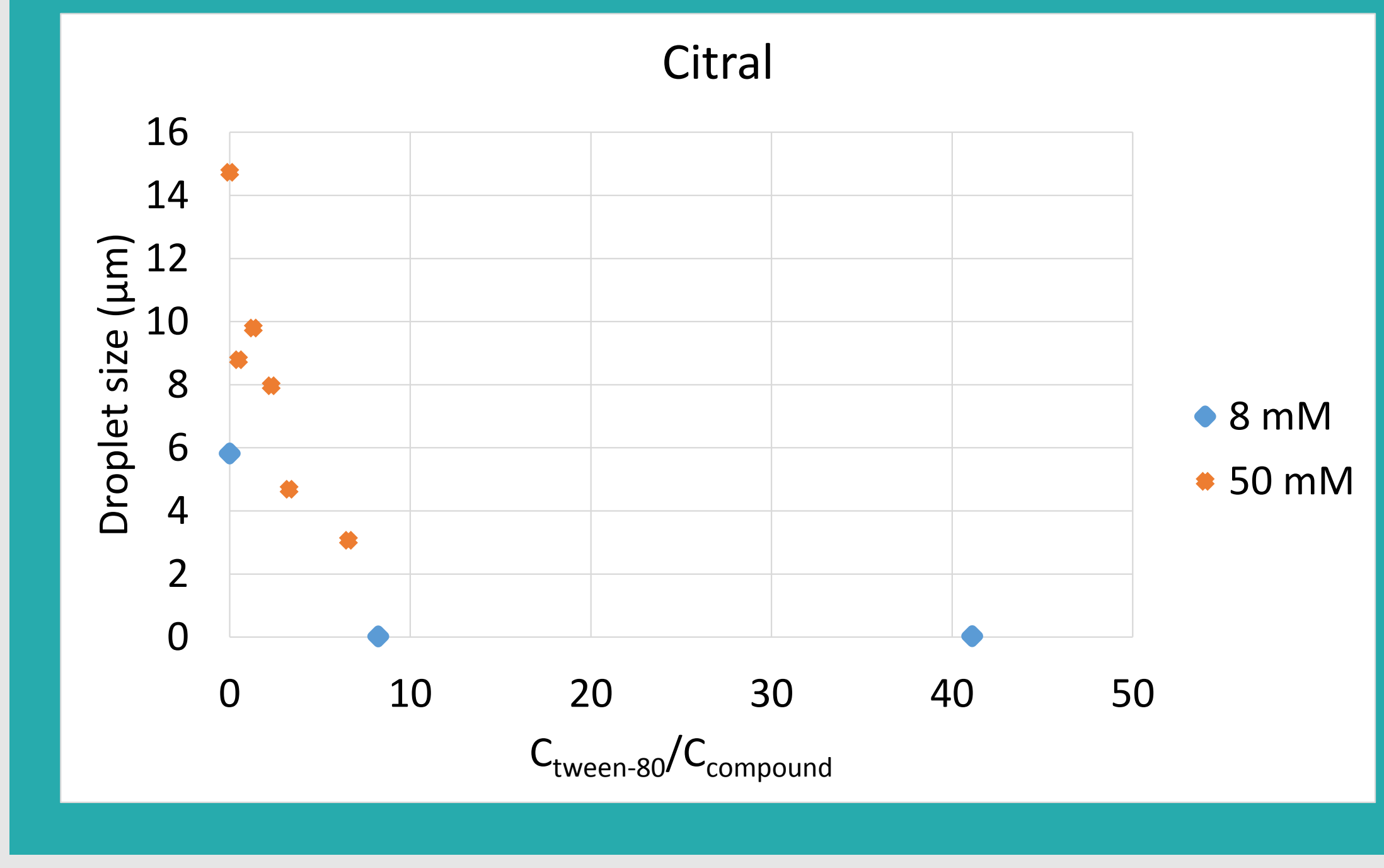
Pre-homogenization
(min. 1h magnetic stirrer (slow))

↓

Measurement
(Mastersizer 3000)

Results:





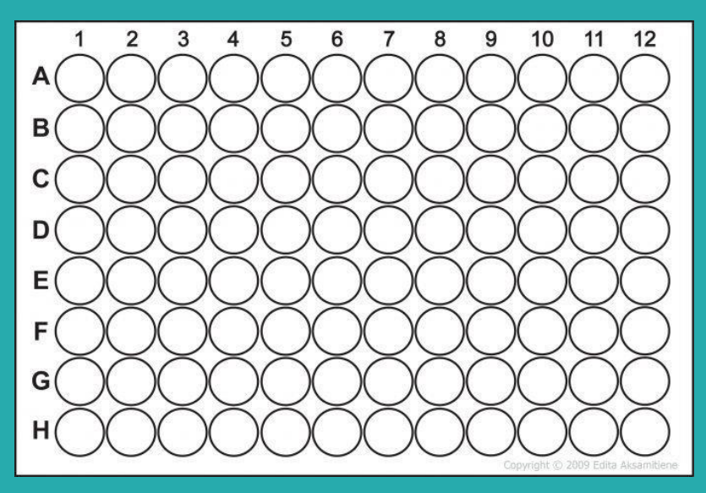
Influence of Tween-80 concentration on antimicrobial activity of individual EO compounds

EO compounds:
Cinnamaldehyde
Citral
Eucalyptol*
Eugenol*
Geraniol*

Set-up:
5 x 10^5 CFU/mL (3 independent inocula):

- *E. coli* LMG2093
- *E. coli* JG33
- *E. coli* JG45
- *S. aureus* LMG8224
- *S. aureus* TIAC39
- *S. aureus* TIAC82

BHI + 0 – 5% Tween-80
MIC of EO compound
Blank = 0 mM EO compound, inoculated

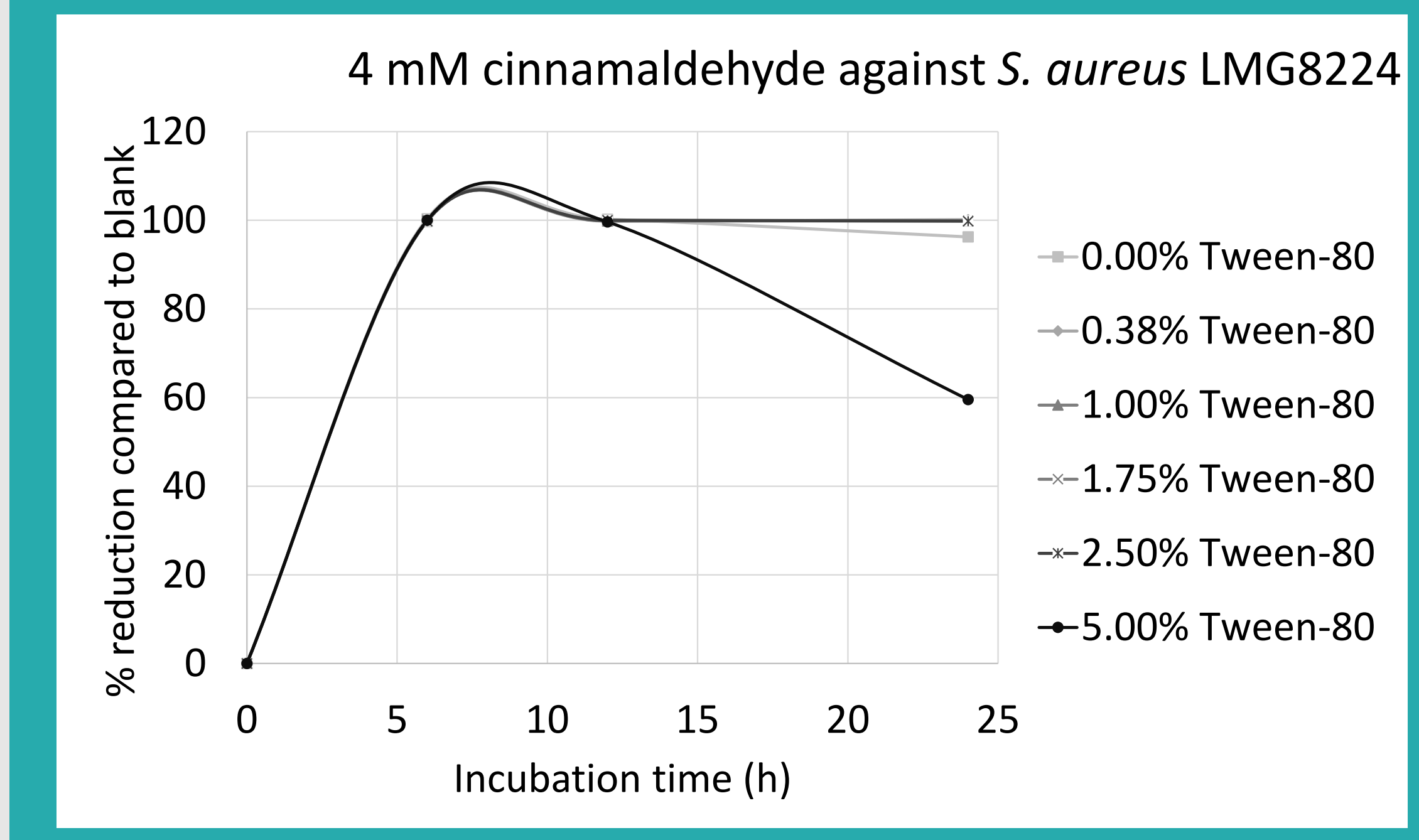


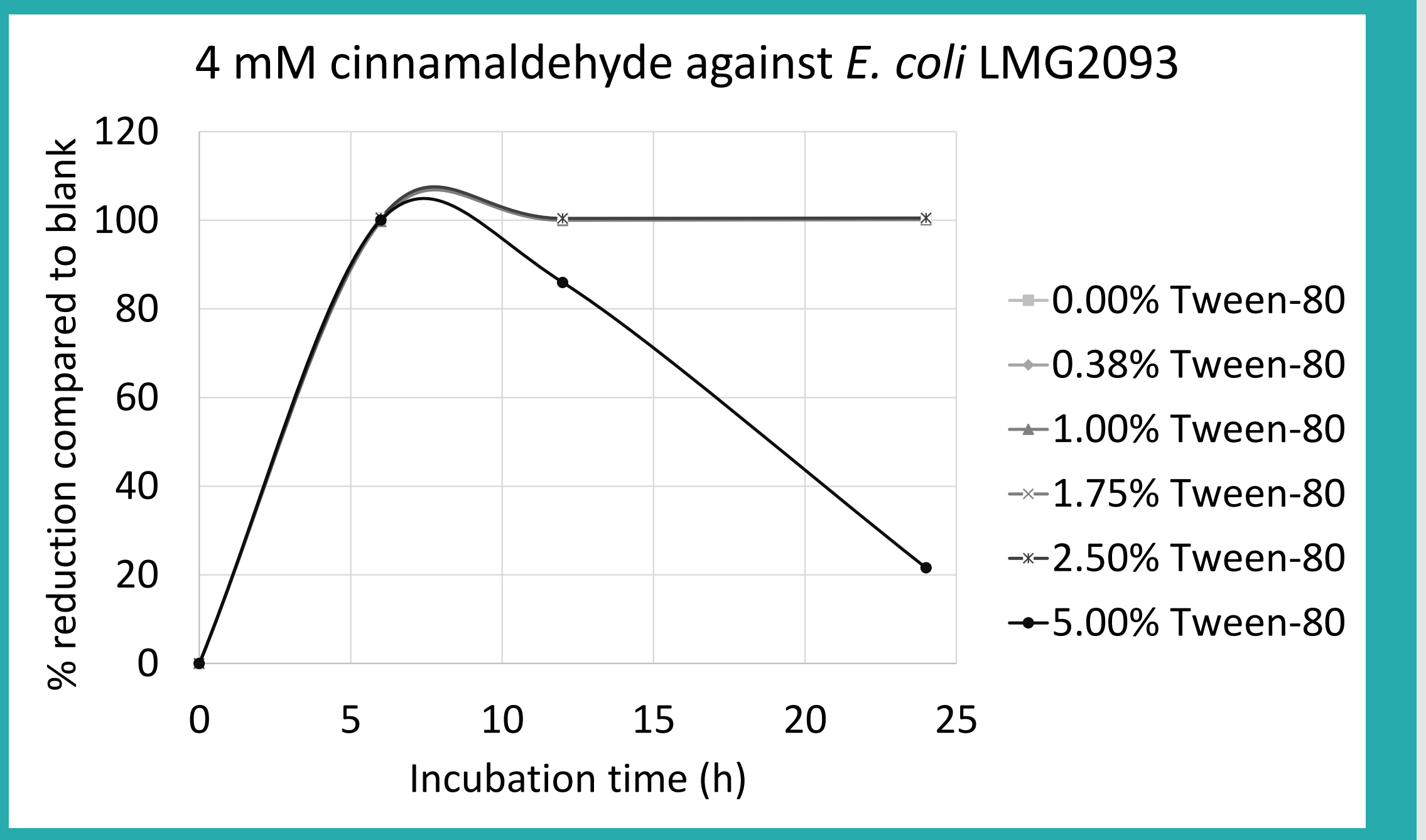
Incubation:
0, 6, 12, 24 h
37°C
Shaking (5 Hz, amplitude 15 mm)

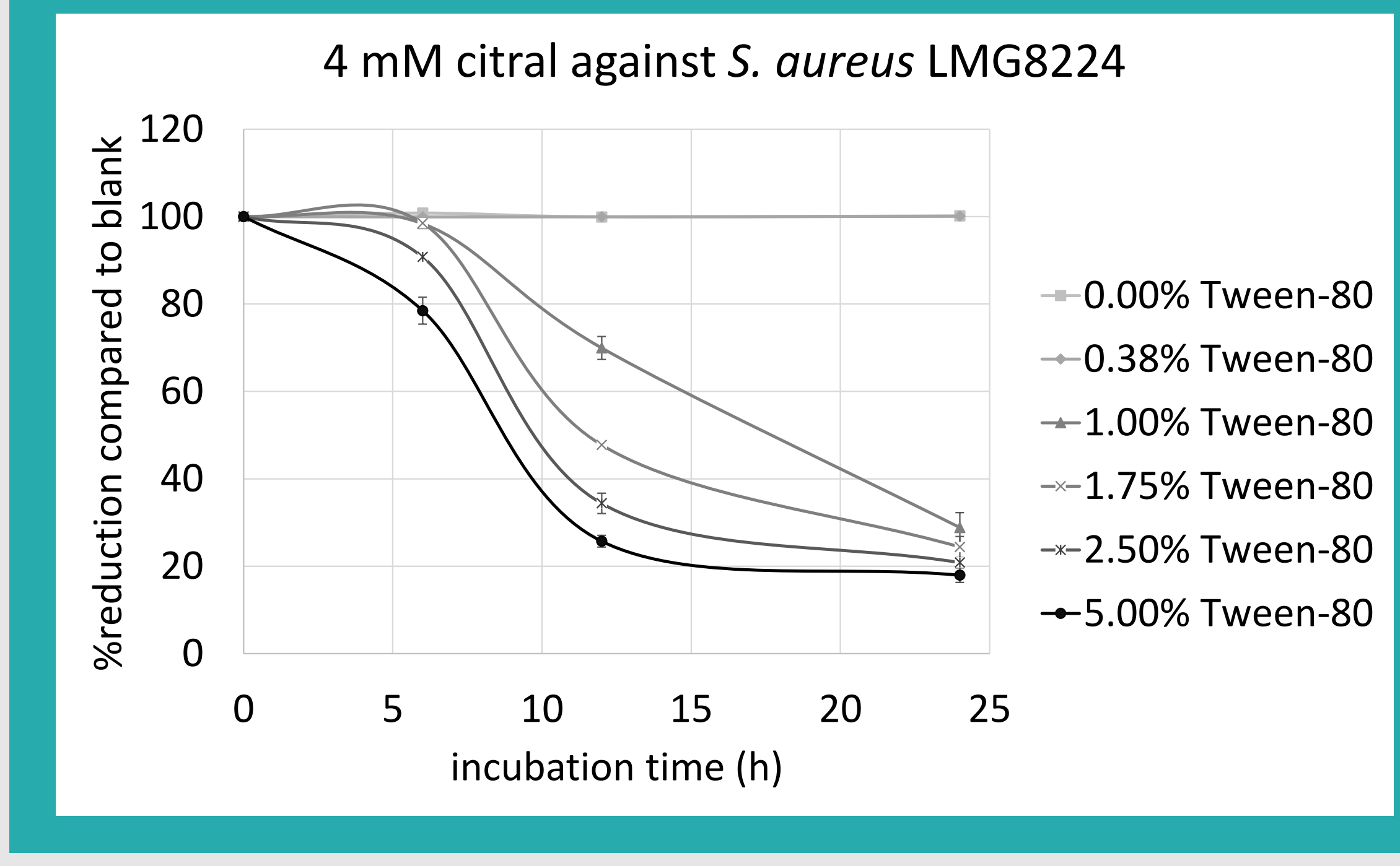
Measurement:
OD_{620}

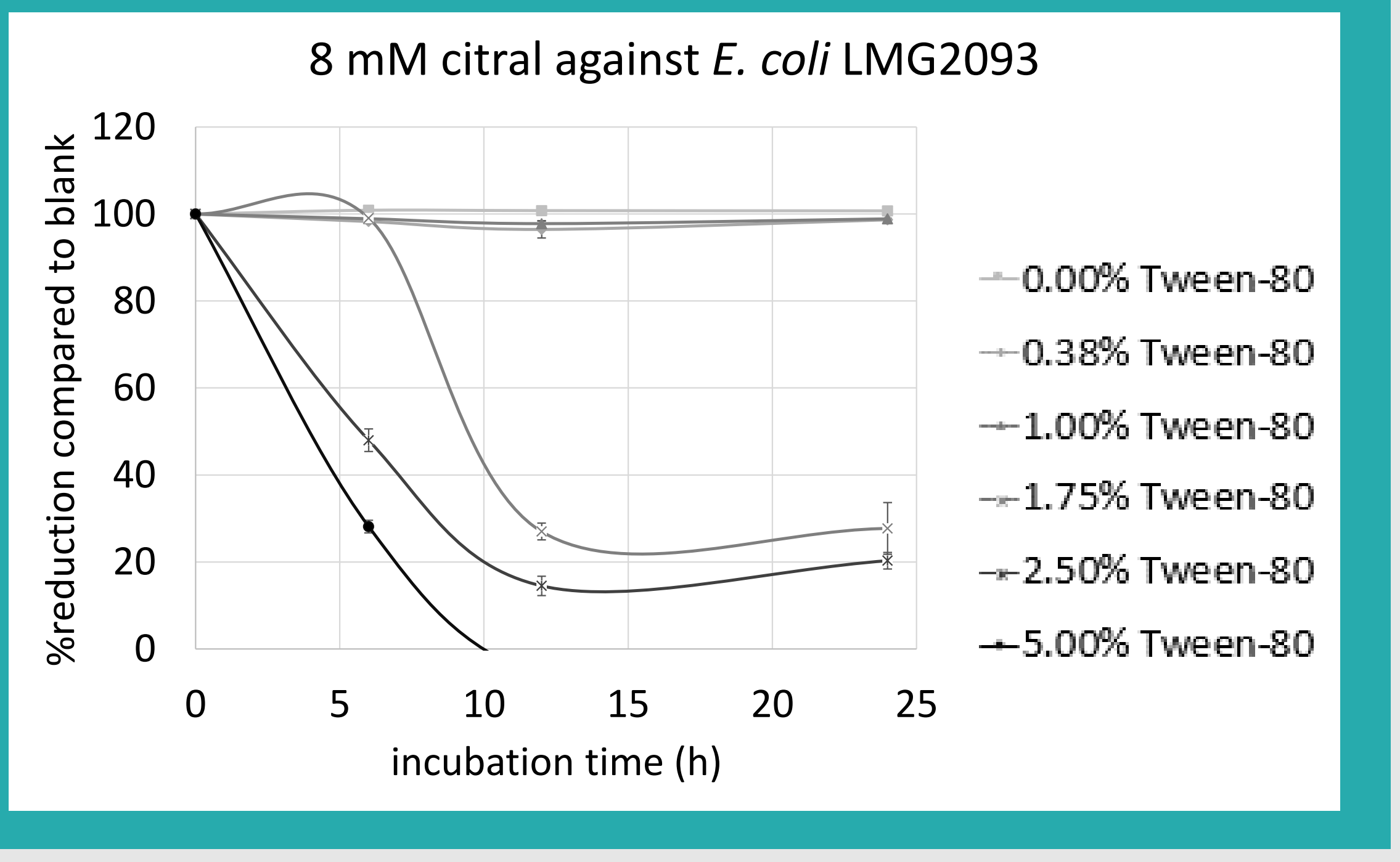
*Results not shown

Results:









Partitioning of the EO compounds between the aqueous phase and micelles: diffusion NMR (H2)

Set-up:

Mixture preparation

↓

1' vortex (max. speed)

↓

Diffusion NMR

Calculations:

$$D_{compound\ in\ mixture} = x \cdot D_{Tween\text{-}80\ in\ mixture} + (1\text{-}x)\ D_{free\ compound}$$

Results:

	Geraniol		Citral	
$C_{Tween\text{-}80}$ ($\%_{v/v}$)	Associated with Tween-80 (%)	Dissolved concentration (mM)	Associated with Tween-80 (%)	Dissolved concentration (mM)
0.38	70	2.4	68	2.6
1.00	80	1.6	77	1.8
5.00	92	0.6	90	0.8

Conclusions

- **H1**: No clear link between the **droplet size** of EO compound emulsions and their antimicrobial activity could be observed.
- **H2**: The **aqueous concentration** of EO compounds in emulsions decreased with higher Tween-80 concentrations, as did the antimicrobial activity.

References

Van de Vel, E.; Sampers, I.; Raes, K. (2017). A review on influencing factors on the minimum inhibitory concentration of essential oils. Crit. Rev. Food Sci. Nutr., 0; Taylor & Francis. Retrieved from https://doi.org/10.1080/10408398.2017.1371112
Wishart, D. S.; Jewison, T.; Guo, A. C.; Wilson, M.; Knox, C.; Liu, Y.; Djoumbou, Y.; et al. (2013). HMDB 3.0-The Human Metabolome Database in 2013. Nucleic Acids Res., 41: 801–807.

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