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## Influence of alkyl polyglucoside (APG) surfactant on solubilization and biological activity of *Melaleuca alternifolia* (tea tree) oil

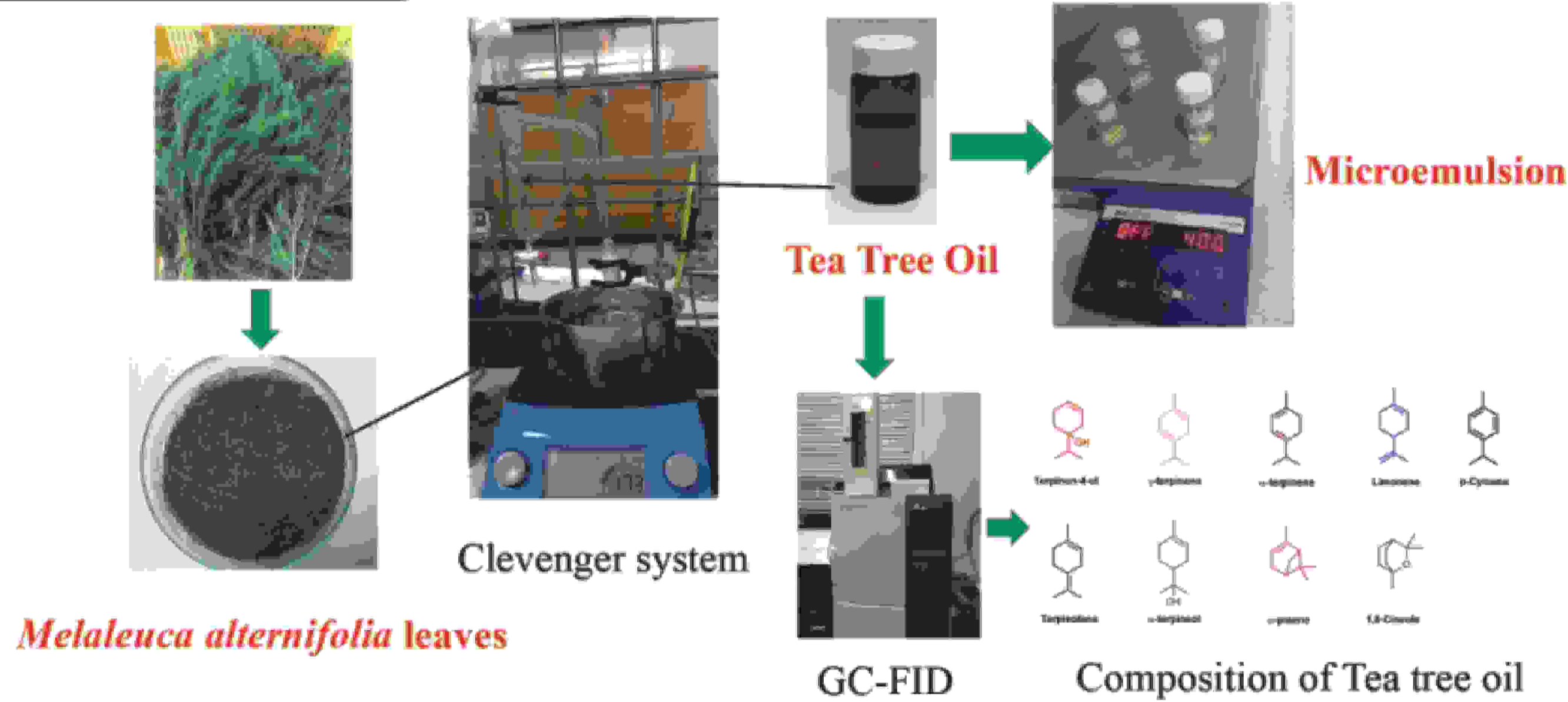
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### I. ABSTRACT

A plant-derived alkyl polyglucoside surfactant (Triton CG110) was formulated with the essential oil of *Melaleuca alternifolia* (tea tree oil) in the presence of propylene glycol as a co-surfactant. In this study, tea tree oil (TTO) was extracted from tea tree leaves by Triton CG110-assisted hydrodistillation. The extraction yield was 6.68% under the optimal conditions with (1) 645.4 ppm Triton CG110, (2) at a liquid/solid ratio of 24.5, and (3) for 128 mins as the extraction time. The pseudo-ternary phase diagrams were constructed and investigated at different weight ratios of surfactant mixtures (Triton CG110/PPG = 1/0, 0.6/1, 1.8/1) with hydrodistilled and commercial TTO, respectively, by water titration method at room temperature. Moreover, shelf stability and biological activity of microemulsions were evaluated.

### II. METHOD



### III. RESULTS

#### Extraction Kinetics

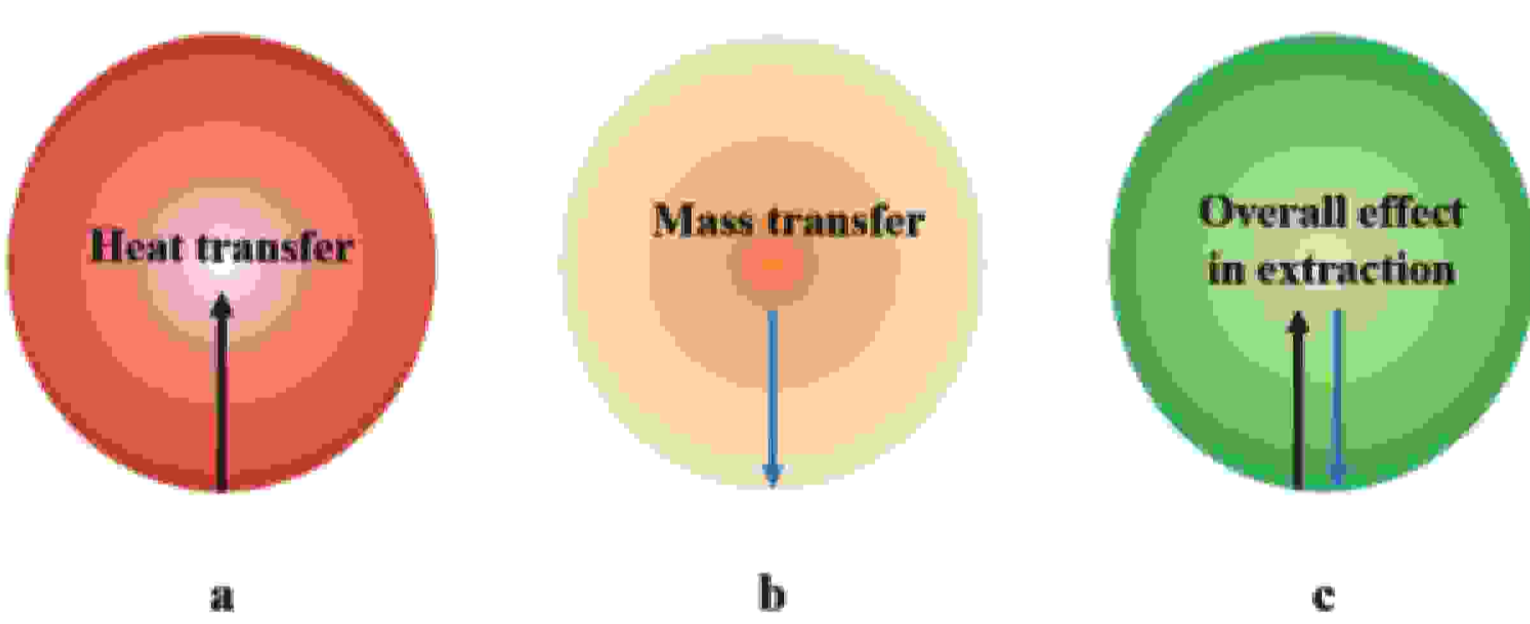


Figure 1. Visualization of mass and heat transport in hydrodistillation.

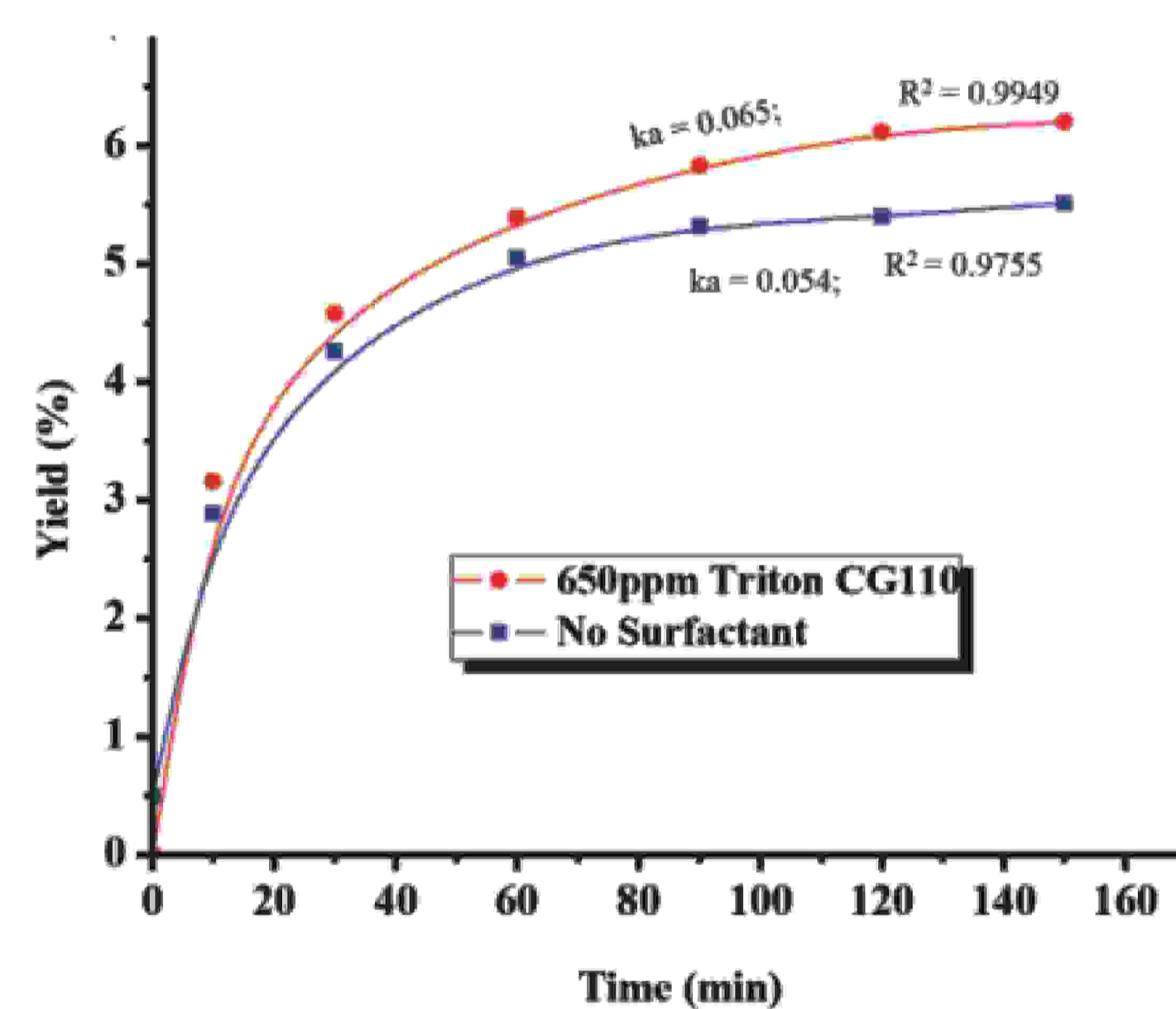


Figure 1. Kinetics of TTO hydrodistillation

#### GC Analysis

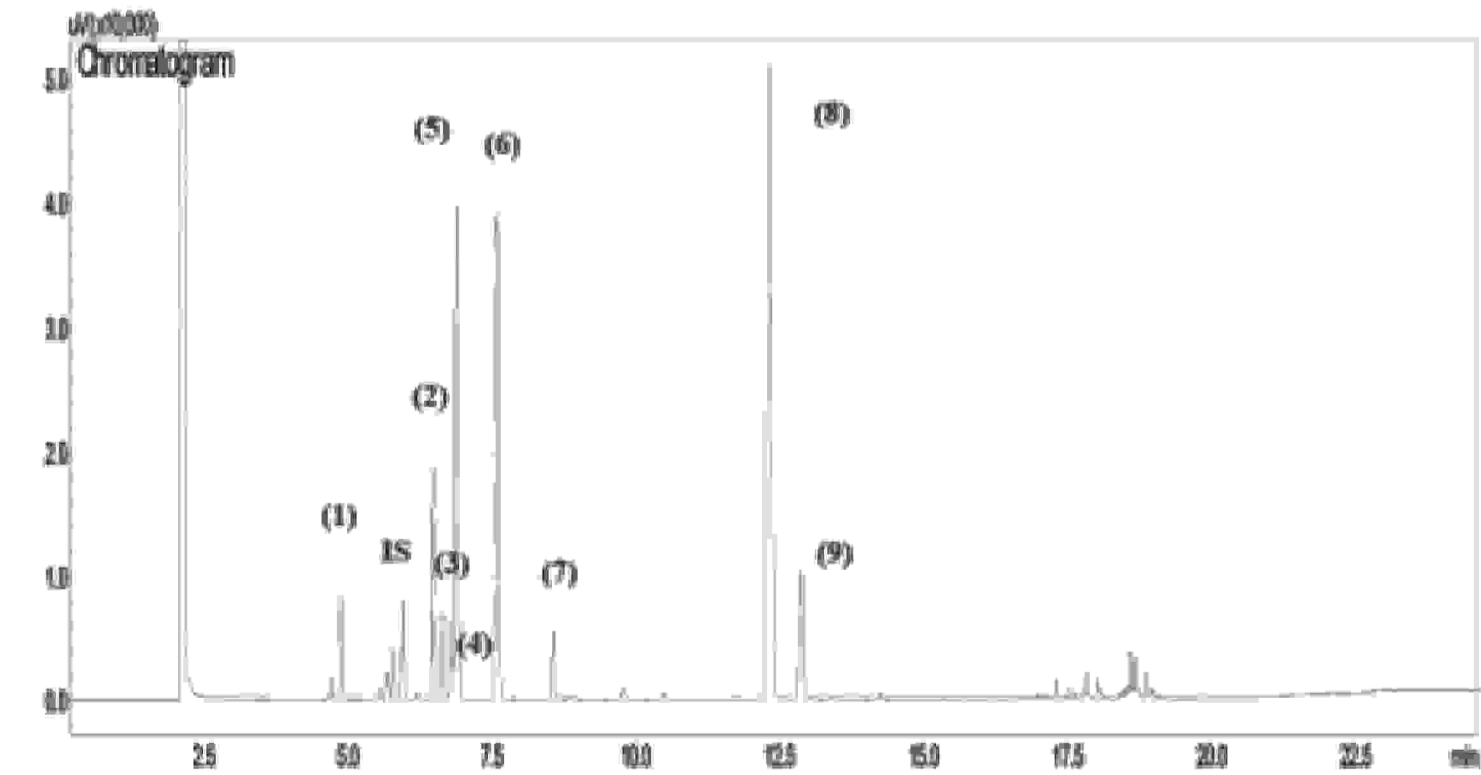


Figure 2. GC-FID chromatogram of hydrodistilled tea tree oil

Table 1. Compositions of the in-house hydrodistilled and commercial tea tree oil (TTO) by GC-FID (according to ISO 4730 but with n-decane as an internal standard)

Peak	Component	ISO 4730 (%)	Commercial TTO (%)	As extracted TTO (%)
1	$\alpha$ -Pinene	1-4	3.0	2.5
2	$\alpha$ -Terpinene	6-12	9.0	8.6
3	p-Cymene	0.5-8	4.0	2.3
4	Limonene	0.5-1.5	1.7	1.3
5	1,8-Cineole	<10	3.0	3.6
6	$\gamma$ -Terpinene	14-28	19	16.1
7	Terpinolene	1.5-5	3.1	2.6
8	Terpinen-4-ol	35-48	43	47.4
9	$\alpha$ -Terpineol	2-5	4.0	4.7
	Other		10.2	10.9

#### Phase diagram

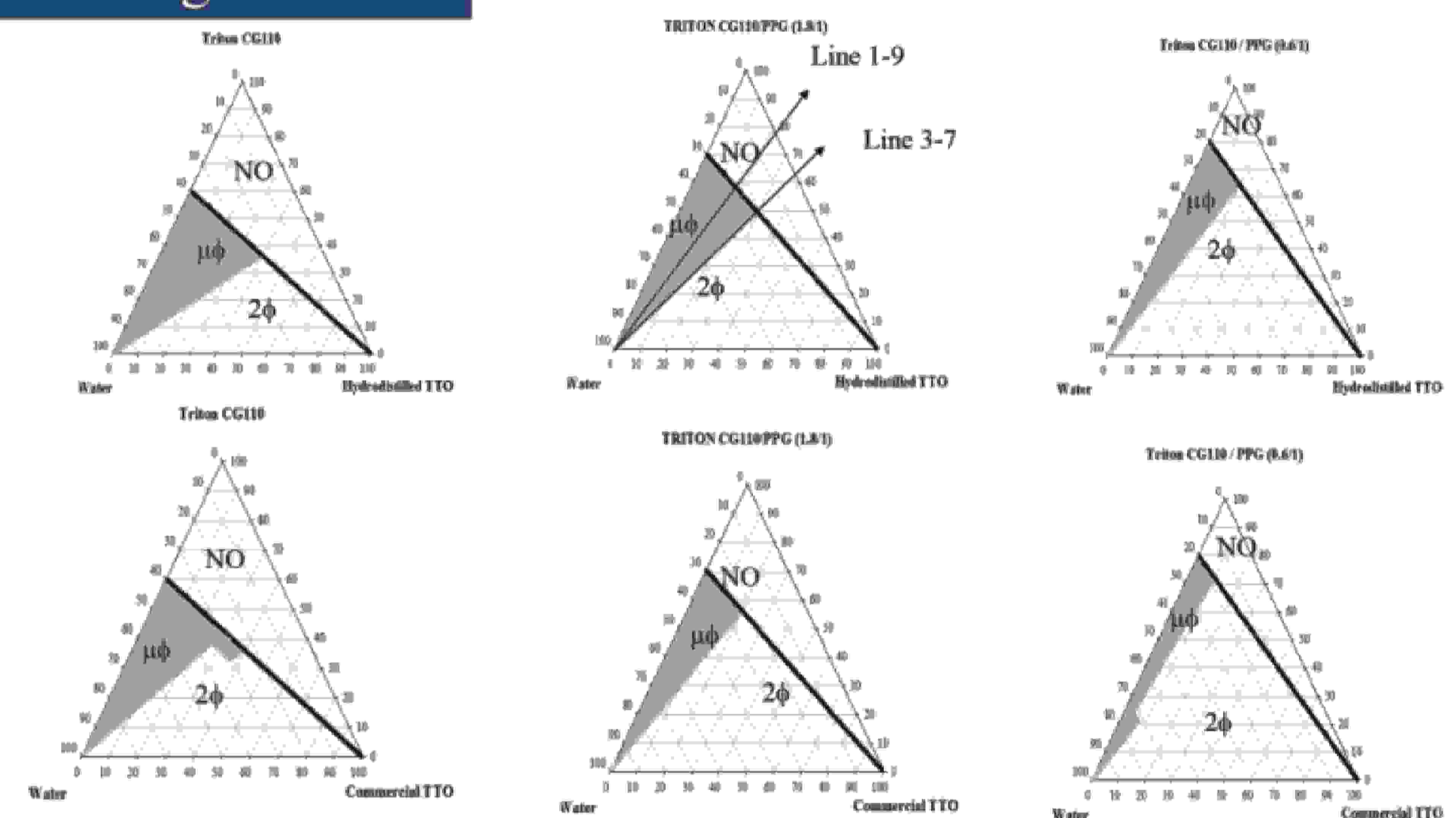


Figure 3. Pseudo-ternary phase diagrams of hydrodistilled TTO (upper) and commercial TTO (lower) with surfactant mixtures of Triton CG-110/PPG at a mass ratio of 1/0, 0.6/1 and 1.8/1. NO: non-observed region,  $\mu\phi$ : microemulsion region,  $2\phi$ : two-phase region

#### Shelf stability

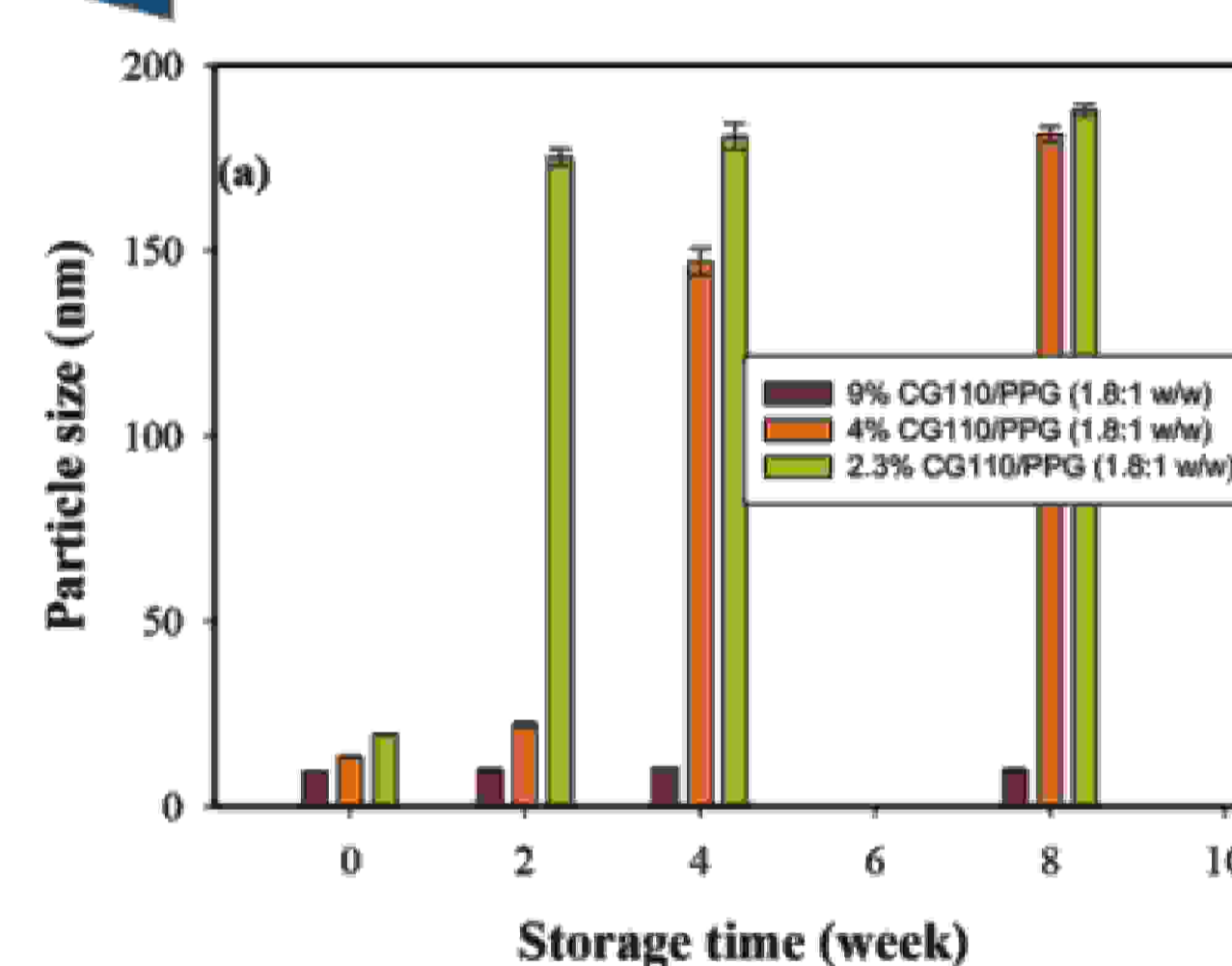


Figure 5. Effect of storage time on particle size of microemulsions made of 1% hydrodistilled TTO with various amount of surfactant mixture

#### Free radical scavenging activity

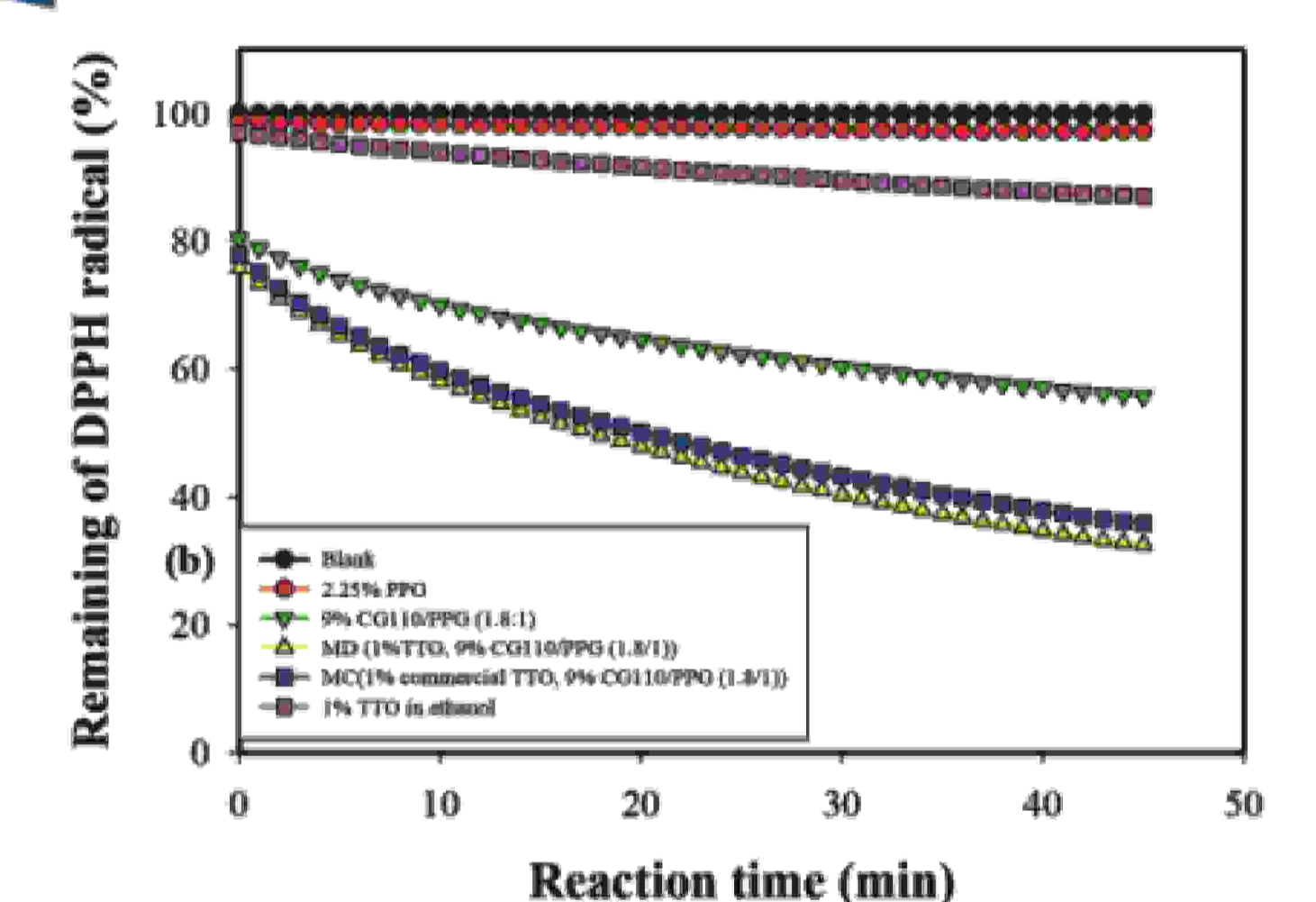


Figure 6. DPPH antioxidant activity of TTO and microemulsion

#### Antibacterial activity

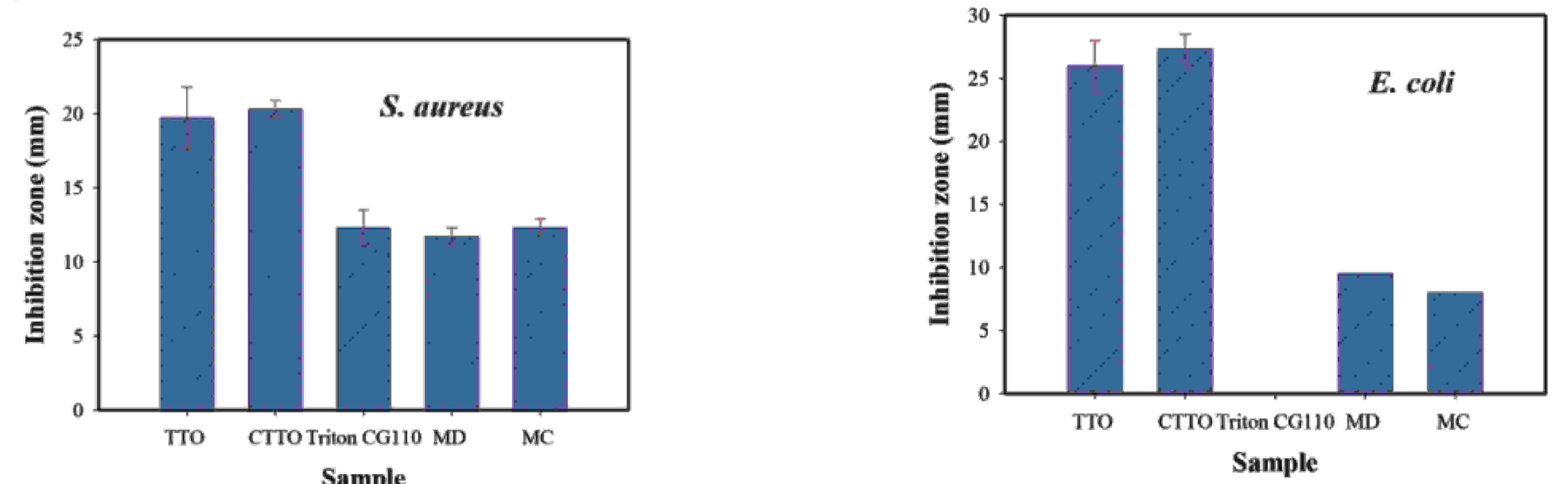


Figure 7. Inhibition zone of hydrodistilled TTO, CTTO-commercial TTO, Triton CG110 (6.75 wt%), microemulsion made of 1 wt% TTO with 9 wt% Triton CG110/PPG (1.8/1), against *S. aureus* and *E. coli*.

### IV. CONCLUSION

The hydrodistillation yield of TTO in presence of Triton CG110 increased by 11% and 9% after 120 and 150 mins, respectively. Microemulsion region made of hydrodistilled TTO was wider than that made of commercial TTO. Only O/W microemulsion was observed in one-phase region. Especially, the inhibition zone diameter for Triton CG110 and microemulsion made 1 wt% TTO were 12.3 mm and 11.7 mm, respectively, against *S. aureus*. In contrast, no observable inhibition zone of Triton CG110 could be found against *E. coli*.



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