Preparation of Tamanu Oil Nanoemulsions by Phase Inversion Temperature (PIT) Method

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Abstract

Tamanu oil may benefit the skin and hair due to its anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. In this study, the phase inversion temperature (PIT) method was used to prepare a stable tamanu oil nanoemulsion at the lowest surfactant content. The factors affecting the formation of nanoemulsions such as type of surfactant, surfactant to oil ratio (SOR), and water content were investigated. The results showed that Tween 80 is suitable for making a stable nanoemulsion. The SOR is more than or equal to 1.5:1 produced emulsions with particle size less than 100 nm. The particle size decreased as SOR, and water content increased. A higher quantity of surfactant caused higher turbulence and affinity towards the aqueous phase, resulting in smaller droplets. Decreasing droplet size by increasing water content may result from a decreased viscosity of the surfactant at the interface that promotes fluidity and the easy movement of the oil phase towards the aqueous phase. The SOR of 3:1 and water content of 80% were selected due to cost, taste, and toxicity concerns. The impact of storage condition on nanoemulsion stability was also investigated. After one month, samples were stored in the refrigerator had an insignificant increase in absorbance. Particle size analysis also showed a similar result (< 20 nm).

Introduction

Nowadays, the requirement to use products derived from natural is gaining much attention. *Calophyllum inophyllum* is grown throughout the tropical regions of the world, including Vietnam. Tamanu oil products are widely used in diesel energy to produce biodiesel, pharmaceutical products, and cosmetics [1,2]. In short, tamanu oil can be used in many fields thanks to its excellent biological properties.

Figure 1. *Calophyllum inophyllum* fruits and flowers [3]

Oil-in-water nanoemulsions are the colloidal systems suitable for encapsulating essential oil [4]. They consist of small oil droplets dispersed in water by an emulsifier. In contrast to the traditional emulsions, the particles in nanoemulsion have an average diameter of less than 200 nm. The small size has some advantages for commercial applications: stability in gravity and droplet agglomeration, high transparency, and increased biological activity [4,5].

This study's objective was to make a stable tamanu oil nanoemulsion at minimum surfactant content due to expense, flavor, and virulence. These results can be used for applications in the cosmetics or pharmaceutical industry.

Methods and Materials

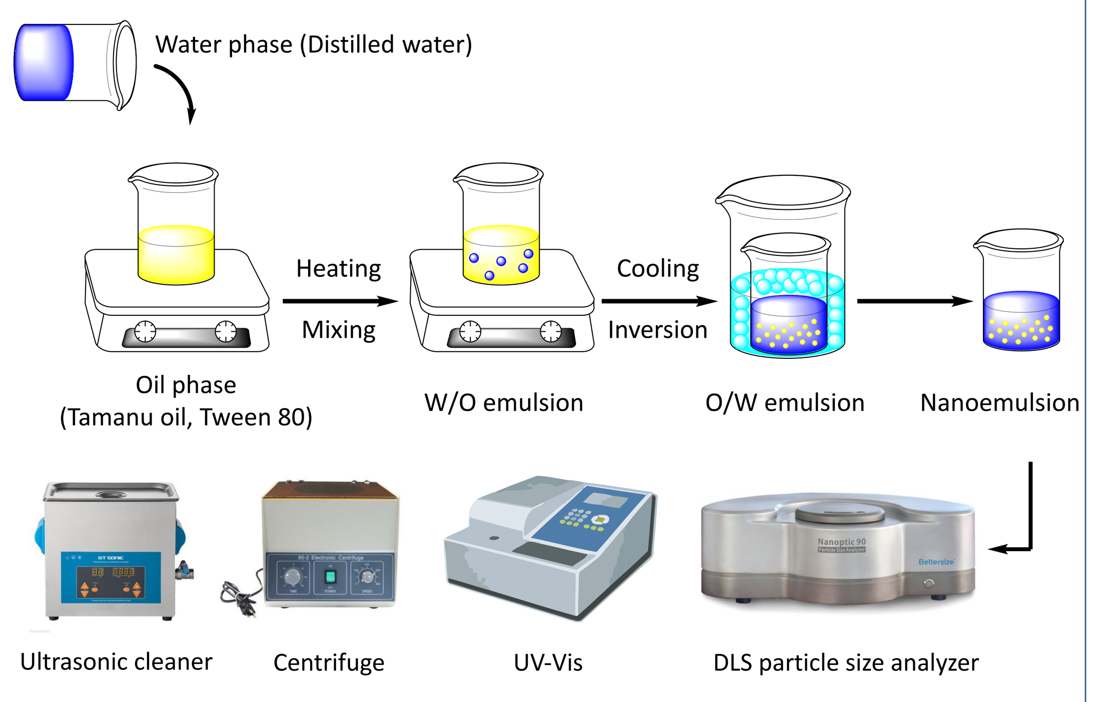

Figure 2. Preparation of tamanu oil nanoemulsions

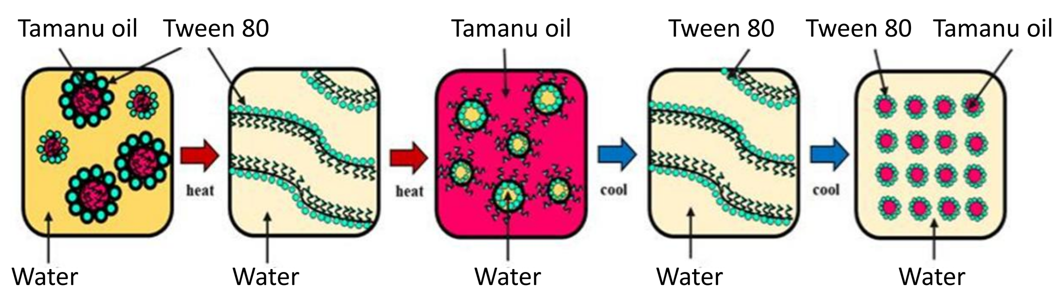

Figure 3. Schematic mechanism diagram for nanoemulsion formation using PIT method [4].

Survey parameters: PIT, type of surfactant, surfactant to oil ratio, water phase content.

Results

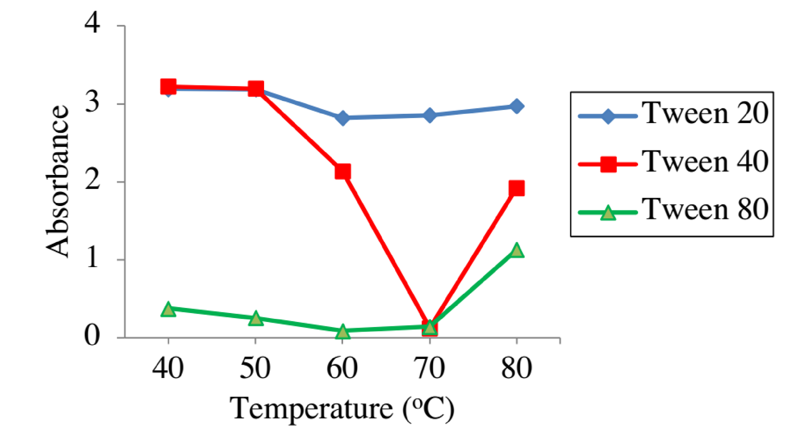

Figure 4. The impact of surfactant types on nanoemulsion formation.

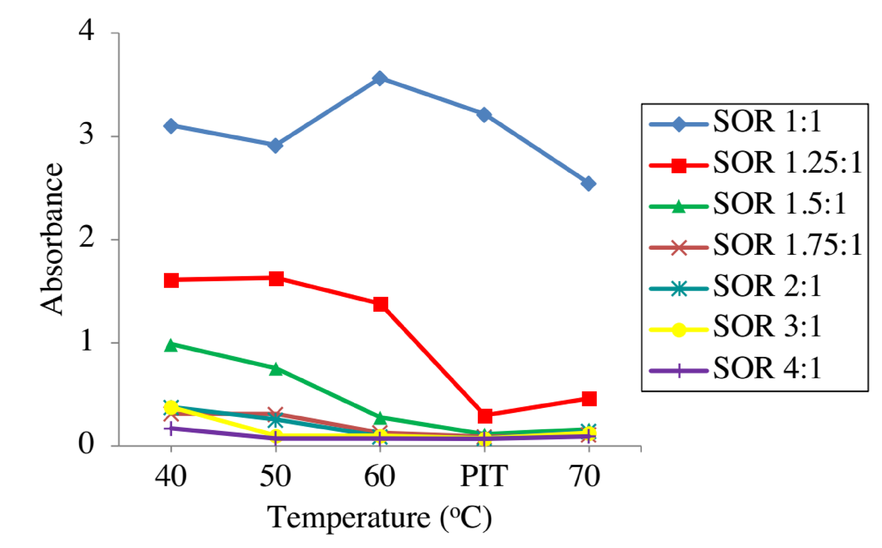

Figure 5. The impact of SOR on nanoemulsion formation.

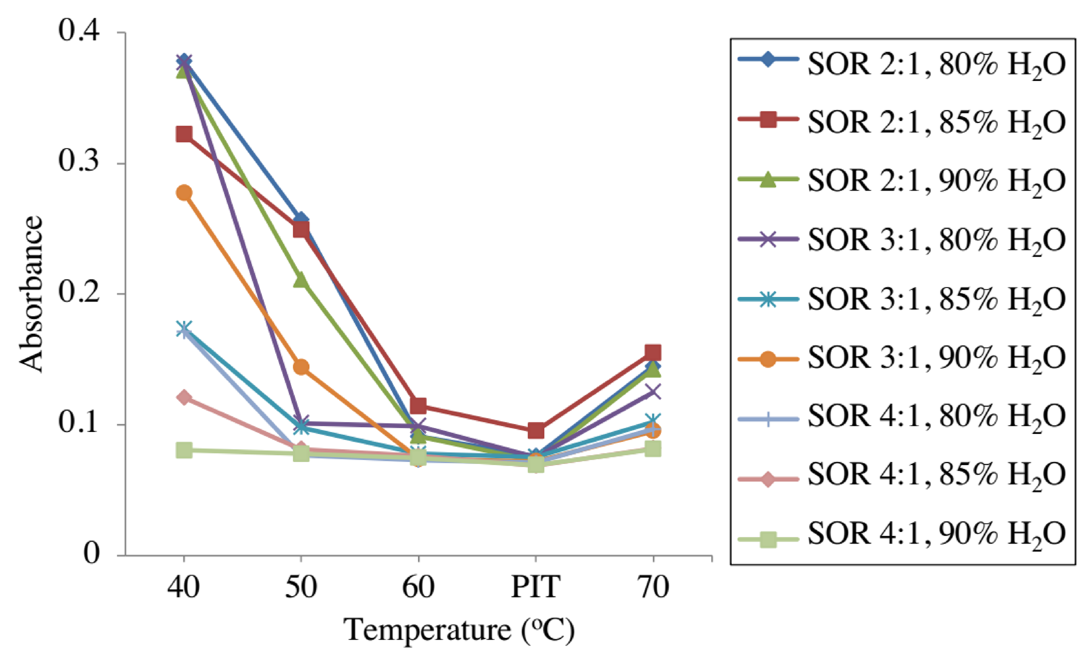

Figure 6. The impact of aqueous phase concentration on nanoemulsion formation.

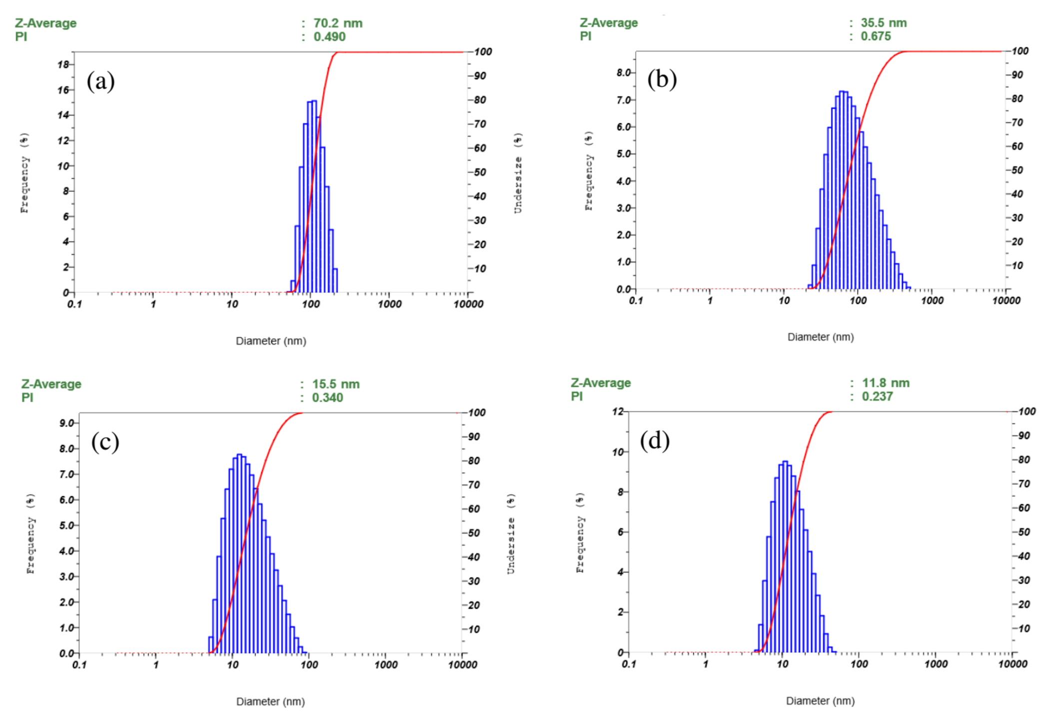

Figure 7. The average droplet diameter of tamanu oil nanoemulsion at different SORs (a) 1:5, (b) 2:1, (c) 3:1, and (d) 4:1.

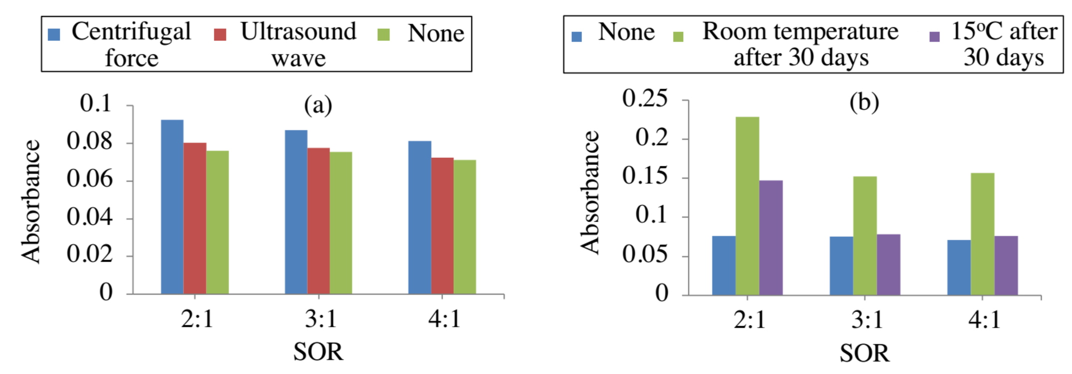

Figure 8. The absorbance of nanoemulsions under (a) the influence of external forces and (b) the different storage conditions.

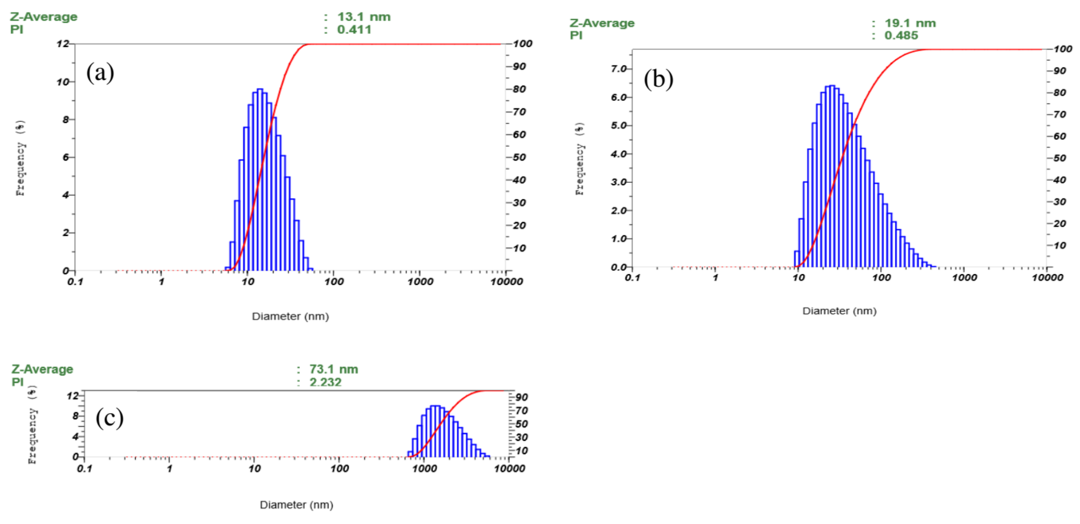

Figure 9. Mean particle diameter of tamanu oil nanoemulsions after one-month storage in the fridge with SOR of (a) 4:1, (b) 3:1, and (c) 2:1.

Conclusions

In this research, the PIT method was employed to prepare a stable nanoemulsion at the lowest surfactant content. This method has never been applied before to make tamanu oil nanoemulsion. Factors such as the type of surfactant, SOR, and water phase content influenced nanoemulsion's formation and stability. Among surfactants, Tween 80 was the most suitable for forming stable nanoemulsions and small droplets. The higher the SOR, the lower the absorbance and particle size. The increase in water phase content also leads to similar results. The SORs above 1.5:1 could make nanoemulsions whose droplet size is less than 100 nm.

The storage condition also affected the stability of nanoemulsions. The samples should be stored at a low temperature instead of room temperature. However, the sample with SOR of 2:1 was unstable after one-month storage in the fridge. The particle size analysis indicated a significant increase. Therefore, the SOR of 3:1 and water content of 80% were chosen due to stability, cost, taste, and toxicity in cosmetics.

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References

1. Sundur S, Shrivastava B, Sharma P, Raj S S and Jayasekhar V L 2014 Int. J. Adv. Res. 2 599–603.
2. Raharivelomanana P, Ansel J-L, Lupo E, Mijouin L, Guillot S, Butaud J-F, Ho R, Lecellier G and Pichon C 2018 OCL 25 D504.
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4. Chuesiang P, Siripatrawan U, Sanguandeekul R, McLandsborough L and McClements D J 2018 J. Colloid Interface Sci. 514 208–16.
5. Chang Y and McClements D J 2014 J. Agric. Food Chem. 62 2306–12.