Viscoelastic Behavior of Olive Oil-in-Water Emulsion Stabilized By Sucrose Fatty Acid Esters

H.W. Tan*, M. Misran and S.K. Khoo

Colloid and Surface Laboratory, Department of Chemistry, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia

*Corresponding author: tanhw@um.edu.my
Fax: x603.79674193

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Abstract:
The rheological behavior of the olive oil-in-water emulsions has been studied by varying the oil to water ratio as well as the surfactant concentration. The viscoelastic property of the olive oil emulsions was investigated with a cone-and-plate system, using a Bohlin C-VOR Rheometer. The obtained results indicated that the emulsions with greater oil and surfactant concentrations are highly packed systems with greater interdroplet interactions as well as higher critical strain. The viscoelastic property of the emulsions can be enhanced by increasing the oil concentration. The elastic modulus of the emulsions was always predominant over the viscous modulus, thereby emphasizing the elastic character of the above mentioned emulsions. The emulsion with a higher oil composition shows greater elasticity, which implies a strong dynamic rigidity of the emulsions. A high oil composition also enhanced the structural integrity as well as the interdroplet interactions of the emulsion.

Zusammenfassung:
Das rheologische Verhalten von Olivenöl in Wasser-Emulsionen wurde untersucht, wobei das Öl zu Wasserverhältnis und die Tensidkonzentration variiert wurden. Das viskoelastische Verhalten der Olivenöl-Emulsionen wurde mit Hilfe eines Bohlin C-VOR-Rheometers gemessen (Kegel-Platte-Geometrie). Die gewonnenen Resultate deuten an, dass die Emulsionen mit größerer Öl- und Tensidkonzentrationen sehr dichte Systeme mit einer größeren Tröpfchen-Tröpfchen-Wechselwirkung und einer höheren kritischen Deformation sind. Die viskoelastischen Eigenschaften der Emulsionen können durch eine höhere Ölkonzentration verstärkt werden. Der Speichermodul der Emulsionen war immer größer als der Verlustmodul, was den elastischen Charakter der Emulsionen betont. Die Emulsion mit dem höheren Ölgehalt besitzt eine höhere Elastizität, was eine starke dynamische Steifigkeit der Emulsionen impliziert. Eine hohe Ölkonzentration erhöhte die strukturelle Widerstandsfähigkeit als auch die Wechselwirkungen zwischen den Tröpfchen der Emulsion.

Résumé:
Le comportement rhéologique d'émulsions d'huile d'olive dans de l'eau a été étudié en variant le ratio entre l'huile et l'eau ainsi que la concentration en surfactant. La propriété viscoélastique des émulsions d'huile d'olive a été étudiée à l'aide d'un système cône-plateau en utilisant un rhéomètre Bohlin C-VOR. Les résultats obtenus indiquent que les émulsions contenant le plus d'huile et de surfactant sont des systèmes hautement compacts avec des interactions entre gouttes plus grandes ainsi que des déformations critiques plus grandes. La propriété viscoélastique des émulsions peut être améliorée en augmentant la concentration en huile. Le module élastique des émulsions est toujours prédominant par rapport au module visqueux, soulignant ainsi le caractère élastique des émulsions ci-dessus mentionnées. L'émulsion possédant la plus grande composition en huile montre une élasticité plus grande, ce qui implique une forte rigidité dynamique des émulsions. Une grande composition en huile améliore également l'intégrité structurelle ainsi que les interactions entre les gouttes de l'émulsion.

Key words: rheology, sucrose ester, olive oil, emulsion

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Figure 7 (above):
The Tan δ of emulsions with (a) 50 %, (b) 60 %, (c) 70 %, and (d) 80 % of oil obtained after one day of storage, which stabilized with 2 wt% (■), 4 wt% (▲), 6 wt% (♦), 8 wt% (▶), and 10 wt% (●) of surfactant.

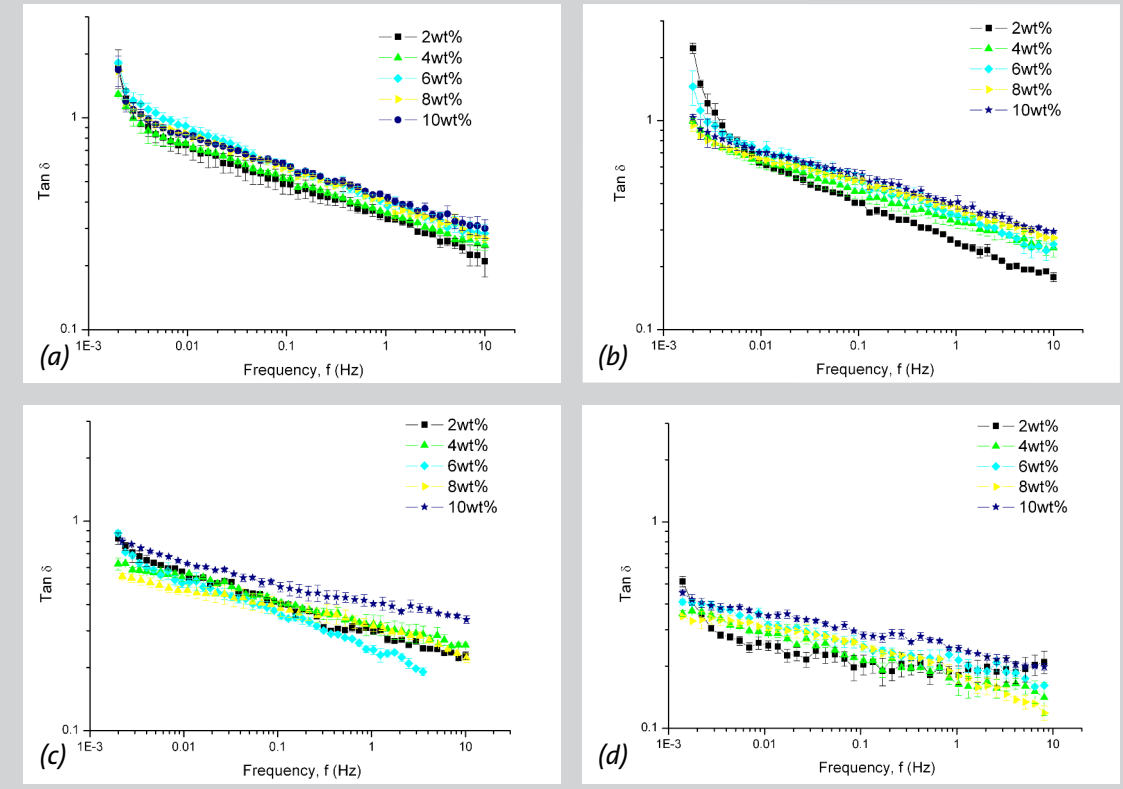
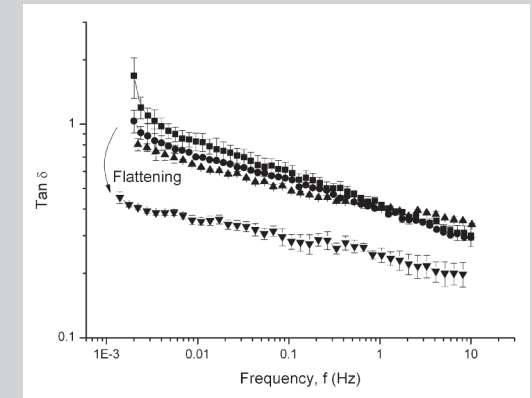


Figure 8:
The effect of oil concentration to the Tan δ of emulsions stabilized with 2 wt% of SFAE (50 % = ■, 60 % = ●, 70 wt% = ▲ and 80 wt% = ▼).



results indicated that there was no complicated network formed amongst the interfacial layers between the droplets. This might due to the surfactant that only functions as stabilizer, created a protective layer that separated and stabilized the oil droplets from the aqueous environment [26, 32].

4 CONCLUSION

The viscoelastic study has provided useful information on the emulsion stability as well as the droplet rigidity. According to the rheological measurement, the emulsions prepared with 80% olive oil were the most stable emulsion with the smallest droplet size. These emulsions exhibited the greatest viscoelastic property. In addition, 2–4 wt% of surfactant is the best condition to stabilize the emulsion droplets in the emulsions with 80 % of olive oil (Table 2). The strength of interaction of the internal structure has also become stronger as the droplet size becomes smaller. Stronger interdroplet interactions increase the shelf life of the emulsions and protect the droplets from the rapid destabilization processes, such as gravitational separation.

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