

**CHAPTER FOUR:
CONCLUSION**

The influence of different dispersing agents on the rheological behaviors of paraffin oil-water emulsion with addition of TiO₂ for uv-protect and moisturizing active ingredient was studied. While making creams with minimal structural defects and longer storage stability, it is important that preparation conditions be optimized. Settled volume properties, Zeta potential, effective diameter of TiO₂ suspension were studied in the presence of Glycolipid (DDM and λ -Carrageenan), nonionic (PEG 10,000 and Brij 35P) and as well as anionic (sodium dodecyl sulfate, SDS).

In the experiments, the higher concentration of dispersing agents at 5.0×10^{-3} mM at 29.5°C shown higher settle volume percentage, higher zeta potential and give a smaller average size of particles distribution in the TiO₂ solution. The results obtained show significant influence of the type of surfactants on the measured quantities. The molecular architecture of three surfactants suggests that they contain same number of carbon atoms in their hydrophobic tail, but differ in their head group polarities which are DDM, SDS and Brij 35P. It means that these surfactants possess same degree of affinity for oil phase, whilst differ in their affinity to aqueous phase. The result is that they differ in their HLB values, thereby stabilizing oil droplets in water at varying degree. The less polar the surfactant, the less water soluble it is, thereby showing greater interfacial activities. Whereas for PEG 10,000 and λ -Carrageenan irrespectively because they contain different number of carbon and head group polarity as well.

Furthermore, Glycolipids exhibited lowest dynamic interfacial tension compared to sodium dodecyl sulphate (SDS) and polyethylene dodecyl ether (Brij 35P). This inferior value of dynamic interfacial tension was due to the hydrophilic-hydrophobic interfacial region of Glycolipids which are λ -Carragenan polysaccharide and DDM disaccharide micelles possess a microenvironment which has more 'hydro-like' manners than other

non-saccharide head group such as ethylene oxide group from polyethylene dodecyl ether or ionic strength from sodium dodecyl sulphate

Meanwhile, comparison of rheological properties of dispersing agents stabilized emulsions shows glycolipids type surfactant, λ -Carrageenan stabilized emulsions exhibited higher shear viscosity at all shear rate compared to DDM, PEG 10,000, Brij 35P and SDS stabilized emulsions. The degree of shear thinning was also higher for λ -Carrageenan stabilized emulsions compared to others dispersing agents stabilized emulsions. λ -Carrageenan stabilized emulsions exhibited higher low shear viscosity compared to DDM, PEG 10,000, Brij 35P and SDS stabilized emulsions. Low shear viscosity increased with surfactant concentration.

Polysaccharide type surfactant, λ -Carrageenan stabilized emulsions exhibited a higher rate of shear thinning at low shear rates and higher yield stress at low frequencies compared to DDM, PEG 10,000, Brij 35P and SDS stabilized emulsions, suggesting that as a surfactant λ -Carrageenan performed better compared to DDM, PEG 10,000, Brij 35P and SDS. Emulsions showing a higher rate of shear thinning at a low shear rate in combination with higher yield stress at low frequencies usually spread easily, a property highly desirable for cosmetic applications. Degree of shear thinning and yield stress of λ -Carrageenan stabilized emulsions could be enhanced with surfactant concentration.

In addition, λ -Carrageenan stabilized emulsions exhibited higher values of both the loss and storage modulus compared to DDM, PEG 10,000, Brij 35P and SDS stabilized emulsions, suggesting it is performing better as an emulsifying agent compared to DDM, PEG 10,000, Brij 35P and SDS Both the yield stress and the storage modulus increased with surfactant (λ -Carrageenan) concentration. Probably it is related to both the reduction in emulsion droplet sizes and increase in dispersed phase concentration with concentration. Emulsion droplets size increased significantly with applied shear,

whereas droplet structure changed from mixed spherical and polygonal into predominantly polygonal and rhombic. These structural changes proposed that the emulsions under investigation are plastic like in nature and unstable. During incubation at 45°C, these oil-in-water emulsions have undergone Ostwald ripening process which means many small droplets sizes form in a system initially but slowly disappear except for a few that grow larger, because larger droplets are more energetically favored than smaller droplets.