Preparation and characterization of PEG-20 glyceryl triisostearate-based bicontinuous phase microemulsions and their application as makeup remover

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Introduction:

Bicontinuous microemulsions have several inherent properties that are useful as biomimetic systems: near zero mean curvature (similar to biomembranes and in contrast to micelles and vesicles), isotropicity, optical clarity, and high levels of interfacial area per volume. WINSOR III bicontinuous phase microemulsion shows transparent appearance. It is usually used in oil recovery, blending of immiscible polymer mixtures, nanomaterial synthesis, coatings, chemical and biochemical reactions, et al. In recent years, a few products in Japan have used bicontinuous microemulsion as makeup remover products. In this study, we developed a new type of PEG-20 glyceryl triisostearate-based bicontinuous phase microemulsions and investigated their makeup removal ability as a makeup remover. The double continuity and compatibilizing properties of oil and water endow these emulsions with good ability to dissolve water-soluble as well as oil-soluble substances. The results of this study suggested that development of bicontinuous microemulsions based makeup remover would be a good potential research direction in the field of makeup remover.

Materials & Methods:

Preparation of bicontinuous microemulsions

Equal mass of ethylhexyl palmitate and water were used as oil phase and water phase, respectively. PEG-20 glyceryl triisostearate of different masses were used as the emulsifier, and glycerin and isostearic acid as the co-emulsifiers. All these ingredients were put into a beaker and mixed at 200 rpm for 20 minutes to obtain bicontinuous phase microemulsions.

Phase Diagrams

The phase behavior of the water/ethylhexyl palmitate/PEG-20 glyceryl triisostearate/glycerin system has been studied at room temperature of 25 °C and oil concentration of 15-35 wt % based on method from previous study. Glycerin was used as a co-emulsifier and ethylhexyl palmitate was used as the oil phase. The ratio of oil and water was 1:1 in the system. The phase diagram was obtained using the titration method by weighing all components in the final mixture. Firstly, samples were prepared by weighing appropriate amounts of surfactant and oil (or surfactant and water) into the beaker. Then water (or oil) was gradually added into the mixture. The samples were kept stirring at 200 rpm by magnetic stirrer under 25 °C. When the mixture became transparent and turbid, the amount of co-emulsifier added in the mixture was recorded. The ratios of each reagent in the experimental system used were as follows:

Table 1 Formula ratio and weight of microemulsion surfactant/oil/water(w/w)

	surfactant/oil/water(w/w)				
ratio(w/w/w)	3/3.5/3.5	4/3/3	5/2.5/2.5	6/2/2	7/1.5/1.5
Weight (g)	0.6/0.7/0.7	0.8/0.6/0.6	1/0.5/0.5	1.2/0.4/0.4	1.4/0.3/0.3

Microstructure morphology of bicontinuous microemulsion

The microstructure morphology of bicontinuous phase microemulsions was analyzed using Cryo-Scanning Electron Microscope and Laser Scanning Confocal Microscope. Before the confocal experiment, oil phase of the emulsions was pre-dyed with Nile Red.

Make-up removal performance

The ability of these bicontinuous microemulsions and commercially available makeup remover products to clean a lipstick mark were compared. After applying lipstick, put makeup remover products on the lipstick mark 10 seconds. Then gently risnsing the makeup remover with water to compare their makeup removal effect.

Results & Discussion:

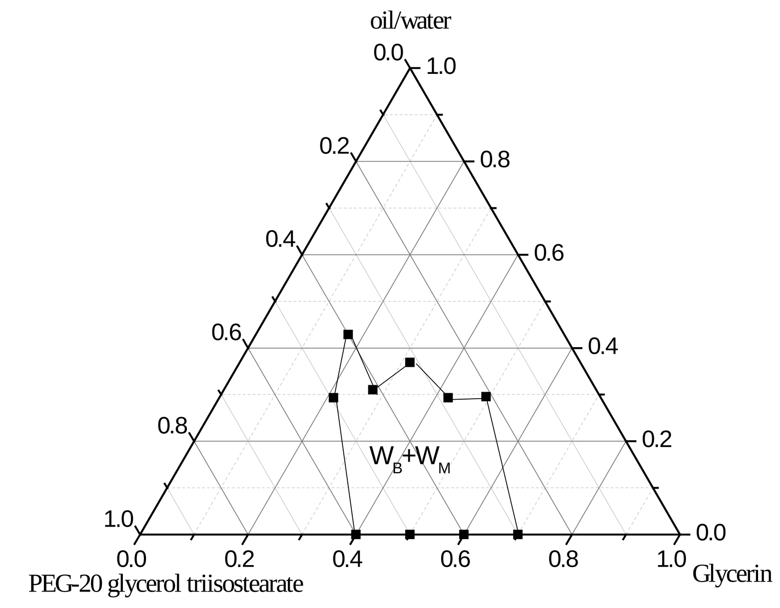

Fig. 1 Pseudoternary phase diagram of water/ ethylhexyl palmitate/ PEG-20 glyceryl triisostearate/ glycerin system at 25 °C.

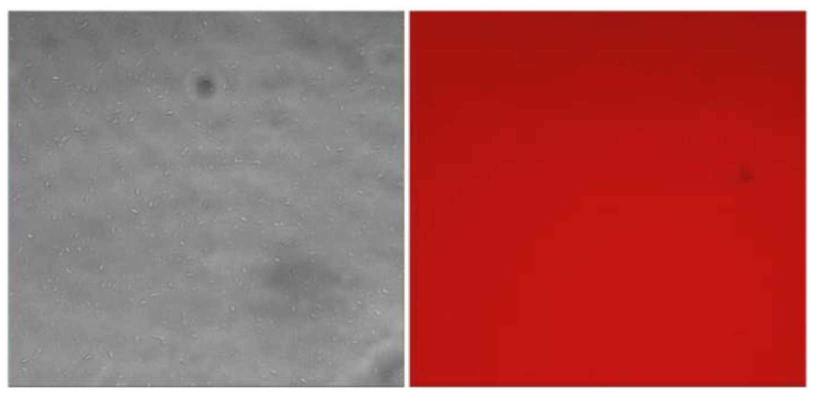

Fig. 2 Image of optical microscope (left) and confocal microscope (right).

The phase diagrams of the water/ ethylhexyl palmitate/ PEG-20 glyceryl triisostearate/ glycerin system has been recorded and presented in **Fig. 1**. The main features are the presence of three single phase regions: W_B+W_M, bicontinuous emulsion and water-in-oil (W/O) microemulsion; W_B, bicontinuous emulsion phase and W_M, microemulsion phase. The rest of the diagram are multiphase regions. When the co-emulsifier was gradually added to the system, the system changed from transparent to turbid. In the phase diagram, the transparent area occupies a quarter of the total area.

The image of the confocal microscope (**Fig. 2**) showed that the oil phase dyed by Nile Red was evenly distributed in the solution. It is suggested that the tested sample is a emulsion with evenly distributed water and oil phase.

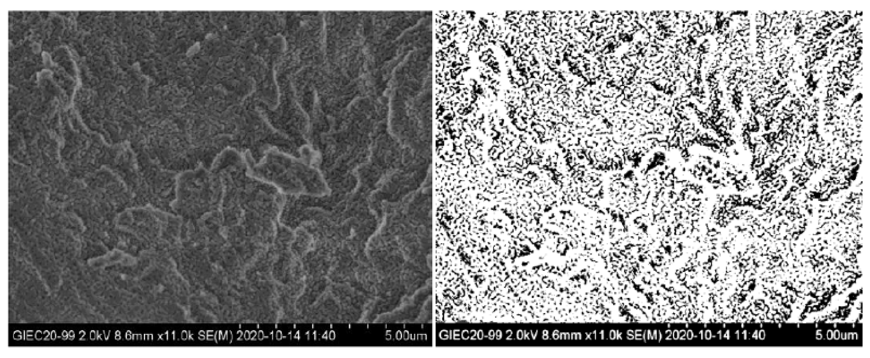

Fig. 3 Image of cryo-scanning electron microscope (left) and its ImagJ processing image (right).

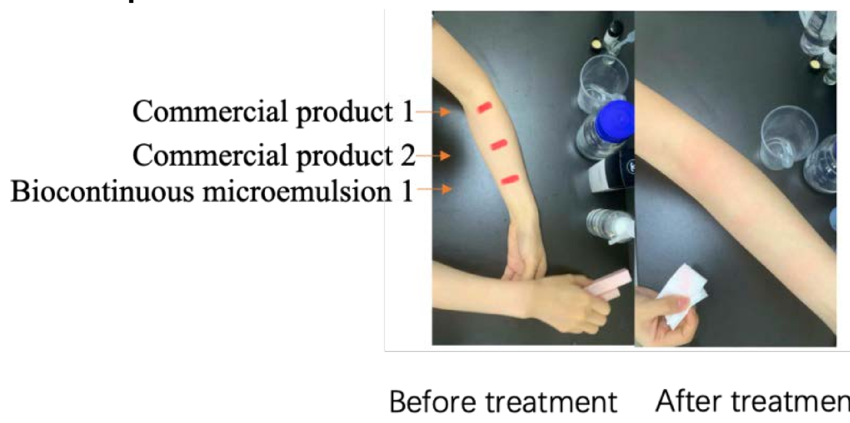

Fig. 4 Results of make-up removal effect.

In **Fig. 3**, Obvious irregular network pore structure can be observed, suggesting that bicontinuous phase microemulsions were successfully prepared in this study.

In order to test the makeup removal effect of the bicontinuous microemulsion, its ability to remove lipstick was tested (**Fig. 4**). Compared with the commercial products 1 and 2, the bicontinuous microemulsion exhibited better makeup removal effect. The results suggest that the bicontinuous phase microemulsion has a good makeup removal effect.

Conclusions:

The water/ethylhexyl palmitate/PEG-20 glyceryl triisostearate/glycerin system was successfully prepared. The phase diagram results show that the system has a large transparent area. The results of cryo-electron microscopy and confocal microscopy showed that the formula we selected contained a porous channel structure. It is further confirmed that the formula we have chosen to obtain is a dual continuous phase microemulsion. The results of makeup removal experiments show that the bicontinuous microemulsions have a better makeup removal effect than commercial products. Our research results suggest that bicontinuous microemulsion has good application value in makeup remover products. On the other hand, our research can provide data support for the makeup removal effect of microemulsion.

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References:

1. Watanabe, K., Sakurai, N., Meno, T., Yasuda, C., Takahashi, S., Hori, A., Tsuchiya, K., & Sakai, H. (2021). Novel Spontaneous Cleansing Feature of Foam─ Hybrid Bicontinuous-Microemulsion-Type Foamy Makeup Remover─. Journal of Society of Cosmetic Chemists of Japan, 55(1): 19-27.
2. Salager, J.-L., Antón, R., Bullón, J., Forgiarini, A., & Marquez, R. (2020). How to use the normalized hydrophilic-lipophilic deviation (HLDN) concept for the formulation of equilibrated and emulsified surfactant-oil-water systems for cosmetics and pharmaceutical products. Cosmetics, 7(3): 57.
3. Alsafadi, D., Khalili, F. I., Juwhari, H., & Lahlouh, B. (2018). Purification and biochemical characterization of photo-active membrane protein bacteriorhodopsin from Haloarcula marismortui, an extreme halophile from the Dead Sea. Int. J. Biol. Macromol., 118: 1942-1947.