GLYCEROL DERIVATIVE AS A CO-SURFACTANT IN PALM OIL-BASED MICROEMULSION FOR PRACTICAL APPLICATIONS

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Microemulsions are normally isotropic (or clear), very small in droplet size (<100 nm), low in viscosity and are thermodynamically stable solutions. However, the ordinary emulsions appear as milky white dispersions with higher viscosity, droplet size of >0.5 μm and are only kinetically stable. Thus, since several years ago, the properties of the microemulsion system have attracted many researchers, formulators, manufacturers and the end-users to carry out studies on how to apply the system in producing high value-added products.

Recently, a study found palm oil-microemulsions to have potential as all-purpose liquid cleaners. (*Figure 1*), showing superior cleaning performance (*Figure 2*) and giving a better shiny appearance than the conventional liquid cleaners (Ismail *et al.*, 2007; 2008). All formulae showed good performance as cleaning solutions even after several dilutions.

TECHNOLOGY INNOVATION

The formulation of palm oil-based microemulsion solutions as all-purpose liquid cleaners requires between 10%-15% (w/w) of 1,2-hexanediol as a conventional co-surfactant in the system. However, the cost of the raw material, 1,2-hexanediol (AR grade), is ~RM 1200 – RM 1400 litre^{-1}. Thus, the production of palm oil-based microemulsion solutions as all-purpose liquid cleaners is not viable with this conventional co-surfactant. Therefore, other alternative non-toxic diols that are cost-effective for the production of palm oil-based microemulsion products have been investigated in-house.

Glycerol *mono*-tert-butyl ether (*Figure 3*) was obtained from an in-house synthesis (Yusrabbil *et al.*, 2007a, b). It is a water-soluble compound (pH ~5 to 6) and consists of about 55%-60% glycerol *mono*-tert-butyl ether and 30%-35% unreacted glycerol.

Figure 1. Palm-microemulsion liquid cleaners.

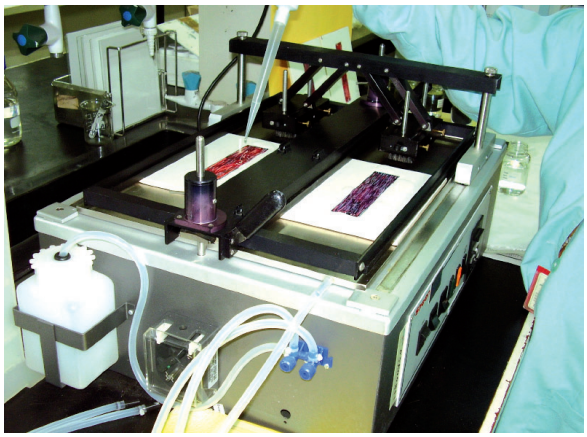

Figure 2. The detergent cleaning tester 10 (DCT 10).

Furthermore, the product has also been purified to about 75%-80% glycerol *mono*-tert-butyl ether and ~5% glycerol. The crude product was found to be non-irritant to the skin and non-toxic to fish.

A preliminary study has found that with incorporation of 10%-15% (w/w) glycerol *mono*-tert-butyl ether (≥ 60% diol), a palm oil-based microemulsion could be formed. This study indicates that glycerol *mono*-tert-butyl ether can be used as a potential alternative co-surfactant for producing palm oil-based microemulsion products such as in agrochemicals for crop care and public health sectors, liquid cleaners with natural insect repellent properties, *etc.*

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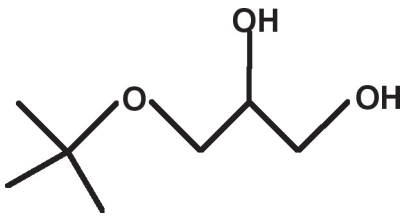

Figure 3. Glycerol mono-*tert-butyl ether [Patent P120070034].*

PROPERTIES OF PALM OIL-BASED MICROEMULSION LIQUID CLEANERS

The physical properties of palm oil-based microemulsion liquid cleaners for hard surfaces are shown in *Table 1*. The particle size, viscosity and pH values are approximately equivalent for all formulae. However, the conductivity values vary from 137 μSm to 976 μSm for 15% and 20% (w/w) of mixed surfactants, respectively. With a very small droplet size (~7.5 to 9.5 nm) and low viscosity, the solutions can be applied onto hard surfaces in diluted or concentrated forms. Thus, palm oil-based microemulsions as liquid-cleaning compositions have the potential to become a superior grease and oily soil remover chosen over powdered cleaning compositions.

CLEANING PERFORMANCE OF THE PALM OIL-BASED MICROEMULSIONS AS ALL-PURPOSE LIQUID CLEANERS

The cleaning tests (*Figure 2*) conducted on a detergent cleaning tester 10 (DCT 10) machine determined that the palm oil-based microemulsion liquid cleaners (F1 and F2) showed superior and comparable cleaning performance to a commercial liquid cleaner even after several dilutions (*Figures 4* and *5*). The products also gave longer shiny effects on the cleaned hard surfaces.

TABLE 1. PROPERTIES OF PALM OIL-BASED MICROEMULSION LIQUID CLEANERS

Formula	Conductivity (μSm)	Particle size (nm)	Viscosity (cP)	pH
F1 (15% S_A+S_B)	137	9.5	12.6	5.0
F2 (15% S_A+S_B+S_C)	919	8.8	12.7	4.8
F1 (20% S_A+S_B)	141	9.0	15.4	5.4
F2 (20% S_A+S_B+S_C)	976	7.5	15.1	5.1

Note: S_A and S_B are the ethoxylated non-ionic surfactants, and S_C is the sulphonated anionic surfactant.

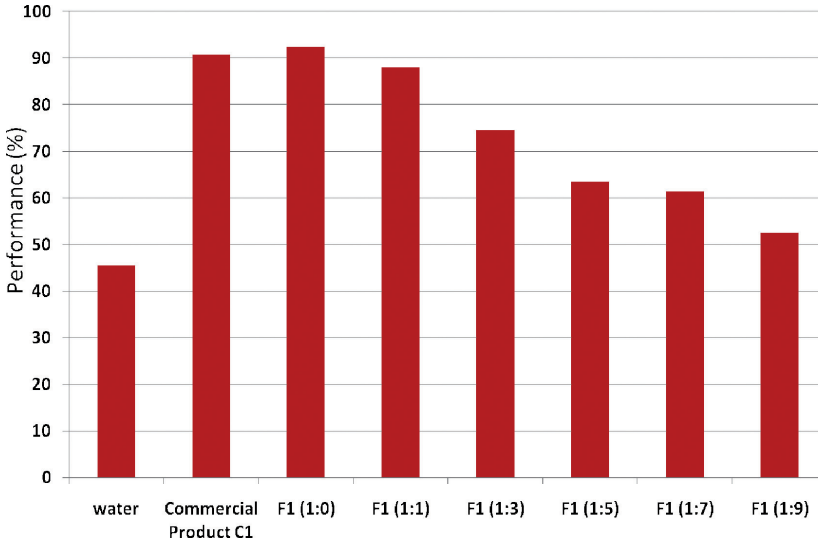

Figure 4. Cleaning performance of palm oil-based microemulsion liquid cleaners (F1) at various ratios of dilution.

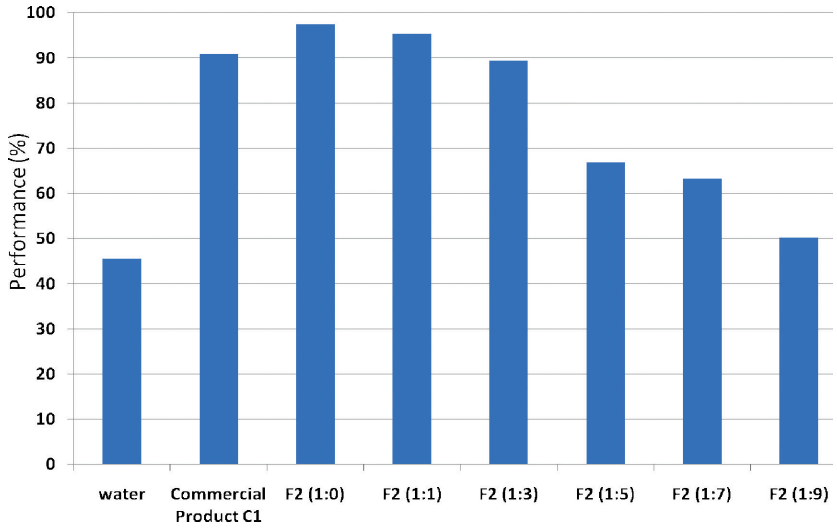

Figure 5. Cleaning performance of palm oil-based microemulsion liquid cleaners (F2) at various ratios of dilution.

ADVANTAGES OF PALM OIL-BASED MICROEMULSIONS AS ALL-PURPOSE LIQUID CLEANERS

Palm oil-based microemulsion liquid cleaners are terpene-free. Hence, the products are a viable option for use in cleaning hard surfaces due to their good cleaning performance and longer shiny effect.

Palm oil-based microemulsion liquid cleaners can be added with oil-soluble active ingredients, such as natural insect repellent, disinfectant and fragrance, which can enhance the value-addition of the products.

COST OF ANALYSIS

The cost of production (using a 5-litre small-scale reactor) for crude (~55%-60%) and purified (~75%-80%) glycerol tert-butyl ether (GTBE) is about RM 317 and RM 600 kg^{-1}, respectively. The cost of production for GTBE should be cheaper if pilot-scale or commercial-scale plants are used. *Table 2* presents the cost of production for palm oil-based microemulsion liquid cleaners by using GTBE and conventional co-surfactants.

CONCLUSION

The study found that crude GTBE (55%-60% GMTBE; 30%-35% glycerol) and purified GTBE (75%-80% GMTBE; ~ 5% glycerol) derived from palm oil-based glycerol can be used as a potential alternative co-surfactant to replace 1,2 hexanediol, the conventional co-surfactant for producing palm oil-based microemulsion products, such as the agrochemicals for crop care and public health sectors; microemulsion-spray cleaners containing natural insect repellent, *etc*.

TABLE 2. COST OF PRODUCTION FOR PALM OIL-BASED MICROEMULSION LIQUID CLEANERS

Component	% (w/w)	Crude GTBE (~RM kg^{-1})	Purified GTBE (~RM kg^{-1})	Commercial hexanediol (~RM kg^{-1})
Surfactant A + B	15.0	1.20	1.20	1.20
Palm methyl ester	8.0	0.25	0.25	0.25
Perfume	0.5	1.00	1.00	1.00
Co-surfactant	12.5	**37.50**	**75.00**	**125.00**
Water	64.0	0.25	0.25	0.25
Total	100	**40.20**	**77.70**	**127.70**

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