IMPROVED PALM-BASED MICROEMULSIONS AS ALL PURPOSE LIQUID CLEANERS

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728

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Microemulsions are normally isotropic (or clear), very small in droplet size (<100 nm), low in viscosity and are thermodynamically stable solu-tions. However, the ordinary emulsions appear as milky white dispersions with higher viscosity, droplet size of >0.5 μm and are only kinetically stable. Thus, the properties of microemulsion systems 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.

There are growing interest in microemulsion systems, which replace hydrocarbon oil with oils derived from natural resources, such as medium alkyl triglycerides and alkyl esters. Natural-based materials have many advantages, such as being renewable, biodegradable, non-flammable, harmless to the environment, and non-toxic to end-users (von Corswant and Soderman, 1998; Warisnoicharoen *et al.*, 2000; Alany *et al.*, 2000; I Ab Raman *et al.*, 2003; 2005; 2007; 2008).

The formation of microemulsions often require high concentration of surfactants, but this can sometimes be reduced by using a co-surfactant. Kahlweit (1995), Kahlweit *et al.* (1996) and Alany *et al.* (2000) found that many short-chain aliphatic alcohols as co-surfactants (*e.g.* 1-pentanol) are regarded as toxic to end-users and aquatic organisms. They found that 1,2 alkanediols (*e.g.* 1,2 hexanediol) have similar properties to aliphatic alcohols, although they are found to be less toxic, and, therefore, more suitable as substitutes for use in the formation of microemulsions.

There are numerous applications for microemulsions, for example in detergent formulations (Colgate Palmolive, 1987; Azemar, 1997). Other examples of detergent products formulated using the microemulsion system are all-purpose spray liquid cleaners for hard household surfaces (Gasco, 1997; Gross, 2004; Gross *et al.*, 2005; Ismail *et al.*, 2007; 2008; 2010; 2011a, b).

The most significant property of microemulsions used in detergent formulations is in improving the solubilisation capacity for both polar and non-polar soil compounds. This is due to the very low interfacial tension achieved between the aqueous and oil phases, and thus the spontaneous formation of microdroplets occurs when the components are brought into contact with each other. Furthermore, the mixed surfactants consisting ethoxylated non-ionic and sulphonated anionic surfactants have better synergistic effects than mixed non-ionic surfactants or single non-ionic surfactant when the palm-microemulsions were used as all-purpose liquid cleaners for household and industrial applications (Ismail *et al.*, 2007; 2008; 2010; 2011a, b).

PROBLEM STATEMENTS

The formation of palm-based microemulsions as all-purpose liquid cleaners require between 10%-15% (w/w) 1,2-hexanediol, the conventional co-surfactant, and glycerol mono-tert-butyl ether (GTBE), the purified glycerol-based diol which had been synthesised (Yusrabbil *et al.*, 2007) in Advanced Oleochemicals Technology Division (AOTD), MPOB. However, the costs for 1,2-hexanediol (AR grade) and GTBE (~80% purity) are ~RM 1500 and ~RM 700 per kg respectively. Thus, the production of palm-based microemulsions as all-purpose liquid cleaners is not commercially viable with these co-surfactants.

Therefore, other alternative co-surfactant which is cost-effective for production of palm-based microemulsions as all-purpose liquid cleaners has been further investigated and developed. This potential co-surfactant is an aliphatic short-chain alcohol, which is only ~RM 40 per litre (AR grade). The cleaning performance of the palm-based microemulsions formed with this co-surfactant as all-purpose liquid cleaners was comparable to conventional co-surfactants, the 1,2 hexanediol and GTBE. Furthermore, the palm-based microemulsion liquid cleaners can be incorporated with oil soluble ingredients, such as natural insect

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repellent, disinfectant and fragrance, which can enhance the value-addition of the products.

PROPERTIES OF PALM-BASED MICROEMULSION LIQUID CLEANERS

The technology demonstrates the application of palm-based derivatives (*e.g.* palm-based methyl esters, surfactants, mixed surfactants and co-surfactants) in the formation of microemulsions for all-purpose liquid cleaners (*Figure 1*). Several studies had been conducted several years ago and found that palm-based microemulsions have the potential to be applied as all-purpose liquid cleaners (Ismail *et al.*, 2007; 2008; 2010; 2011a, b). They had shown superior cleaning performance and giving better shiny appearance than the conventional liquid cleaners. In addition, all formulae showed good performance as cleaning solutions even after several dilutions.

Figure 1. Palm-based microemulsion liquid cleaners.

The physical properties of palm-based microemulsion liquid cleaners for hard surfaces are shown in *Table 1*. The conductivity, particles size, viscosity and pH values are approximately equivalent for all formulae. With very small droplets size (~7.5 to 8.8 nm) and low in viscosity, the microemulsion solutions can be applied onto hard surfaces in diluted or concentrated forms. Thus, the palm-based microemulsions as liquid cleaners have the potential to become superior grease and oily soil removers than powdered cleaning products.

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

The cleaning tests (*Figure 2*) were conducted by using a detergent cleaning tester 10 (DCT 10). The cleaning performance tests determined that the palm-based microemulsion liquid cleaners at 15% w/w (F1) and 20% w/w (F2) mixed $S_A/S_B/S_C$ surfactants showed superior or comparable cleaning performance to the commercial liquid cleaner even after several dilutions (*Figure 3*). The products also gave longer shining effects on the cleaned hard surfaces.

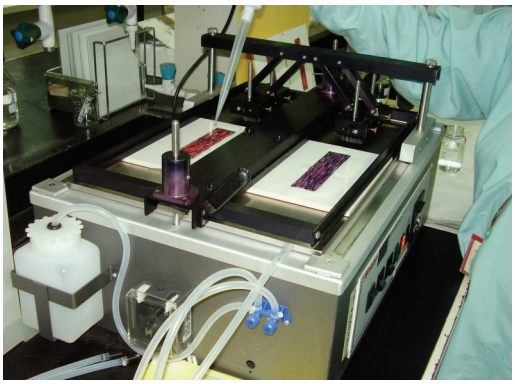

Figure 2. A detergent cleaning tester 10 (DCT 10) machine.

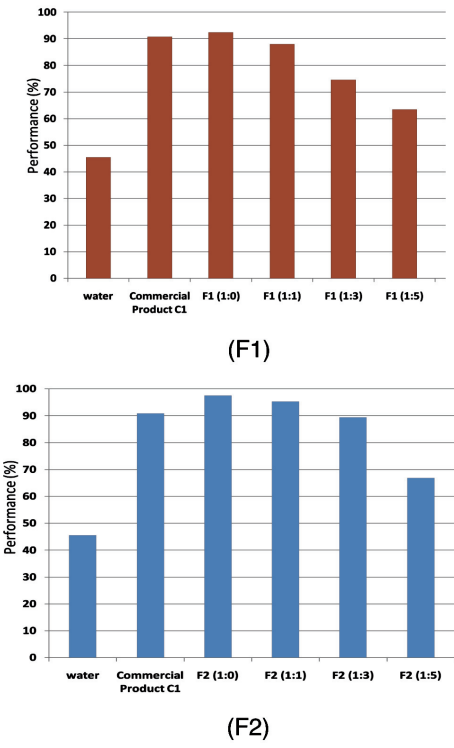

Figure 3. Cleaning performance of palm-based microemulsion liquid cleaners (F1 and F2) at various ratios of dilution.

Previous studies had also determined that mixed surfactants consisting of ethoxylated non-ionic and sulphonated anionic surfactants have better

TABLE 1. PROPERTIES OF PALM-BASED MICROEMULSION AS ALL-PURPOSE LIQUID CLEANERS

Formula	Conductivity (μSm)	Particle size (nm)	Viscosity (cP)	pH
F1 (15% S_A+S_B+S_C)	919	8.8	12.7	4.8
F2 (20% S_A+S_B+S_C)	976	7.5	15.1	5.1

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

synergistic effects than mixed non-ionic surfactants or single non-ionic surfactant when the palm-microemulsions were used as all-purpose liquid cleaners for household and industrial applications (Ismail *et al.*, 2007; 2008; 2010; 2011a, b).

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

1. Palm-based derivatives are renewable, environmental-friendly, less flammable (due to higher flash points), and cause less medical problems to end-users compared to petroleum-based solvents.
2. Palm-based microemulsion liquid cleaners are superior grease and oily soil remover than the powdered cleaning products.
3. Palm-based microemulsion spray liquid cleaners are terpene-free. Furthermore, due to its good cleaning performance and longer shining effect, the products are suitable for use in cleaning of hard surfaces.
4. Palm-based microemulsion spray liquid cleaners can be incorporated with oil soluble ingredients, such as natural insect repellent, disinfectant and fragrance which can enhance the value-addition on the products.

COST OF ANALYSIS

The costs of raw materials for producing palm-based microemulsions as all-purpose liquid cleaners are shown in *Table 2*. The estimated cost for producing palm-based microemulsions as all-purpose liquid cleaners is very much lower, *i.e.*, RM 15.25 - RM 16.89 per kg product by using the short chain aliphatic alcohol (*e.g.* 1-propanol) as the innovative and cost-effective co-surfactant compared to the purified (~75%-80%) GTBE and the conventional 1,2 hexanediol. Furthermore, the estimated cost of palm-based microemulsion liquid cleaner is also cheaper than the commercial all-purpose liquid cleaners (~RM 30 – RM 50 per kg).

CONCLUSION

This study determined that mixed surfactants consisting of ethoxylated non-ionic and sulphonated anionic surfactants have better performance than the commercial all-purpose liquid cleaners. Furthermore, the short chain aliphatic alcohol or 1-propanol has good potential to be applied as an alternative and a cost-effective co-surfactant to replace purified GTBE derived from natural-based glycerol and 1,2 hexanediol, the conventional co-surfactant for producing

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

Item	Compositions	% (w/w)	Formula with GTBE (RM kg^{-1})	Formula with 1,2 hexanediol (RM kg^{-1})	New formula with 1-propanol (RM kg^{-1})
1	Surfactants: S_A+S_B+S_C	15-20	4.9-6.6	4.9-6.6	4.9-6.6
2	Palm methyl esters	7	0.35	0.35	0.35
3	*Serai wangi*	3	4.50	4.50	4.50
4	Co-surfactant	12	72	120	4.79
5	Water-based colour	0.3	0.42	0.42	0.42
6	Distilled water	62.7-57.7	0.24-0.23	0.24-0.23	0.24-0.23
Total		100	82.46-84.10	130.46-132.10	15.25 - 16.89

palm-based microemulsion as all-purpose liquid cleaners. In conclusion, palm-based materials can be formulated into palm-based microemulsions as all-purpose liquid cleaners, which can be another platform for value addition for the oleochemical downstream industry.

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