

SYNERGISTIC EFFECT BETWEEN SODIUM LAURYL SULPHATE AND SODIUM LAURYL ETHER SULPHATE WITH ALKYL POLYGLYCOSIDE

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ABSTRACT

The performance of two palm-based anionic surfactants, sodium lauryl sulphate (SLS) and sodium lauryl ether sulphate (SLES), and a non-ionic surfactant, alkyl polyglycoside (APG) was studied. The parameters measured were critical micelle concentration, surface tension, detergency and foaming. The combination of both SLS:APG and SLES:APG both at ratio 6:4, achieved the lowest surface tension compared to SLS and SLES alone. Subsequently, the best detergency was also found at the same ratio for the SLS:APG and SLES:APG systems. These surfactant mixtures also enhanced the foam volume and stability.

Keywords: surfactant, detergency, foaming.

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INTRODUCTION

Generally, the main component for cleaners or detergents is a surfactant or mixture of surfactants (Hoffman *et al.*, 1997; Nickel *et al.*, 1995; Tamura *et al.*, 1999). Surfactants are classified according to their hydrophilic groups. Studies have indicated that combinations of anionic and non-ionic surfactants perform better than a single surfactant alone (Dal *et al.*, 2004; Goloub *et al.*, 2000) due to the chemical nature of the hydrophilic groups (Behler *et al.*, 1996). The synergism between two surfactants will affect the surfactant properties such as detergency, foaming and wetting (Tsuji, 1998).

The non-ionic surfactant, alkyl polyglycoside (APG), was reported to be biodegradable and mild, has high foaming power, high foam stability and good cleaning power (Baumann, 1990) and exhibit synergism in combination with an anionic surfactant (Rosen and Sulthana, 2001).

MATERIALS AND METHODS

Materials

Two anionic surfactants, sodium lauryl sulphate (SLS) C12-C14 with 88% active and sodium lauryl ether sulphate (SLES) C12-C14 2EO with 70% active, and a non-ionic surfactant, alkyl polyglycoside (APG) C12-C14 with 50% active, were supplied by Cognis Oleochemicals (M) Sdn Bhd.

Surface Tension Measurement

All the surfactants were soluble in water, at the concentration ranges between 0.00001% to 1% were used in this study. The 1% surfactant solutions were prepared in a standard 100 cm³ volumetric flask (w/v) and then diluted to desire concentrations. The surface tension of each individual and the mixed surfactants were measured with a Sigma S70 surface tensiometer by the Du Nouy ring technique with a precision ± 0.01 mNm⁻¹. The temperature was set at 25°C ± 0.1 °C. The surfactant CMC was determined at the concentration where the surface tension was minimum.

Foaming Power

A 500 ml cylinder was filled with 0.2 g surfactant in 200 ml deionized water. Using a perforated base

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rod, the solution was stroked 30 times at a constant rate. Foam was generated and readings taken at both its top and bottom level to estimate its volume, immediately (V_0) and 5 min later (V_5). This was to determine the foaming power and foam stability. Foam stability (percentage) was expressed as the ratio V_5/V_0 .

Detergency Test

The method used was Leenert's improved detergency test. Six pieces of glass plates were dipped for 1-2 s in a soil bath containing 10 g of ghee and soyabean oil, 0.25 g monoolein and 60 ml chloroform. The 0.1 g of Red Oil Sudan III was dissolved in the soil bath (R_a). The soiled plates were dried for 2 hr before proceeding to the next step. The plates were then soaked in 1.5 g surfactant diluted with 1000 ml water containing 59.0 ppm calcium chloride dihydrate and 27.2 ppm magnesium chloride. Using Leenert's improved detergency tester, the soiled plates were placed in a glass container and washed with speed fixed at 250 ± 10 rpm and temperature at $25 \pm 1^\circ\text{C}$ for 3 min. After washing, these plates were rinsed with water containing 59.0 ppm calcium chloride dihydrate and 27.2 ppm magnesium chloride at the same speed and temperature. The washed plates were air dried for 24 hr. To completely remove the soil, the washed plates were placed in 100 ml chloroform each. Lovibond Tintometer Colour Model E was used to determine the soil found in the chloroform (R_b) from

which the % soil removal was calculated as:

$$\% \text{ soil removal} = (R_a - R_b) / R_a \times 100$$

where R_a is the colour of the original soil bath before dipping and R_b the red colour of the soil in 100 ml chloroform.

RESULTS AND DISCUSSION

Surface Tension Measurement

A surfactant will decrease the air-water interfacial force and lower the surface tension of the system. *Figure 1* shows the surface tension versus concentration of SLS, SLES and APG. Using either SLS or SLES, the surface tensions were found higher (32.0 mNm^{-1} and 33.8 mNm^{-1} respectively) than with using APG (27.2 mNm^{-1}) because of the lower polar charge of the latter (Potter, 1994). Mixing APG in the anionic surfactants further reduced the surface tension compared by the anionic surfactants (*Figures 2 and 3*). This suggests a mixed micelle formation between the anionic and non-ionic surfactants (Zhu *et al.*, 1984; Zhang and Yin, 2005). Competition between the surfactant molecules changes the interface of the solution, causing a decrease/increase in the surface tension. A decrease would make the breaking between soil and the surface easier. The best detergency was obtained from a ratio of 6.4 SLS:APG with the surface tension recorded at 28.4 mNm^{-1} . The best detergency for SLES:APG was also obtained from the ratio 6.4 with surface tension of 29.0 mNm^{-1} .

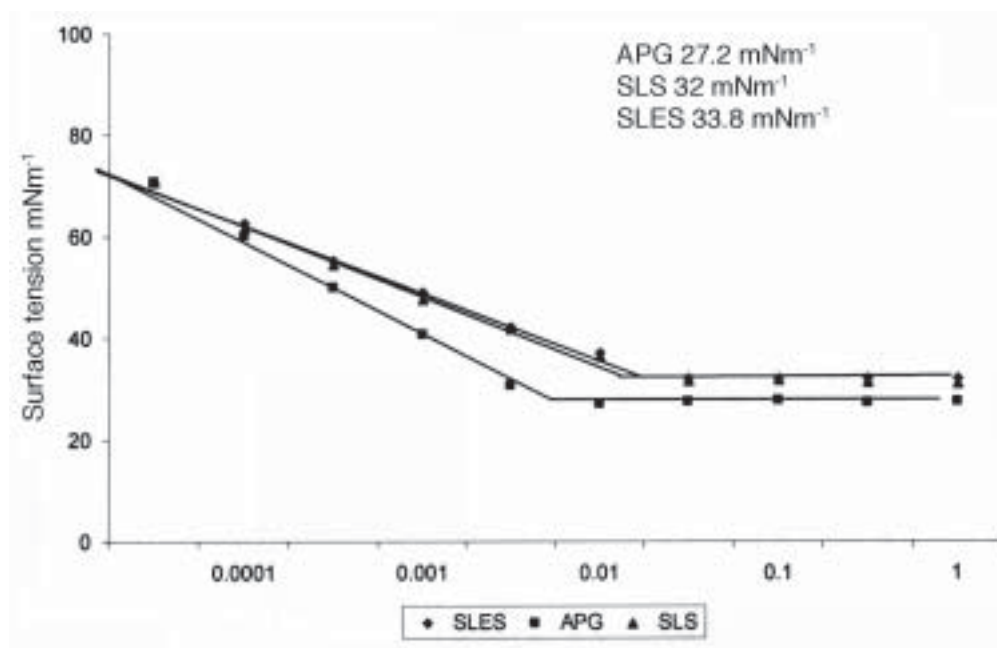


Figure 1. Surface tension versus concentration of individual surfactants.

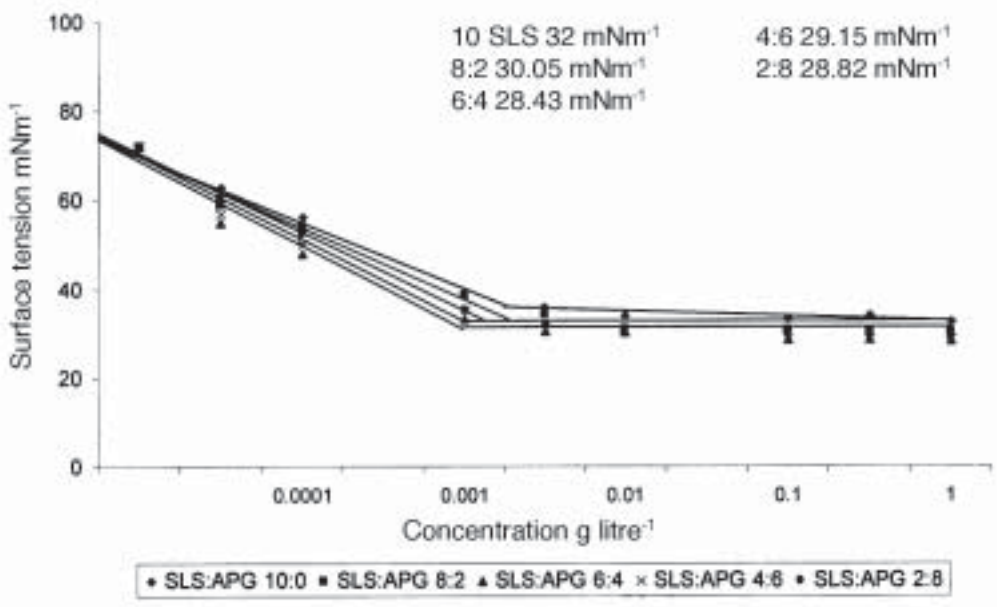


Figure 2. Surface tension by SLS:APG at different weight ratios.

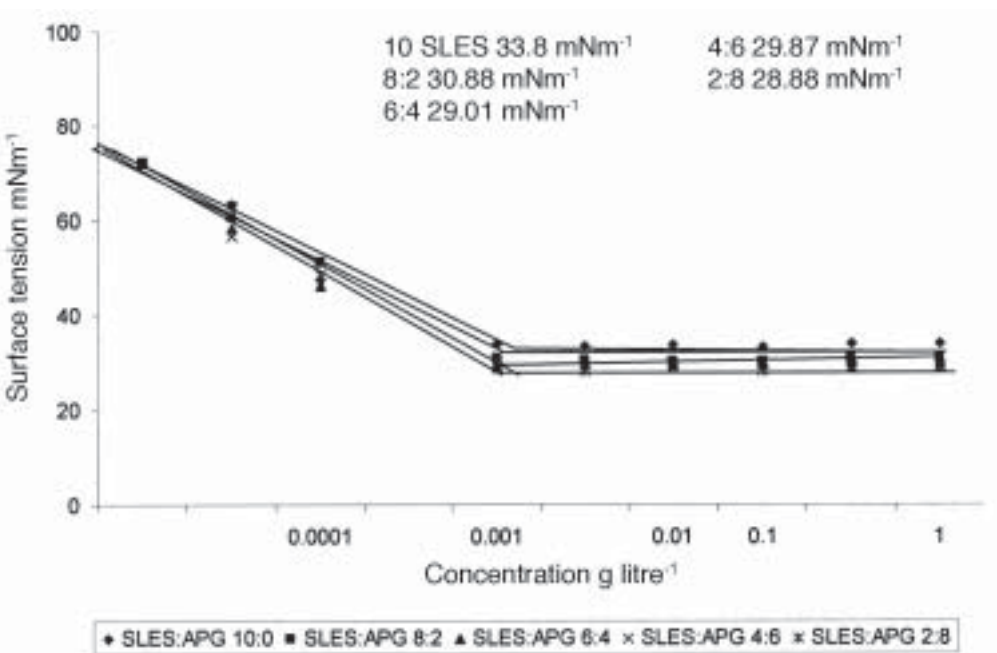


Figure 3. Surface tension by SLES: APG at different weight ratios.

Foaming

Figures 4 and 6 show that the foams by SLS and SLES alone decreased rapidly after 5 min. However, a synergistic effect was observed with addition of APG and the foam volume improved. The foaming ability of the surfactant mixtures was found to be stable compared to those of individual surfactants (Patil *et al.*, 2004). Both SLS and SLES mixtures produce comparable foaming power. The best foaming volume and foam stability was found at the ratio 6:4 for both system. It was reported that foam is stable when the surfactant is adsorbed on the air

or water interface where the molecules are arranged parallel in a lamellar structure (Anil and Wasan, 1988). Some studies have indicated that foaming is maximum at CMC, however, it would also depend on the type of surfactant, its concentration and the temperature involved (Potter, 1994). Cleaning products are often assessed by foaming as their cleaning ability although there is no relationship between them (Heitland and Marsen, 1987). In this study however, the best detergency was obtained from the surfactant ratio that also gave the highest foam volume.

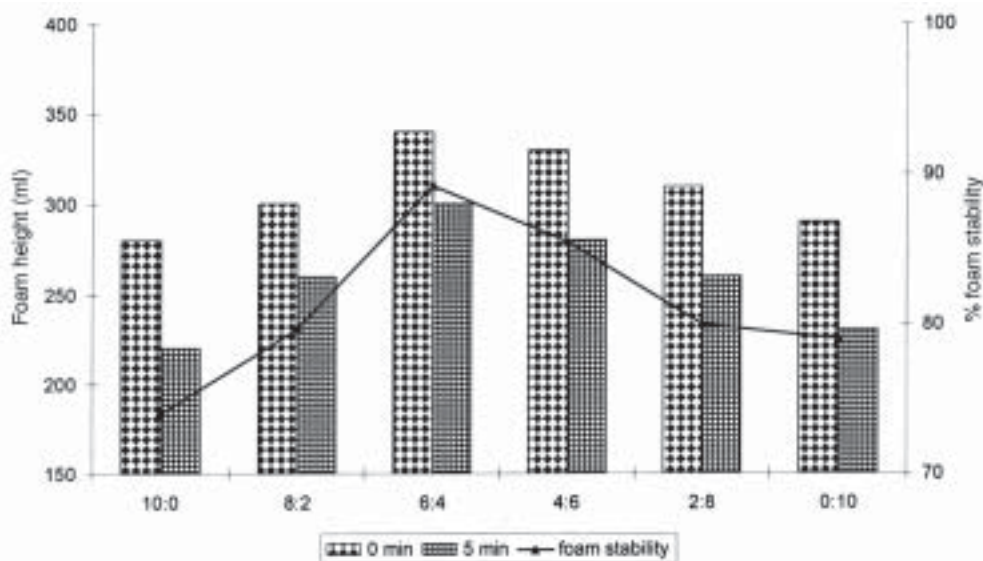


Figure 4. Foam height and stability by SLS: APG at different weight ratios.

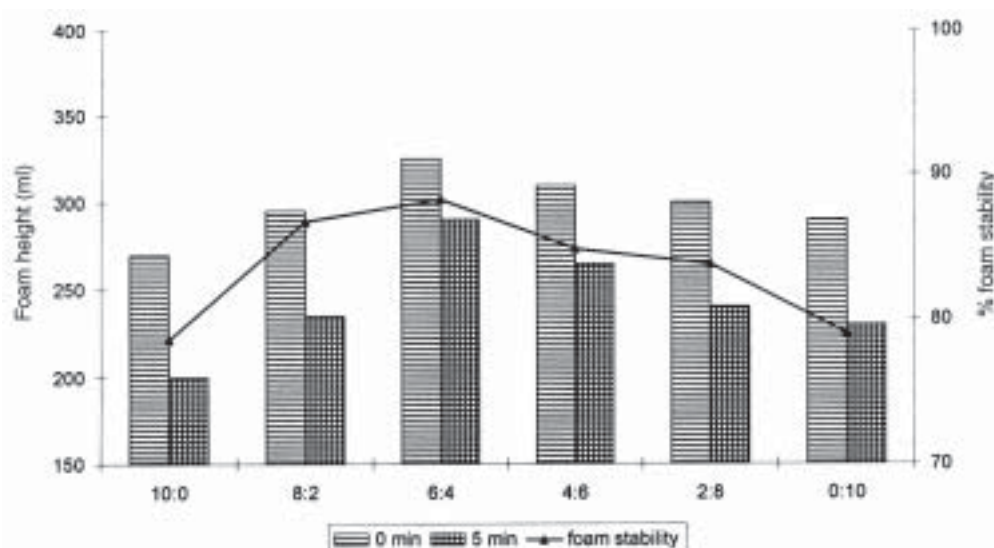


Figure 5. Foam height and stability for SLES:APG at different weight ratios.

Detergency

The detergencies of the two anionic surfactants and their combinations with the non-ionic surfactant APG were tested based on the removal of soil from glass plates. The detergencies for SLS: APG and SLES: APG were better than that of the individual surfactants. The best detergency for SLS: APG was 83.0% and 81.6% for SLES:APG. Almost all the systems achieved >70% detergency. Only 2:8 SLS/SLES:APG exhibited <70%. The enhanced detergency was due to synergy,

$$\text{Synergy} = (\text{OCD}-\text{TCD})/\text{TCD} \times 100\%$$

where OCD is the observed combined detergency and TCD the theoretical combined detergency (Kang *et al.*, 2001). The combinations were in the ratios 8:2,

6:4, 4:6 and 2:8 (Figures 6 and 7). The results indicated synergies between SLS:APG and SLES:APG at all ratios. The maximum synergistic effect was obtained at the ratio 6:4, with 26.9% and 29.5% synergy for the SLS and SLES mixtures respectively. The detergency increased with the surfactant concentration and higher detergency was obtained with the surfactants giving lower surface tension, (Figure 8), similar to the findings by Monroe *et al.* (1993) and Urum and Pekdemir (2004).

To study the effect of APG content, it was added from 2%-10%. The amount of SLS and SLES used was fixed at 6%. Results in Figure 8 show that the highest detergency for SLES:APG was obtained at ratio 6:4 with 85.0% detergency. For SLS:APG the detergency was 86.0% also at ratio 6:4. The CMC of a surfactant is the concentration at which micelles

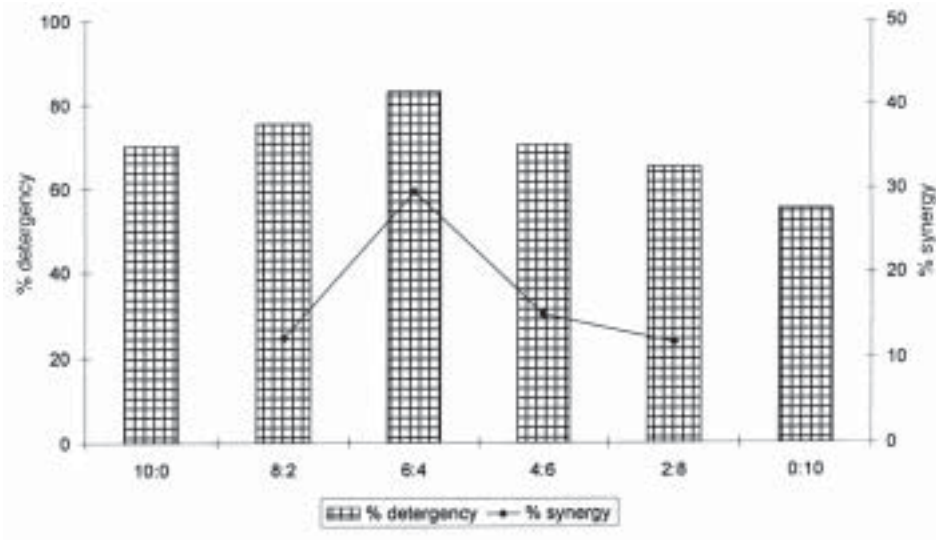


Figure 6. Detergency and synergy of SLS:APG.

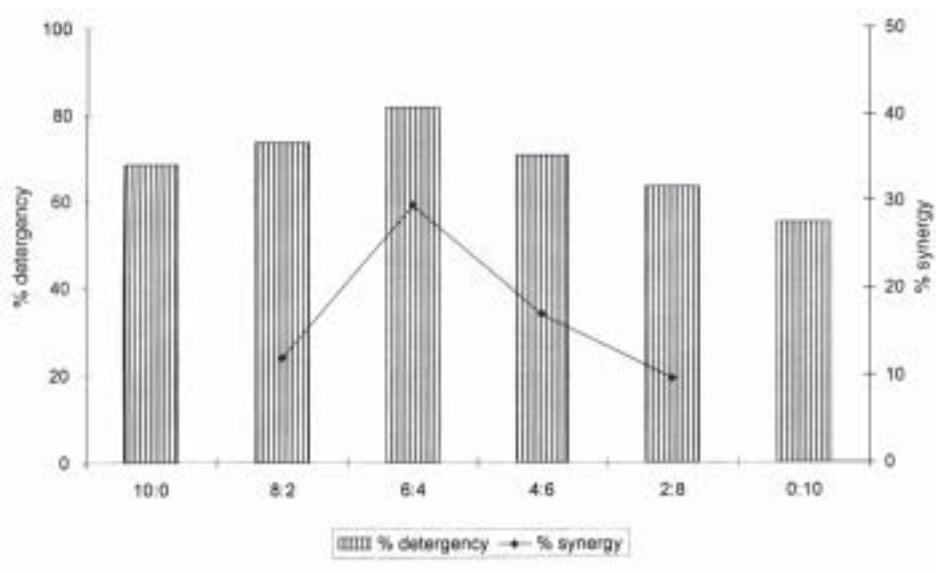


Figure 7. Detergency and synergy of SLES:APG.

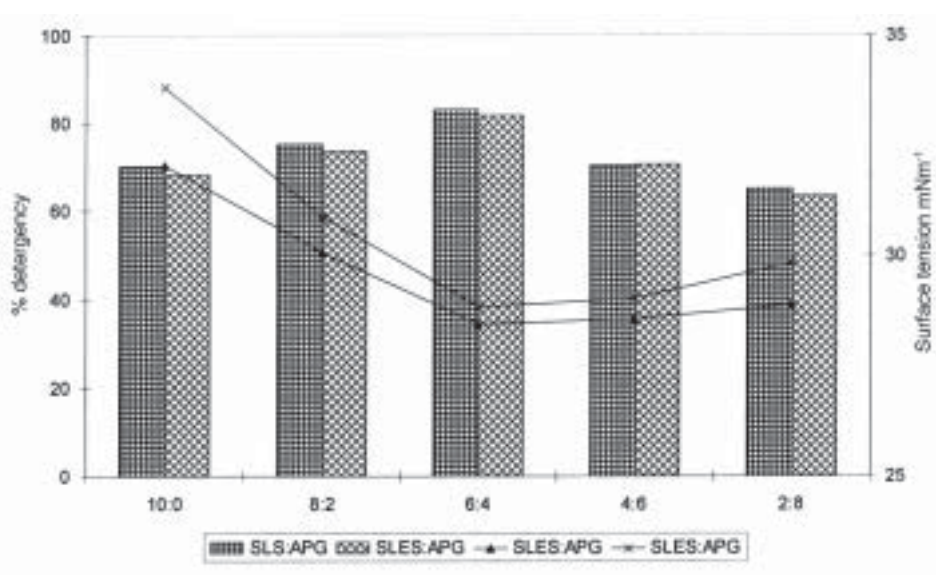


Figure 8. Detergency and surface tension of surfactant mixtures.

begin to form at the lowest surface tension. On economic grounds, as non-ionic surfactants are more expensive, incorporating less non-ionic surfactant would be more desirable.

CONCLUSION

This study showed that adding APG improved SLS and SLES foaming properties, synergism in detergency between them. A reduction in the surface tension was obtained, thus indicating that APG can be used to produce better cleaning products.

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