Palm-based Surfactants Synergy in Soap Applications

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INTRODUCTION

The α-SME is an alternative anionic surfactant to linear alkyl benzene sulphonates (LAS), fatty alcohol sulphates (FAS) and (the now maligned) branched alkyl sulphates (BAS). Historically, LAS and BAS were the workhorse surfactants for many detergent formulations. But BAS has now been banned from use by many countries due to its low biodegradation quality, leaving only LAS as the mainstay for many formulations.

In Malaysia, there is an abundance of fatty methyl esters primarily from the oleochemical companies as well as from the manufacturers of vitamin E and carotenes from palm oil. In view of this, there was an incentive to produce α-SME from palm methyl esters. In addition, with the ban on BAS in Malaysia, LAS became the primary surfactant in detergent formulations. The cost of production for LAS is higher compared to BAS and this has enticed the Palm Oil Research Institute of Malaysia (PORIM), now known as the Malaysian Palm Oil Board (MPOB), to investigate an alternative anionic surfactant to LAS. Here, α-SME can offer a price advantage, good detergency and tolerance towards water hardness.

Soap is a common and traditional surfactant that can be obtained from palm oil. It is cheap and easy to manufacture. It has a particular disadvantage, being sensitive to hard water or to high levels of calcium and magnesium salts in water. In such event, the calcium and magnesium salts of the soap will precipitate out - foaming the scum and waxy cake that clogs drains and pipes. Malaysia is one of the world's largest producers of soap noodles and it was felt that a positive synergy between α-SME and soap can enhance the use of soap.

This study originated from the curiosity if there could be a synergy in detergency performance between α-SME and palm-based soap. The following question was posed: can the performance of soap be enhanced by the addition of α-SME?

MATERIALS AND METHODS

Soaps (C8 and C10) were obtained from Derichem (Malaysia) Sdn. Bhd., while C12, C14, C16, C18 soaps were obtained from Cognis Oleochemicals (Malaysia) Sdn. Bhd. The α-SME from palm stearin, 94.4% active ingredient, supplied by Chemithon Corporation of USA was used as received. Individual chain lengths of C10, C12, C14, C16 and C18 α-SME were prepared from the corresponding methyl esters. Detergency measurements were conducted on AS-9 swatches (stained with groundnut oil, pigments and stabilizers on cotton cretonne). These swatches were obtained from Westlairds, United Kingdom. The reflectance (whiteness) of the soiled swatches was measured using Macbeth Colour - Eye 3000. A solution of 250 ml of 1 g dm^{-3} surfactant solution was charged into the Terg-O-Tometer stainless steel drums and allowed to reach the desired temperature of washing. Four swatches of soiled AS-9 were placed in each drum containing the detergent solution. The washing was conducted for 10 min at 120 rpm. Upon completion, the liquor was decanted; the swatches were squeezed to remove any remaining liquor and then returned to the drums with an additional 250 ml distilled water. The rinsing was conducted for 3 min at 120 rpm, and this rinsing was executed twice. Following that, the swatches were dried by spinning for 1 min in a commercial dryer and then ironed. The reflectance of these washed-swatches was measured. The detergency of soil removal was calculated using the following formula:

$$\% \text{ Soil removal} = [AW-BW] / [OC-BW] \times 100\%,$$

where AW is the reflectance of the swatches after watching, BW is the reflectance of the swatches before washing, and OC is the reflectance of the original cloth before soiling.

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RESULTS AND DISCUSSION

The α-SME from palm stearin was combined with soap noodles produced by Derichem and Cognis in Malaysia and the detergency was evaluated. It was found that the mixtures exhibited detergency as the sum of their parts *(Figure 1)*. The anticipated synergy did not manifest. A possible explanation was that the synergy was masked

Palm-based soaps.

between pure cuts of α-SME of C12, C14, C16 and C18 with soap of the chain lengths of C12, C14, C16 and C18. The combinations were done in the ratio of 70:30, 50:50 and 30:70 *(Figure 4)*. *Figure 5* illustrates the synergy obtained between the combination of C12 soap with C16 α-SME and that of C16 soap with C12 α-SME. It was observed that the detergency was much higher than the sum of the parts of α-SME and soap alone. This is illustrated by the synergy on the same graph. Incidentally, the combination of C16 soap with C12 α-SME showed a much lower synergy.

by the presence of various chain lengths of surfactant as well as the presence of disalt (from the α-SME). It is well known that the detergency of a particular surfactant is dependent on the particular chain length.

In view of the lack of synergy in detergency, pure cut α-SME was prepared from the corresponding fatty methyl esters. All α-SME obtained had a very low disalt content (0%-1%). *Figure 2* indicates the detergency of pure α-SME at two different levels of water hardness. The C16 α-SME indicates the highest detergency at 50 ppm water hardness while C14 and C16 α-SME exhibit primarily the similar detergency at 350 ppm water hardness.

When α-SMEs and soaps were combined in the ratio of 70:30, 50:50 and 30:70 and their detergency at 50 ppm water hardness were measured, certain combinations showed enhanced detergency that could not be explained by the sum of detergency associated with soap and α-SME. This enhanced detergency was displayed as synergy. All combinations exhibited synergy with the exception of C12:C18 α-SME and C14:C16 α-SME *(Figure 3)*.

Investigation into the synergy between α-SME and soap was conducted with the combination

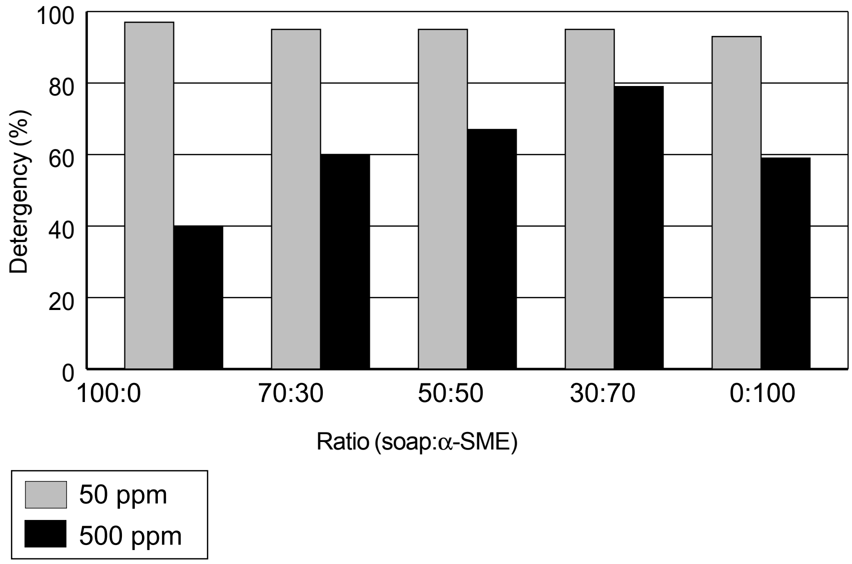

Figure 1. Detergency of soap and α-SME palm stearin on AS 9 cloth at 50 and 500 ppm water hardness with surfactant concentration of 1%.

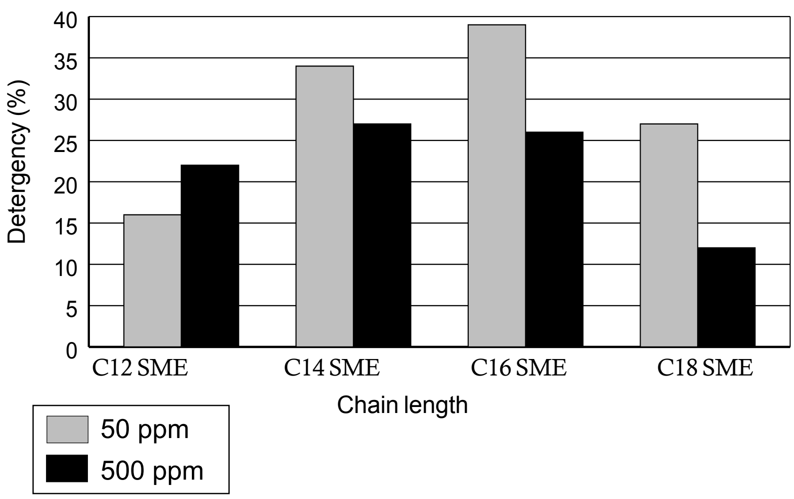

Figure 2. Detergency of pure and α-SME palm stearin on AS 9 cloth at 50 and 500 ppm water hardness with surfactant concentration of 1%.

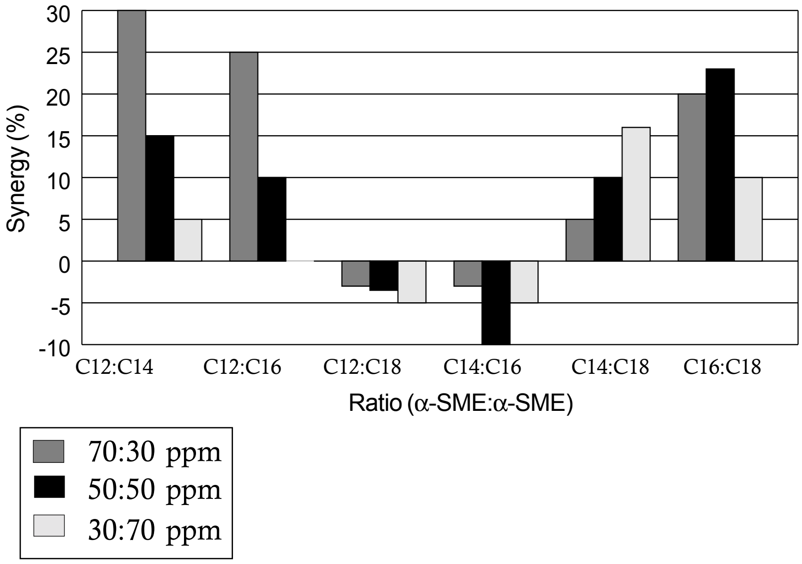

Figure 3. Synergy between two different chain lengths of α-SME at room temperature and at 50 ppm water hardness.

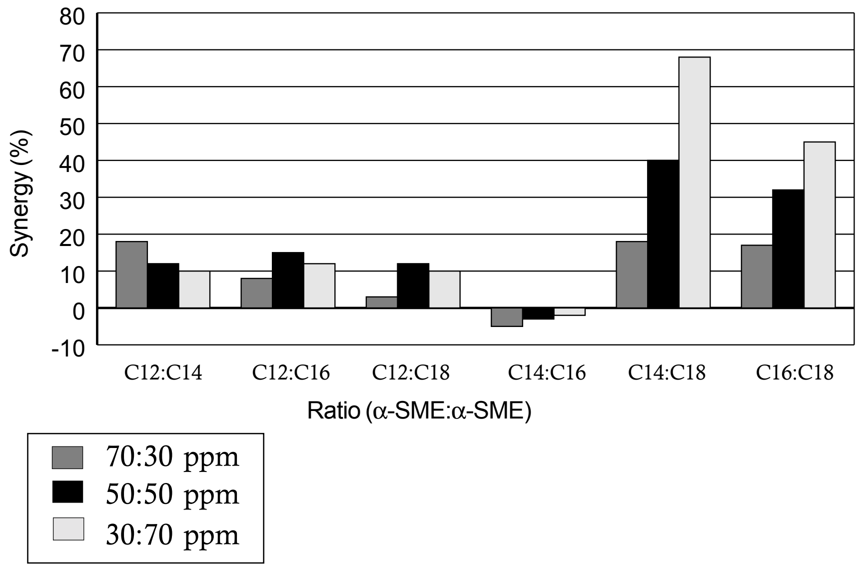

Figure 4. Synergy between two different chain lengths of α-SME at room temperature and at 350 ppm water hardness.

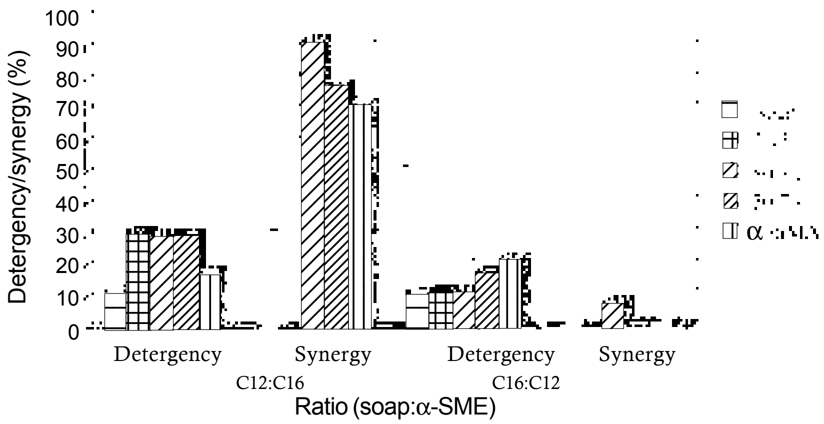

Figure 5. Detergency and synergy at room temperature and at 350 ppm water hardness.

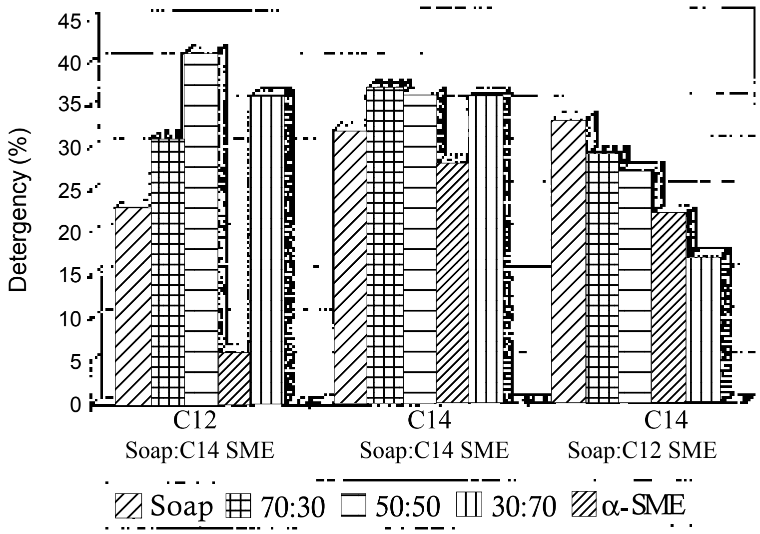

Figure 6. Detergency of C12 soap/C14α-SME, C14 soap/C14α-SME and C14 soap/C12α-SME at 50 ppm water hardness.

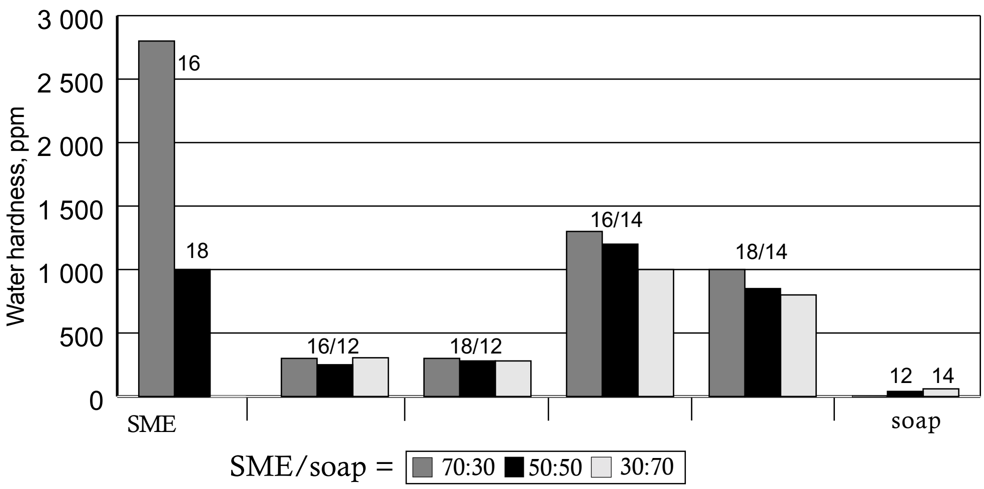

Figure 7. Water hardness tolerance of α-SME and soap at various ratios and chain lengths.

Figure 6 indicates an example where the combination of C12 soap and C14 α-SME had better detergency compared to C14 soap with C14 α-SME, which in turn had better detergency than C14 soap with C12 α-SME. The exact factor(s) influencing the synergy is currently being investigated.

In addition to the improved detergency observed in a soap and α-SME formulation, there is an added advantage in the form of improved water hardness tolerance for soap. This is exhibited in *Figure 7*.

CONCLUSION

A positive deflection for the synergy indicates a better than expected detergency based on the sum of the parts. In this case, addition of soap to α-SME improves the detergency of either surfactant component. For example, addition of 30% C12 α-SME to C16 soap improved the detergency and it displayed a synergy of above 90%.

Soap is a traditional surfactant and it is easy to produce. The abundance of palm oil in Malaysia led to the growth of the oleochemical industry and consequently to Malaysia being the world's largest producer of soap noodles. The reason why soap has not been used more extensively in detergent purposes is due to its lack of tolerance to hard water. Third World countries in particular, especially in the Asean region and China, have access to hard water. Hence, soap is not the best surfactant for laundry use under such conditions.

MPOB has been exploring the possibility of producing α-SME from palm oil for a number of years. The relative ease compared to LAS production, hardness tolerance and biodegradability, makes α-SME a candidate to replace LAS. In addition, palm-based α-SME is from a renewable resource.

As described in this paper, a formulation of soap and α-SME produces a synergy in detergency that exceeds the sum of its parts. Not only is the performance of the surfactants enhanced, but additionally an improved hardness tolerance is displayed.

In view of this, the hardness tolerance of soap can be improved dramatically on the addition of α-SME. Compared to LAS, it is relatively cheap to produce α-SME. Hence, in addition to the improved detergency that α-SME lends to soap, it is also a cheap product to produce.

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REFERENCE

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